Fifth ASEAN STATE OF THE ENVIRONMENT REPORT

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Fifth ASEAN State of the Environment Report

The ASEAN Secretariat
Jakarta

The Association of Southeast Asian Nations (ASEAN) was established on 8 August 1967.
The Member States are Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam.
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Message from the Secretary-General of ASEAN

The Association of Southeast Asian Nations (ASEAN) is proud to present the 5th ASEAN State of Environment Report (SOER5) in conjunction with the celebration of the Golden 50th Anniversary of ASEAN in 2017.

SOER5 is part of ASEAN's continuous efforts to build a body of knowledge and collective responses to issues concerning the environment in ASEAN. Focusing on the ASEAN region, SOER5 is designed to complement the existing United Nations Environment (UN Environment)'s Global Environment Outlook series. SOER5 presents information on the state of, trends in, prospects for the environment in ASEAN both at regional and global context; and actions taken at the national and regional levels to address environmental issues. It also identifies challenges and opportunities for ASEAN to contribute to addressing global environment issues in view of the ASEAN Community Vision 2025 and the 2030 Agenda for Sustainable Development.

SOER5 emphasises that profound changes and developments, such as growing population and rapid urbanisation, continue to pose significant pressures on socio-economic systems and the environment in ASEAN. The Report also shows that strong commitment and significant progress have been made to promote and ensure balanced social development and environmental protection for the benefit of the people in our region.

However, a lot more could be done and be coordinated at national, regional and global levels to support ASEAN's vision of sustainable environment. It is our hope that SOER5 will give a renewed impetus to the ASEAN environment cooperation process. With collective resolve for the protection and conservation of the environment, ASEAN will go a long way to enhance the sustainable management of the environment for our next generations.

I would like to express my sincere appreciation to all those who have been involved in the preparation of this insightful report, to ASEAN Member States for their continued support in providing data, insights, and oversight. My sincere thanks also go to UN Environment, the Government of Japan, and Hanns Seidel Foundation for their generous financial support for this publication.

LE LUONG MINH

Secretary-General of ASEAN

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Acronyms and Abbreviations

AADMER	ASEAN Agreement on Disaster Management and Emergency Response
AATHP	ASEAN Agreement on Transboundary Haze Pollution
ACB	ASEAN Centre for Biodiversity
ADB	Asia Development Bank
AEC	ASEAN Economic Community
AIESC	ASEAN Initiative on Environmentally Sustainable Cities
AIFS	ASEAN Integrated Food Security
AJCSD	ASEAN-Japan Chemical Safety Database
AMAF	ASEAN Ministers of Agriculture and Forestry
AMCAP	ASEAN Minerals Cooperation Action Plan
AMS	ASEAN Member State
AOSRAP	ASEAN Oil Spill Response Action Plan
APAEC	ASEAN Plan of Action on Energy Cooperation
APFP	ASEAN Peatland Forest Project
APSC	ASEAN Political Security Community
ASEAN	Association of Southeast Asian Nations
ASCC	ASEAN Socio-Cultural Community
ASGM	Artisanal and small scale mining
ASPA-WRM	ASEAN Strategic Plan of Action on Water Resources Management
ASPEN	ASEAN Strategic Plan on the Environment
AWGESC	ASEAN Working Group on Environmentally Sustainable Cities
BOD	Biochemical oxygen demand
CBD	Convention on Biodiversity
CCA	Climate Change Adaptation
CCS	Carbon Capture and Storage
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLMV	Cambodia, Laos PDR, Myanmar, Viet Nam
DENR	Department of Environment and Natural Resources (Philippines)
DO	Dissolved Oxygen [levels]
DOE	Department of Environment (Malaysia)
DPSIR	Drivers, Pressures, State, Impacts and Response assessment framework
DRR	Disaster Risk Reduction
EEZ	Exclusive Economic Zone
EMB	Environmental Management Bureau (Philippines)
ESC	Environmental Sustainable Cities

EEA	European Environment Agency
EPD	Environmental Protection Division
ETS	Early Turnover Scheme
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign Direct Investment
GCCSI	Global Carbon Capture and Storage Institute
GDP	Gross Domestic Product
GEC	Global Environment Center
GHG	Greenhouse Gas
GIZ	German Association for International Cooperation
GW	Gigawatt
HDI	Human Development Index
HMS	ASEAN Sub-regional Haze Monitoring System
IAS	Invasive Alien Species
IEA	International Energy Agency
INDC	Intended Nationally Determined Contributions
IWRM	Integrated Water Resources Management
IUCN	International Union for Conservation of Nature
IUU	Illegal, Unreported, and Unregulated [fishing]
JCEC	Japan Coal Energy Centre
LECZ	Low Elevation Coastal Zone
MW	Megawatt
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MRC	Mekong River Commission
MSW	Municipal Solid Waste
MTOE	Million Tonnes of Oil Equivalent
OECD	Organization for Economic Co-operation and Development
PCD	Pollution Control Department (Thailand)
PCEEP	Philippines-Chiller Energy Efficiency Project
PEPP	Philippine Environment Partnership Program
PM	Particulate Matter
PSR	Pressure, State, Response assessment framework
RCEP	Regional Comprehensive Economic Partnership
RCP	Representative Concentration Pathway
SDG	Sustainable Development Goal
SOC	Soil Organic Carbon
SPD	Sustainable Port Development
SUPA	Sustainable Use of Peatland and Haze Mitigation in ASEAN
UNEP	United Nations Environmental Programme

UN-Habitat	United Nations Human Settlements Programme
VOC	Volatile Organic Compounds
WHO	World Health Organization
WQI	Water Quality Index
WRM	Water Resource Management
WTE	Waste-to-Energy

Executive Summary

Since the last the publication of the Fourth ASEAN State of the Environment in 2009, the ASEAN region has undergone significant changes. These changes have happened not only in economic sense, but also socio-demographic and physical (environmental) aspects.

With Gross Domestic Product (GDP) of US$2.4 trillion, today ASEAN is the sixth-largest economy in the world. Economic growth in ASEAN has been steady at about 5% annually since 2010, after recovering from the global and regional financial crisis in 2008. With an average annual growth rate of 7%, Cambodia, Lao PDR, Myanmar and Viet Nam (CLMV) outperformed ASEAN6 in economic development. The advance of the ASEAN Economic Community in 2015, where ASEAN is moving towards a globally competitive single market and production base, with a free flow of goods, services, labour, investments and capital across the 10 ASEAN Member States (AMS), has further increase trade and investment in the region.

On the demographic aspect, ASEAN has seen a general increase in population throughout the region. Collectively, the population of the ten AMS has grown from 544.4 million people in 2004, to 628.9 million people in 2015. This increasing population has been coupled with rapid expansion of urban areas. The current urban population in ASEAN accounts for about 47% of the total population and it is expected to reach 63% by 2050. Singapore, Brunei and Malaysia are already highly urbanised, with more than 75% of the population living in urban areas. While Indonesia and Thailand are usually considered to have a predominantly rural population, this has changed as both countries currently have almost half of their people now living in urban areas. All AMS except for Cambodia are expected to have more than half of their population living in cities by 2050.

ASEAN's regional climate is influenced by maritime wind systems, which originate in both the South China Sea and the Indian Ocean, therefore the ASEAN region is affected by the El Niño and La Niña phenomena that often alters the seasonal monsoon cycle and causes wide-ranging changes in weather patterns. Also given its location on the convergent boundaries of the Earth's tectonic plates and on the typhoon belt, the ASEAN region is also exposed to various natural hazards including earthquakes and tsunamis, volcanic eruptions and typhoons. The ASEAN region also experiences periodic and seasonal episodes of both floods and droughts. In fact, in ASEAN, the most common disasters are floods, tropical storms and landslides. During the dry summer season, the ASEAN region experiences intense smoke haze and air pollution that is heavily influenced by the monsoon wind patterns. The frequency and intensity of hydro, meteoro- and climatological disasters has been increasing over the last 50 years particularly compared to geophysical disasters, at least in part due to the impact of climate change on disaster frequency and intensity. Economic losses have dramatically increased in recent decades, particularly in Thailand and the Philippines. For example, Thailand suffered over US$ 45 billion in economic loss and damage as a result of the prolonged, nation-wide, flood in 2011. In 2013, Typhoon Haiyan (Yolanda) caused US$ 10 billion in loss and damages.

These changes have posed significant pressures to various natural resources and environmental systems. The Fifth ASEAN State of the Environment Report (SOER5) attempts to capture these changes and its impacts to reflect on the state of the environment in this region. SOER5 follows the drivers-pressures-states and trends-

impacts-responses model (DPSIR). This model states that the pressure from human activities on the environment causes the state (condition) of the environment to change thus requiring a response that affects human activities and the state of the environment as well.

Analysis of the state of atmosphere in the ASEAN region reveals that air pollution levels are increasing in the region with the energy sector being responsible for the largest carbon dioxide emissions and it is predicted that energy-related CO2 emission levels could rise in the ASEAN region by 61% from 2014 to 2025. As significantly urbanising region, cities are major sources of greenhouse gases, and therefore ASEAN cities need to urgently seek low-carbon economies, infrastructure and transport. There is also a need for improved air quality monitoring and standards which are consistent across all AMS, so that air quality trends can be more adequately observed and acted upon. Transboundary haze pollution resulting from land and forest fires in the ASEAN region is a persistent challenge, and impacts most of ASEAN Member States (AMS). Up to 90% of transboundary smoke haze in ASEAN is linked to peat fires related to expansion of large-scale commercial plantations. While responses are in place to tackle the haze pollution, more holistic measures are needed to address the issue at its source by improved land management and controls on the expansion of commercial plantations.

In the ASEAN's land system, between 1990 and 2012, most ASEAN Member States (AMS) experienced a decline in forest cover mainly due to the expansion into forest lands of commercial plantations, particularly for rubber and oil palm. Peat and mangrove forests are the most vulnerable forest types and are disappearing at a faster rate than other forest types. This is of significant concern for climate change mitigation due to the high carbon sequestration capacity of these forest types. Land erosion and soil fertility loss from forest conversion continues to be urgent concerns that need to be addressed in policy and therefore an updated study of soil status within the region is needed.

The ASEAN region is a major contributor to global biodiversity, containing four of the world's 34 biodiversity hotspots and three mega-diverse nations. Biota and ecosystems of all types are under threat in the region from various pressures including deforestation and other land-use changes, habitat degradation and alteration, invasive alien species, genetic erosion, and over-exploitation of certain wildlife species. The economic growth-driven development of the ASEAN Member States (AMS) is fuelling most of the increase in natural resource exploitation and ensuing biodiversity loss. Biodiversity loss and ecosystem degradation have substantial impacts on people's livelihoods, food security, and well-being in the region. The importance of ecosystem and biodiversity conservation is increasingly recognized in the region. AMS have taken measures at international, regional and national levels to respond to biodiversity loss and ecosystem degradation and have reported progress, nevertheless there remains much to do to counter current trends of biodiversity loss in ASEAN.

ASEAN's freshwater system experiences pressure as water demand is expected to increase by about one-third by 2025 and double during the latter half of the 21st century, resulting in increased water stress and water insecurity across the ASEAN region. Most ASEAN Member States (AMS) have made significant progress in improving access to safe drinking water and sanitation facilities, except Cambodia and Indonesia where about half of the population still lack access to safe drinking water. The main threat to water availability and water quality in most AMS is poor management, coordination and awareness. Rapid urban development and poor spatial planning leads to encroachment

of the built environment into flood-prone areas and serious degradation of catchments. Climate change adds a level of uncertainty to water availability and leads to increasing frequency and intensity of extreme flood and drought events in the region. It also causes alteration of river flow regimes, loss of wetlands and floodplains, and salinity intrusion in river deltas due to sea level rise. Low wastewater treatment levels for a growing population, as well as the dumping of personal and industrial wastes, are contaminating various water sources and considerably reducing the quality of freshwater, which is leading to increased exposure to human health and environmental risks.

Coasts and oceans in ASEAN region boast rich resources, however these resources are currently under pressure as they are overfished and degraded. Key ecosystems such as coral reefs, mangroves, and seagrass meadows are under threat from overexploitation and climate change. Coastal development is increasingly affecting the health of the seas; marine debris pollution is a serious issue alongside climate change and overfishing. Climate change and subsequent sea-level rise will have deep impacts on the productivity of coasts and oceans in ASEAN, affecting the well-being of coastal inhabitants while poverty among the rising coastal populations continues to be of significant concern. For preserving coastal resources, ongoing regional innovations in marine protected area management, no-take reserves and community-based coastal resources management can potentially reverse these trends.

As economy grows rapidly in ASEAN, the patterns of production and consumption show an increasingly unsustainable trend across the ASEAN region. Although efficiency and productivity are increasing, improved waste and chemicals management is needed across the ASEAN region. Resource use continues to rise upwards in line with rapid urbanization and industrialization. The rising amounts of waste and its management poses a serious challenge for most AMS, especially plastic bags, e-waste and food waste. Landfill is still the main disposal method, however 3Rs and waste-to-energy have become popular in the region. The use of pesticides continues to rise in the agricultural sector and is one of the biggest chemical management challenges in the ASEAN region. Some banned chemicals are still being used. There are already existing innovations to address issues in production and consumptions in ASEAN such as green/sustainable public procurement (GPP/SPP) and ecolabeling, and these need to be expanded and developed further for more sustainable consumption and production in ASEAN.

ASEAN Member States, both nationally and collectively under the ASEAN cooperation framework, made significant efforts in responding to the environmental challenges. However, a lot more could be done in order to achieve 'a sustainable community that promotes social development and environmental protection through effective mechanisms to meet the current and future needs of our peoples', as envisioned in ASEAN Community Vision 2025. The report recommends that it is very important for ASEAN and relevant stakeholders concerned with the state of the environment in ASEAN to ensure: 1) enhanced cross-sectoral/cross-pillar/integrated coordination mechanisms; 2) effective and timely monitoring and evaluation systems; 3) better prioritization and implementation mechanisms; 4) higher commitment and resource mobilization especially to have more systematic and timely collection and analysis of data and information; and 5) closer synchronization and increased synergy between SOER and ASEAN Strategic Plan on Environment.

This 5th ASEAN state of the environment report provides policymakers and relevant stakeholders with key information and facts to make informed decisions and develop

strategies on addressing pressures and impacts to environmental systems in respective context. It is also essential to realise that many of these pressures and impacts are interlinked, therefore a systemic view is deemed necessary to consider in important decisions. Addressing these pressures and impacts will also contribute to the achievement of ASEAN Community Vision 2025, Sustainable Development Goals under the 2030 Agenda for Sustainable Development, and many other global commitments.

Section 1
Regional Context and Priorities

Section 1: Regional Context and Priorities

1. Introduction

This section provides an overview of the ASEAN region, describing the key patterns and trends in regional socio-economic and environmental issues, and highlights the potential risks and challenges to sustainable development.

ASEAN State of the Environment Reports

ASEAN publishes its State of the Environment Report (SOER) periodically. The First ASEAN SOER was published in 1997, covering the then seven ASEAN Member States (AMS). Three years later, the Second ASEAN SOER was published, covering all of the current ten AMS. The Third SOER was released in 2006. This Fifth ASEAN SOER (2017) (SOER5) follows the Fourth SOER (2009) which was released in 2010.

Framework and Organization of the Fifth ASEAN State of the Environment Report 2017

SOER5 follows the Driving force – Pressure – State – Impact – Response (DPSIR) model. This model states that the pressure from human activities on the environment causes the state (condition) of the environment to change thus requiring a response that affects human activities and the state of the environment as well.

SOER5 aims to support the continued development of a robust regional institutional and policy framework for ASEAN to effectively implement its mandate, ensure better coordination among the various sectors and the three community pillars (see above), and support regional efforts for coordinated actions at the national level to realize the purposes of the ASEAN Charter.

SOER5 highlights the key challenges for the ASEAN region by analyzing the state and trends of social, economic and environmental conditions and looking in-depth at six thematic areas i.e. atmosphere, land, biota and ecosystems, fresh water, coasts and oceans, production and consumption.

Structure of the report

SOER5 has three sections.

Section 1 provides an overview of the regional context and priorities. It has two subsections: 1.1 describes regional trends in environment and development patterns since the last SOER in 2009 and highlights potential risks and opportunities for sustainable development; 1.2 highlights the most pressing environmental issues facing the ASEAN region, and identifies gaps in policy and implementation and opportunities for change.

Section 2 includes the following six thematic chapters as follows:

Chapter 2.1: Atmosphere – air and climate. This chapter looks at the situation of air quality and pollution in the ASEAN region and describes efforts to reduce air pollution and to mitigate climate change. Poor air quality, driven by increased urbanization, industrialization, transport and energy, is causing long-term and wide-ranging health and economic impacts in the ASEAN region.

Chapter 2.2: Land. This chapter explores the status of land and forest resources, and the drivers and pressures in the ASEAN region that affect their quality and availability. A variety of socioeconomic factors, in particular, global and regional food demands and changes in regional consumption patterns are placing pressures on land and forest resources, particularly soil fertility.

Chapter 2.3: Biota and ecosystems. This chapter explores the status and trends of biota and ecosystems in the ASEAN region, and the variety of pressures and threats to biodiversity and ecosystems. Despite covering only 3% of the Earth's land, the ASEAN region has a rich biodiversity with exceptionally high level of species endemism. This rich biodiversity and the associated ecosystem services contribute to agriculture, food security and the livelihoods of millions of people, and the preservation of indigenous cultures.

Chapter 2.4: Freshwater. This chapter looks at the water situation in the AMS that are facing a number of challenges related to water quality and sanitation, water-related disasters, and weak governance. Water demand in the ASEAN region is expected to increase by about one-third in 2025 and double during the later half of the 21st century to serve urbanization and economic development needs.

Chapter 2.5: Coasts and oceans. This chapter looks at the status of coastal and ocean resources and the threats posed by overfishing and degradation caused by overexploitation and climate change. ASEAN has some of the longest coastlines and richest ocean resources in terms of marine biodiversity, including mangrove areas, coral reefs and seagrass beds, alongside a productive fisheries industry.

Chapter 2.6: Production and consumption. This chapter analyses the state and trends of sustainable production and consumption focusing on resource efficiency, process efficiency, waste management, and chemicals management.

Section 3 provides key policy recommendations and ways forward. It points out some of the priority actions that need to be taken by ASEAN to address the challenges faced by the regional environment sector in a more concerted, effective and timely manner.

2. Regional context and priorities

Box 1. About ASEAN

The Association of Southeast Asian Nations, or ASEAN, was established on 8 August 1967 in Bangkok, Thailand, with the signing of the ASEAN Declaration (Bangkok Declaration)[1]. The ASEAN Member States are Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam (see Figure 1).

At the 9th ASEAN Summit in 2003, the ASEAN Leaders adopted the Declaration of ASEAN Concord I[2] comprising three pillars, namely ASEAN Political-Security Community (APSC), ASEAN Economic Community (AEC), and ASEAN Socio-Cultural Community (ASCC) that would be closely intertwined and mutually reinforcing, for the purpose of ensuring durable peace, stability and shared prosperity in the ASEAN region.

At the 27th ASEAN Summit on 22 November 2015, the ASEAN Leaders welcomed the formal establishment of the ASEAN Community 2015 on 31 December 2015, which is a culmination of a five-decade long effort of community building since the signing of the Bangkok Declaration in 1967.

Concurrently, the ASEAN Leaders adopted the ASEAN 2025: Forging Ahead Together[3], that charts the future direction of the ASEAN Community into the next decade. It is a forward-looking roadmap that articulates ASEAN goals and aspirations to realise further consolidation, integration and stronger cohesiveness as a Community. ASEAN is working towards a Community that is politically cohesive, economically integrated, and socially responsible.

Recognising the importance of environmental cooperation for sustainable development and regional integration, ASEAN has, since 1977, cooperated closely in promoting environmental cooperation among the AMS. ASEAN cooperation on environment is currently guided by the ASCC Blueprint 2025, which envisions 'an ASEAN Community that engages and benefits the peoples and is inclusive, sustainable, resilient, and dynamic'.

2.1 Geography

The ASEAN region comprises two sub-regions i.e. mainland Southeast Asia (SEA) and maritime SEA. The mainland SEA, which consists of Cambodia, Lao PDR, Myanmar, Thailand and Viet Nam, is known as the Mekong region, due to a significant part of it being located in the extensive Mekong river basin. The mainland SEA features north-south mountain ranges, plateaus and extensive river systems.

The Maritime Southeast Asia, commonly referred to as the Malay Archipelago, consists of Brunei Darussalam, Indonesia, Malaysia, the Philippines and Singapore. Malaysia is separated by the South China Sea with Peninsular Malaysia on the mainland and Sabah and Sarawak on the island of Borneo, while Indonesia and the Philippines are archipelagic island nations. Except Singapore, which is characterized as low-land, most of the islands in the Maritime SEA are volcanic in origin (ASEAN Secretariat, 2009).

Located in the fringes of the Indian and the Pacific Oceans, the SEA region has three major seas (i.e. the South China Sea, the Andaman Sea and the Philippine Sea) and two gulfs (i.e. the Gulf of Tonkin and the Gulf of Thailand) which offer diverse

1. http://asean.org/the-asean-declaration-bangkok-declaration-bangkok-8-august-1967/
2. http://asean.org/?static_post=declaration-of-asean-concord-ii-bali-concord-ii
3. http://asean.org/storage/2016/01/ASCC-Blueprint-2025.pdf

marine and mineral resources for fishery, tourism and trade. The region hosts some of the busiest international shipping channels (Hand, 2015) that includes the well-known Straits of Malacca, a key navigation channel between the Indian Ocean and the Pacific Ocean.

The total area of the region is about 4.46 million square kilometers (km^2), accounting for 3% of the world's total land area. Singapore is the smallest AMS in terms of land size i.e. 710 square kilometers, and the biggest AMS is Indonesia with the total land area of 1.9 million km2 (ASEAN Secretariat, 2009).

Figure 1. Map of ASEAN Member States

2.2 Climate

The regional climate is influenced by maritime wind systems, which originate in both the South China Sea and the Indian Ocean. Two main monsoon seasons predominating in the ASEAN region are – the Northeast monsoon from December to March, and the Southwest Monsoon from June to September. The Northeast monsoon is characterized by a dry season in the northern ASEAN region (Cambodia, Lao PDR, Myanmar, northern Philippines, northern Thailand, and Viet Nam) and a rainy season in the southern ASEAN region (Brunei Darussalam, Indonesia, Malaysia, southern Philippines, Singapore, southern Thailand). The converse applies for the Southwest monsoon. AMS such as the Philippines, Viet Nam and Myanmar are particularly at risk of being affected by typhoons or cyclones during this time of the

year. Average annual precipitation ranges between 1,000 and 4,000 millimeters, while average humidity is between 70 and 90% (Kripalani & Kulkarni, 1997).

Due to its geographical location, the ASEAN region is affected by the El Niño and La Niña phenomena that often alter the seasonal monsoon cycle and cause wide-ranging changes in weather patterns. Given its location on the convergent boundaries of the Earth's tectonic plates and on the typhoon belt, the ASEAN region is also exposed to various natural hazards including earthquakes and tsunamis, volcanic eruptions and typhoons. The ASEAN region experiences periodic and seasonal episodes of both floods and droughts. During the dry summer season, the ASEAN region experiences intense smoke haze caused by land and forest fire and air pollution that is exacerbated by the monsoon wind patterns (ASEAN Secretariat, 2009).

2.3 Population

ASEAN accounted for 11.6% of the world population in 2015. The population increased from 188 million people in 1955 to 629 million people in 2015. The population is projected to increase to 741 million people in 2035, and to 785 million people in 2050, at an average rate of 0.85% per annum. By 2030, three AMS will have a population of more than 100 million people: Indonesia (284 million), Philippines (127 million), and Viet Nam (103 million) (ASEAN 2013). Urban populations are also rising fast: the population in urban areas is expected to increase from ca. 47% of the total population in 2015 to 63% in 2050.

2.4 Economy

With a combined GDP of US$2.4 trillion, ASEAN is the sixth-largest economy in the world. However, the regional association includes economies with vast differences: for example, the GDP per capita of the wealthiest AMS, Singapore, is over 50 times higher than that of its poorest AMS, Myanmar. But Singapore's population of 5.5 million is only a small fraction of that of Indonesia, which, with a population of 250 million, is the most populous AMS, and the largest economy in the ASEAN region (The Economist Intelligence Unit, 2016). Economic growth in ASEAN has been steady at ca. 5% annually since 2010, after recovering from the global and regional financial crisis in 2008. With an average annual growth rate of 7%, Cambodia, Lao PDR, Myanmar and Viet Nam (CLMV) outperformed ASEAN in economic development (see Figure 10 and also Chapter 2.6).

2.5 Demographic change

Increasing population

The regional trend shows a general increase in population throughout the ASEAN region. Collectively, the population of the ten AMS has grown from 544.4 million people in 2004, to 628.9 million people in 2015, and constitutes the 6th largest economy in the world and the 4th largest in Asia (The Economist Intelligence Unit, 2016).

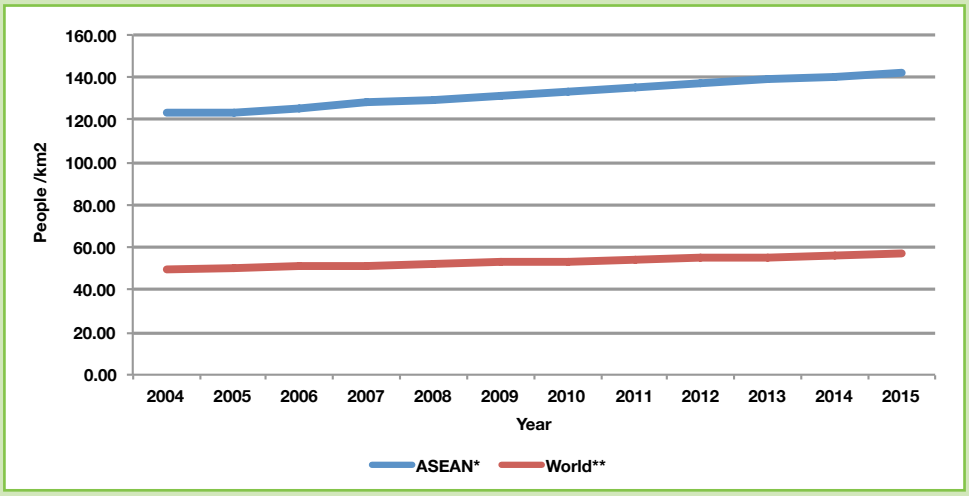
ASEAN's population is growing at a slightly higher rate i.e. 1.3% in 2015 (ASEAN Secretariat, 2015) compared to that of the world's average of 1.18%[4] .

Concurrently, there has been a rapid expansion of urban areas. The current urban population accounts for about 47% of the total population and it is expected to

4. http://data.worldbank.org/indicator

reach 63% by 2050. This is true except for Singapore, Brunei and Malaysia which are highly urbanized with more than 75% of the population living in urban areas. While Indonesia and Thailand are usually considered to have a predominantly rural population, this is changing: both have almost half of their people now living in urban areas. All AMS except for Cambodia are expected to have more than half of their population living in cities by 2050 (ASEAN Secretariat, 2015).

Population density in ASEAN, at 142 people per km^2 in 2015, is almost three times higher than the world average at 56.63, which had been consistently the case over the last 10 years (Figure 2).



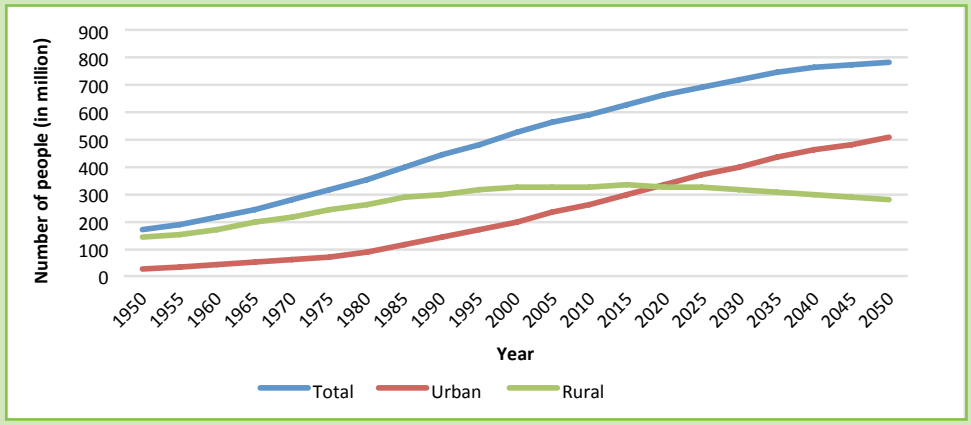
*Source: *ASEAN Statistical Year Book 2015; ** World Bank Indicators*

Figure 2. Population density (people per km2 of land area) in ASEAN and the World, 2004 - 2015

Leaving the countryside

The ASEAN region has cities of different sizes: megacities of over 10 million (such as Jakarta), large cities with 5 million - 10 million (such as Kuala Lumpur), medium-sized cities with 1 million-5 million (such as Yangon) and small cities with populations ranging between 500,000 and 1m (such as Vientiane). Apart from its megacities, ASEAN is home to 20 medium-sized and 21 small cities. This reflects a global trend in the rise of smaller urban areas (The Economist Intelligence Unit, 2016). In the AMS, the population in both the megacities, and the expanding agglomeration of smaller urban areas, is showing a rising trend. In 2015, almost half (46.8%) of the ASEAN region's population was living in urban areas (Figure 3).

There has been a rapid expansion of urban areas. Over the last two decades, the urban population of AMS has been growing at an annual rate of 2.65%, which is twice the rate of the overall population growth. In 2015, the population in both megacities and smaller urban areas accounts for 47% of the total population. The figure is expected to reach 63% by 2050 (Figure 3). Nevertheless, Singapore, Brunei and Malaysia are already highly urbanized with more than 75% of the population living in urban areas (ASEAN Secretariat, 2015).



Source: World Bank Indicator

Figure 3. Projection of ASEAN population by 2050 (in million)

Effects of urbanization

The rapid urbanization of the cities in the ASEAN region has resulted in a number of negative impacts: increasing inequality in access to basic social services such as water, sanitation, housing, education and health care, and increasing environmental problems including air and water pollution, and challenges to cope with the growing amounts of solid waste (Sheng, 2011). Urbanization places considerable pressures on infrastructure, and increases social insecurity and employment (Savage, 2006).

A major challenge for ASEAN governments is that the urban population growth is outpacing their efforts to improve city infrastructure. Public transport systems have tried to catch up since the last decade. For example, Jakarta has recently begun to plan for urban transportation systems while Bangkok is still struggling to expand its fledgling subway and elevated rail transport (Li, 2017). At the same time, building infrastructure to meet the growing demands for inner-city transport further worsen air and water pollution (see also chapters 2.1 Atmosphere and 2.4 Freshwater).

Unsustainable urbanization also has disastrous effects on global ecosystems. The rapidly growing urban areas of Asia encroach upon biodiversity hotspots and thus threaten biodiversity and affect ecosystem productivity by causing loss of habitat, biomass, and carbon storage (Seto, Güneralp, & Hutyra, 2012).

Widening rural-urban inequality

Another key concern for governments in the ASEAN region is the widening urban–rural inequality. For example, in Indonesia, the income gap – measured by the ratio of per capita consumption expenditure in urban areas to that in rural areas – increased from 1.23 in the 1990s to 1.42 in the mid-2000s. In the Philippines, the urban–rural divide rose from 2.07 in the 1990s to 2.26 in the early 2000s. A number of factors account for the urban-centred economic development, such as the different pace of human capital accumulation in urban and rural areas, market-driven urbanization and industrialization, and agglomeration of economies (de Groot et al. 2008). The urban–rural income gap contributes approximately 20% to overall inequality in Indonesia, Philippines and Viet Nam (Asian Development Bank, 2014b).

Between-AMS inequality is a further aspect of inequality in the ASEAN region, i.e. the stark difference in development between developed and middle-income AMS,

i.e. Brunei Darussalam, Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam, and the least developed AMS, i.e. Cambodia, Lao PDR, and Myanmar (Asian Development Bank, 2014b).

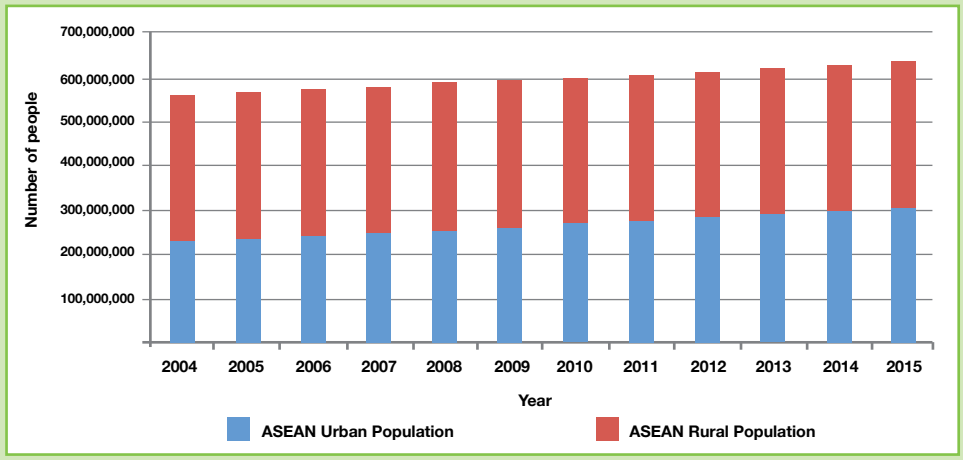
Rapid economic growth leads to the expansion of the middle-class. The middle-class in Southeast Asia made up 55% of the total population between 2002–2006 (OECD, 2013), which is an estimate of 300 million people. The rise of the middle-class and their materialism, consumption power and "wasteful behaviour" cause increasing water and energy consumption loss of biodiversity and degradation of ecosystems (Savage, 2006, p. 50).

It is projected that environmental problems will worsen because the middle-class continues to grow (Asian Development Bank, 2010) and their material lifestyle is unlikely to change, as it signifies success and modernization (Sheng, 2011).

2.6 Socio-economic development

Since the signing of the ASEAN Declaration in 1967, regional integration has been progressing within three main frameworks including ASEAN, ASEAN+3, and ASEAN+6, gradually expanding in geographic scope and issues of shared concern (OECD, 2015). ASEAN+3 strengthens and deepens ASEAN's cooperation with three East Asia nations – China, Republic of Korea and Japan on finance, tourism, agriculture and forestry, energy, minerals, the environment and social welfare. ASEAN+6 involves three more nations: Australia, India, and New Zealand. Progress has been made in regional integration through various agreements, initiatives, and strategic plans under the ASEAN Economic Community (AEC), such as the most recent AEC Blueprint 2025 and Regional Comprehensive Economic Partnership (RCEP).

Changes in employment patterns



Source: ASEAN Statistical Year Book 2015

Figure 4. ASEAN urban and rural population, 2004 - 2015

A major trend during the last 25 years has been that more people are leaving the agriculture sector (rice farming, forestry and fisheries) to find work elsewhere, such as in the trade and services sector. In general, however, all three sectors remain vital for employment with over a quarter of the ASEAN region's population (26.8 %) being dependent on employment in agriculture, trade and services sectors (Figure 4).

Internal and international migration

Rates of internal migration predominantly from rural to urban areas, as well as intra-AMS, have been growing throughout the ASEAN region, partly driven by labor and job opportunities in urban areas (Table 1). Migration continues to be one of the key drivers of urbanization (as migrant laborers are involved in infrastructure development) and changing lifestyles.

Table 1. Migrant people in ASEAN Member States (2014)

ASEAN Member State	Labour force(*)	Migrant people (in thousand)	Female population share (%)	Top three source countries
Brunei Darussalam (**)	203.6	86.8	40.66	Indonesia, Malaysia, Philippines
Cambodia	-	335.8	51.7	Viet Nam, Thailand, China
Indonesia	-	122.9	44.5	China, UK
Lao PDR	-	18.9	48	Viet Nam, China, Thailand
Malaysia	13,931.6	2,357.6	45.2	Indonesia, Philippines, China
Myanmar	22.110.0	88.7	48.7	China, India, Pakistan
Philippines	40.049.7	435.4	51.1	US, China, UK
Singapore (***)	3,530.8	1,355.7	N/A	Malaysia, China, India
Thailand	38,960.0	1,157.3	48.4	China,Myanmar, Lao PDR
Viet Nam	53,748.0	69.3	36.6	N/A

Source: Project gender impact of the ASEAN economic community (ASEAN secretariat, 2016), cited from ILO 2014
Note:
* ASEAN Statistical Year Book 2015
** Data is dated by mid-2015 , provided by Brunei Darussalam
*** Data updated by Singapore

Besides internal rural-urban migration, intra-ASEAN migrants, formal and informal, form an important part of the labor force in some AMS. Malaysia, Thailand and Singapore attract foreign workers from other AMS due to relatively high wages and a growing demand for labor for urban infrastructure development [5].

Distribution of wealth

From 1990 to 2012 most of the AMS made remarkable progress in poverty reduction, from an average of 45% in 1990 (6 AMS at the time) down to 15.3%, over two decades (Table 2).

Table 2. Poor section of the population based on national poverty line (percentage)

ASEAN Member State	1990	2000	2012
	Brunei Darussalam Indonesia Malaysia Philippines Singapore Thailand	Brunei Darussalam Cambodia Lao PDR Indonesia Malaysia Myanmar Philippines Singapore Thailand Viet Nam	Brunei Darussalam Cambodia Lao PDR Indonesia Malaysia Myanmar Philippines Singapore Thailand Viet Nam
Poverty Rate*	45.0	33.0	15.3**

Source: Thinking globally , Prospering Regionally - ASEAN Economic Community 2015
* % Population Living Below US$ 1.25 PPP per capita per day
** As of 2010

5. http://www.iom.int/world-migration

The efforts of AMS to improve wealth distribution have been far less successful. Cambodia deserves credit for being the most successful AMS in narrowing the gap between the rich and the poor. Cambodia's Gini coefficient[6] decreased by 0.136 between 2007 and 2012. Economic disparity also slightly reduced in the Philippines (by 0.034), Singapore (by 0.009) and Viet Nam (by 0.047) during the same period. However, the trend is opposite in Indonesia and Malaysia where the Gini coefficient rose by 0.05 and 0.021[7] respectively (Table 3).

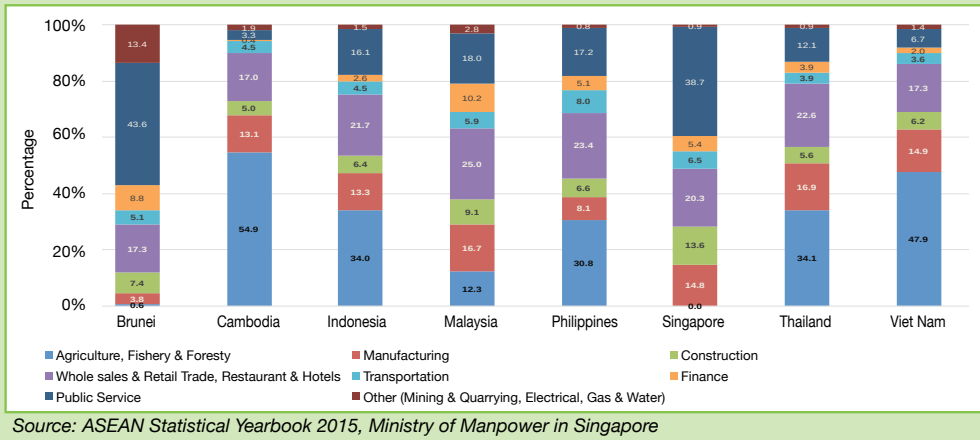
Table 3. Gini Coefficient of Select ASEAN Member States, 2000 - 2014

ASEAN Member State	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Cambodia	0.419	-	0.444	0.379	0.360	-	0.317	0.308	-	-
Indonesia	0.343	0.357	0.360	0.350	0.370	0.380	0.410	0.410	0.413	0.413
Lao PDR	-	0.354	-	0.367	-	-	-	0.379	-	-
Malaysia	0.379	-	0.441	-	0.441	-	-	0.431	-	0.401
Philippines	0.440	0.458	-	-	0.464	-	-	0.430	-	-
Singapore	-	-	0.482	0.474	0.471	0.472	0.473	-	-	-
Thailand	0.425	0.418	0.397	0.401	0.396	0.394	0.375	0.393	-	-
Viet Nam	0.378	0.420	-	0.434	-	0.433	-	0.387	-	-

Source: ASEAN Statistical Yearbook, 2015

Quality of life

The quality of life of ASEAN citizens improved in the 1990s but has remained mostly unchanged since 2011. The promise of prosperity supposedly brought about by economic integration and free trade has yet materialized for most of the population. The Human Development Index (HDI)[8] for the period 1990-2014 (Figure 5) shows an insignificant change in the living standards, health and knowledge of citizens of AMS, reflecting a plateau in the well-being after a remarkable progress during the previous two decades (1990-2010).



Source: ASEAN Statistical Yearbook 2015, Ministry of Manpower in Singapore

Figure 5. Employment by occupation in Southeast Asia in 2014

6. The Gini coefficient is a statistical measure of the degree of variation or inequality represented in a set of values, used especially in analyzing income inequality
7. Malaysia's Gini coefficient is for the period between 2007-2009
8. HDI measures average achievement in three basic dimensions of human development—a long and healthy life, knowledge and a decent standard of living

Gender equality

A recent ASEAN report (ASEAN Secretariat, 2016) projecting gender impacts on the AEC, concluded that although the AEC has created more jobs for women, it has not changed existing patterns of inequality in wages and employment. The report argued that inequalities in the labor force inhibit women from taking opportunities created by trade and investment. For instance, the growing skilled-labor market is dominated by men. Women tend to find employment only in low-skilled sectors such as clerical and sales jobs or in the agriculture and garment sectors, which are relatively low paid and tedious. The Gender Inequality Index[9] (Table 4) shows that overall, a lower number of women are participating in the labor force than men.

One of the key reasons why women tend to work in the more labor-intensive areas of employment, is their low level of education, which prevents them from securing high-skilled employment. Table 5 shows the gender gaps in education and women's participation in employment in all AMS, except for Singapore. The percentage of women aged 25 and older that have received secondary education is lower than that of men in all AMS, except for Myanmar and the Philippines. The number of women working in vulnerable fields of employment, such as garments, agriculture, self-employment and unpaid labor contributing to the family and household, is higher than that of men, with the exception of Singapore (Figure 6). More women than men work in areas of employment with low compliance to minimum wages. Women also have less opportunity to access well-paid work and social protection (ASEAN Secretariat, 2016).

Gender inequalities in the labor market affects national productive capacity and human resources development, and thus can have negative impacts on economic growth (Cuberes & Teignier, 2015). ASEAN recognizes that increased investment in girls' education, can increase national productive capacity and economic investments (ASEAN Secretariat, 2016).

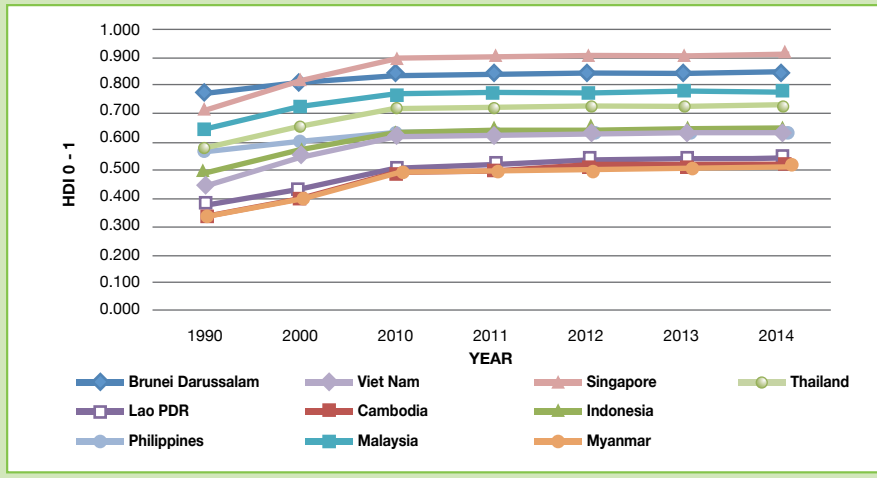
Table 4. Gender Inequality Index in the AMS

ASEAN Member State	Gender Inequality Hope		Maternal mortally ratio	Adolescent brith date	Share of seats in parliament	Population with at least some secondary education (% ages 25 and older)		Labour force participation rate (% ages 15 and older)	
	Value	Rank	(death per 100,000 live births)	(births per 1,000 women ages 15-19)	(% held by women)	Female	Male	Female	Male
	2014	2014	2013	2010/2015	2014	2005-2014	2005-2014	2013	2013
Brunei Darussalam	-	-	27	23	-	63.9	67.8	52.6	75.3
Cambodia	0.477	104	170	44.3	19	9.9	22.9	78.8	86.5
Indonesia	0.494	110	190	48.3	17.1	39.9	49.2	51.4	84.2
Lao PDR	-	-	-	65	25	22.9	37	76.3	79.1
Malaysia	0.209	42	21.4	12	14.2	65.1	71.3	81.0	56.2
Myanmar	0.413	85	200	12.1	4.7	22.9	15.3	75.2	82.3
Philippines	0.42	89	120	46.8	27.1	65.9	63.7	51.1	79.7
Singapore	0.088	13	6	6	25.3	74.1	81	58.8	77.1
Thailand	0.38	76	26	41	6.1	35.7	40.8	64.3	80.7
Viet Nam	0.308	60	49	29	24.3	59.4	71.2	73	82.2

Source: http://hdr.undp.org/en/composite/GII

9. Measures inequality in achievement between women and men in three dimensions: reproductive health, empowerment and the labor market.

Although women's labor dominates the agriculture sector, they have less power than men in acquiring and managing land, because of a lack of information and prevalent patriarchal practices that maintain the status quo of men as the nominal heads of households (ASEAN Secretariat, 2016).



Source: HDRO calculations based on data from UNDESA (2015), UNESCO Institute for Statistics (2015), United Nations Statistics Division (2015), World Bank (2015a), Barro and Lee (2014) and IMF (2015)a

Figure 6. Human Development Index (HDI) for the period 1990-2014

2.7 Economic growth and agricultural expansion

Global demand for food and bioenergy and the emergence of China's market, are all key drivers of agriculture-based and export-led economic growth of many AMS. Coupled with the changing socio-economic circumstance in ASEAN, these factors are resulting in a greater demand for food and animal products, which in turn places further pressures for agricultural expansion through forest conversion.

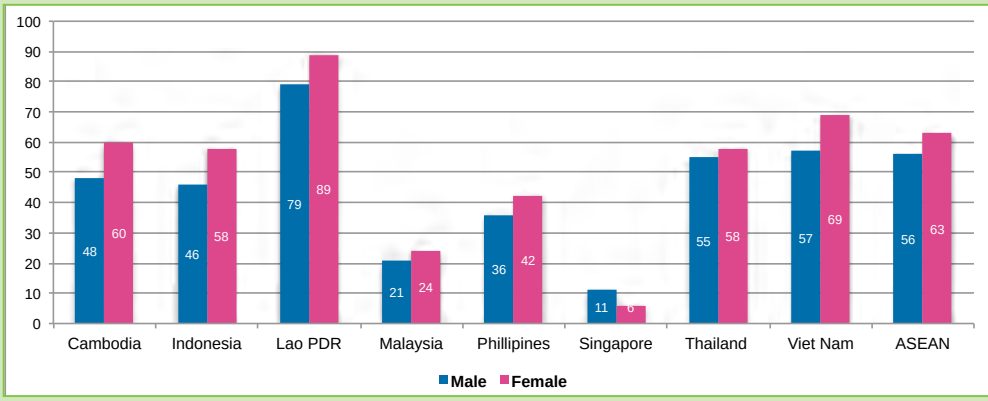
Though agriculture accounted for only 14% of the total GDP of ASEAN in 2014, the sector plays a key role in job creation for many AMS such as Cambodia (54.9%), Indonesia (34%), the Philippines (30.8%), Thailand (34.1%) and Viet Nam (47.9%) (ASEAN Secretariat, 2015).

The export value of ASEAN agricultural commodities increased by 44% between 2009 to 2015, from nearly US$50 billion to over US$72 billion (The ASEAN Secretariat, 2009, 2015). ASEAN itself is the biggest export market for agriculture commodities, with a market share of 19.8% in 2014, followed by China (11.7%) and EU (10.8%) (ibid.) Regional economic integration has boosted the trade flow among AMS, with intra-ASEAN trade value having doubled between the period 2005-2014, and accounting for 24% of the total trade in the ASEAN region in 2014 (ASEAN Secretariat, 2015). The expansion of agriculture-based export has significant implications not only on the movement of labor but poses many concerns for land-use and natural resources management in the ASEAN region.

Expansion of agri-business investments

The period 2009-2015 witnessed a remarkable leap in Foreign Direct Investment (FDI) in the agriculture, forestry and fishery sectors in the ASEAN region (Figure 7). Most

of the investment came from within AMS, e.g. 84% in 2015. Land-constrained AMS such as Singapore and Malaysia have been encouraging their agribusiness firms to invest in other land-abundant and low labor-cost AMS (ASEAN Secretariat, 2013). A significant proportion of Viet Nam's investment in AMS is on hydropower, agriculture and construction projects (ASEAN Secretariat, 2014).



Source: Projected gender impact of the ASEAN Economic Community, ASEAN Secretariat, 2016

Figure 7. Share of vulnerable employment

In general agricultural areas in ASEAN are expanding while farming practices are intensifying with most AMS having increased the area for agriculture in the last 50 years, particularly in Cambodia, Indonesia, the Philippines, Thailand and Viet Nam. But the reverse is true in Brunei Darussalam and Singapore where cultivated land areas have decreased (see also chapter 2.4 Freshwater.)

Economic integration has been linked with land conversion and biodiversity loss throughout the ASEAN region. In the Mekong region, foreign investors typically from larger economies (Thailand, Viet Nam and China), enter smaller economies (Cambodia, Lao PDR and Myanmar), and get granted large land concessions for industrial agriculture, plantations and extractive logging and mining activities, to supply raw materials for domestic use (CEPF, 2011; Samdhana Institute, 2016). Investments have also expanded road networks to ease the transport of goods. The three "economic corridors" supported by the Asian Development Bank (ADB), stretching across China, Myanmar, Thailand, Lao PDR, Cambodia and Viet Nam, have improved road access to previously remote areas, increasing agricultural expansion and forest resource extraction (CEPF, 2011), and causing increased biodiversity loss and impacts on ecosystem services (see also chapter 2.3 Biota and Ecosystems).

The expansion of commercial agriculture including large-scale land concessions is resulting in a number of social and ecological impacts such as land conflicts, resettlement of indigenous populations, deforestation and loss of biodiversity.

The clearing of tropical forests for large-scale commercial agriculture and medium- to small-scale farming, has resulted in significant carbon emissions. The cheapest and most convenient method for land clearance is burning, a method of choice for both smallholder agriculturists and agro-industrial companies such as oil palm plantations (Lee et al., 2016). These land use changes result in other environmental challenges such as habitat loss (SVTC 2014) and transboundary health problems caused by haze (see chapter 2.1 Air).

Agro-fuels expansion: Implications for local land-use

The increased investment in agriculture (Figure 7) and the consequent rapid expansion of land acquisition by agri-business threatens biodiversity, ecosystem services and the livelihoods of rural people in the AMS (Colchester & Chao, 2011a; Polack, 2012).

The conversion of peat land into oil palm plantations results in land subsidence and increase in flood risks (Hooijer et al., 2015). It can often also cause fires which result in generation of smoke haze with its concomitant adverse effects. Against the canvas of weak governance, unsecured land rights and ambiguous land classification, land acquisition in many cases lead to deforestation and change of land ownership, leading to land conflicts and threatening livelihoods of smallholder farmers (Borras & Franco, 2011; Mukherjee & Sovacool, 2014a; Phalan, 2009; Polack, 2012)

Expansion of agro-fuel crops affects traditional landowners and indigenous communities with land scarcity, land conflicts and rising land prices (Colchester & Chao, 2011b; Leonard, 2011; Mukherjee & Sovacool, 2014b). The lack of recognition by the state of traditional land tenure system and customary land ownership has created opportunities for the industry to encroach upon communal lands. Such "de-culturalisation of production practices" are insensitive to traditional farming system and makes smallholders dependent on large companies (Colchester & Chao, 2011b; Mukherjee & Sovacool, 2014b).

Commercial investment in oil palm plantations in Sumatra, Indonesia by domestic and transnational companies has resulted in the displacement of the indigenous Kinali community from parts of their lands, and damaged their rice farming livelihoods. The expansion of infrastructure around the plantations has also facilitated the entry of more plantation companies into the area seeking land for oil palm (Mabey & McNally, 1999). Lack of secure land tenure is often a major source of social inequity in rural areas as farming systems undergo change through commercial development (see chapter 2.2 Land).

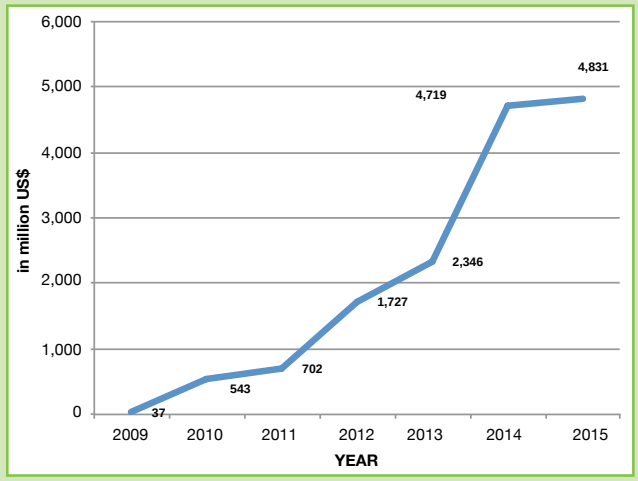
Biodiversity loss from agri-business expansion

Biodiversity loss is of considerable concern with oil palm plantations given they are established by clearing previously forested areas, while monoculture plantations support far fewer species than the forests they replaced. Other negative impacts include habitat fragmentation and pollution, all of which contribute to significant loss of biodiversity (Fitzherbert et al., 2008). In South Thailand, changes in bird communities were noted following the conversion of lowland forest to commercial oil palm and rubber plantations (Aratrakorn, Thunhikorn, & Donald, 2006). Studies of communities of ground-dwelling ants in different plantations in Sabah, Malaysia, found that the oil palm plantation ground ant community was severely reduced in species richness in comparison to the forest interior (Brühl & Eltz, 2010).

Biodiversity loss is also of concern in the coasts and oceans of the ASEAN region where different coastal and marine resources abound, including coral reefs, mangroves, seagrass beds, pelagic fisheries, demersal fisheries, and seabed minerals. The ASEAN region is also known for marine biodiversity, and also otherwise known as the Coral Triangle (Asian Development Bank, 2014a). Like many coastal areas around the world, the coasts of the AMS experience various environmental and anthropogenic hazards and physical processes, in particular, affecting the many major towns and cities that are located in low elevation coastal zones (LECZ) (see chapter 2.5 Coasts and Oceans).

Rising trend in fossil fuels and hydropower

The demand for fossil fuels to drive economic growth continues unabated. The increased living standards of population in the AMS comes with the increased demand for fossil fuel energy. Over the last 12 years, energy demand in ASEAN has increased 2.5 times, from 176 Million Tons of Oil Equivalent (Mtoe) in 1990 to 437 Mtoe in 2013, to support a remarkable economic growth of 5.1% per year in that period. Energy demand is expected to continue growing to at least 3.5% per year until 2035 according to the 4th ASEAN Energy Outlook (ASEAN Centre for Energy Team, 2015).



Source: ASEAN Investment Reports from 2009 to 2015

Figure 8. FDI in agriculture, forestry and fishery in ASEAN 2009-2015

Energy supply in the ASEAN region has increased by 50% since 2000, to meet the increasing demand of urbanization and economic development. Energy demand in the ASEAN region relies heavily on fossil fuels amounting to 74% in 2013 (IEA 2015). The International Energy Agency (2015) forecasts that the ASEAN's demand for electricity will triple between 2013 – 2040. Fossil fuel share in the primary energy mix i.e. coal and oil, is expected to rise in the coming 25 years. Specifically, the demand for coal is likely to triple by 2040, making it the largest fuel in the energy mix. Demand for oil will also rise by 65% (IEA 2015).

Fossil fuels such as oil and coal constitute the majority of energy sources of the AMS (IEA 2015). Indonesia, Viet Nam and Thailand are able to meet domestic demand, given that they are in the top five coal producing nations, with annual pro-duction of 274 Mtoe, 29.1 Mtoe and 10.6 Mtoe, respectively, in 2015 (World Energy Council, 2017).

Hydropower is one of the main sources of electricity in the region. Many AMS have been increasing investment in large dams. Currently, the installed capacity of hydropower in the ASEAN region is 43.261 Gigawatts (GW)[10] (World Energy Council, 2017) (See Figure 8).

Despite being controversial for its significant impacts on river ecosystems, on fisheries biodiversity and on local livelihoods as well as resettlement concerns, hydropower development continues to be sought after for electricity generation by the governments of less developed and emerging AMS such as Cambodia, Lao PDR, Myanmar and Viet Nam due to their abundant river resources (see also chapter 2.4 Freshwater).

10. Data does not include Brunei Darussalam (World Energy Council, 2017)

In 2015 alone, Viet Nam commissioned four hydropower dams with a total capacity of 1.03 GW. Viet Nam plans to increase its installed hydropower capacity to 17.4 GW by 2020 (World Energy Council, 2017). In 2015 the Philippines and Lao PDR added 29 Megawatts (MW) and 599 MW respectively, while Myanmar has commissioned 140 MW (World Energy Council, 2017). In 2016, a total of 392 dams were being commissioned, under construction or planned in the Mekong region alone (Do, Dinar, & Joint Institute for Strategic Energy Analysis, 2016). Table 5 shows the breakdown of hydropower plants in the Mekong region. In 2015, Lao PDR had the highest number of dams – 57 dams – either being planned or under construction (Do et al., 2016) (see chapter 2.2 Land).

Table 5. Commissioned and planned hydropower plants in the Mekong region (2016)

Country	Commisioned	Under construction	Planned	Total
China	17	10	17	44
Myanmar	0	0	6	6
Lao PDR	20	26	57	103
Thailand	7	0	0	7
Cambodia	0	1	11	12
Viet Nam	22	0	2	24

Source: WLE Greater Mekong (2015).

Renewable energy and energy efficiency

As the need to import more energy is growing in the ASEAN region, energy security has become a pressing issue for government policies (IEA 2015). The share of bioenergy and other renewable energy in the primary energy mix in the ASEAN region has reduced from 32% in 2000 to 25% in 2013, but there is an increasing shift away from traditional biomass to geothermal, hydropower, wind and solar photovoltaics (ibid)[11].

The growth of renewable energy, however, is not keeping up with increasing energy demands (UNEP, 2016a). Indonesia is the leading AMS in biofuel and geothermal energy, accounting for 25.7% and 7.6% of its energy supply (IEA 2015). Industrialization in ASEAN has been rapidly progressing since 1998, while increasing its contribution to the total GDP. The value added from industry in ASEAN accounts for about 35% of the total GDP in 2015, which is about 5% higher than the global average.

Energy production in the ASEAN region has also become more efficient. The amount of energy required to generate a unit of GDP (energy intensity) has reduced from 29.2 MJ in 1970 to 19.4 MJ in 2015 (Schandl, West, Baynes, & Hosking, 2016a, 2016b, 2016c, 2016d, 2016e, 2016f, 2016g, 2016h; UNEP, 2015a).The reasons for this improvement include the shift away from traditional biomass to more modern energy sources, the removal of subsidies to fossil fuels in some AMS, and the penetration of energy-efficient technologies and appliances (IEA 2015).

Industrialization and materials consumption

The AMS are at varying stages of development, yet they are facing similar challenges of high rates of urbanization and industrialization, which are increasing demands for

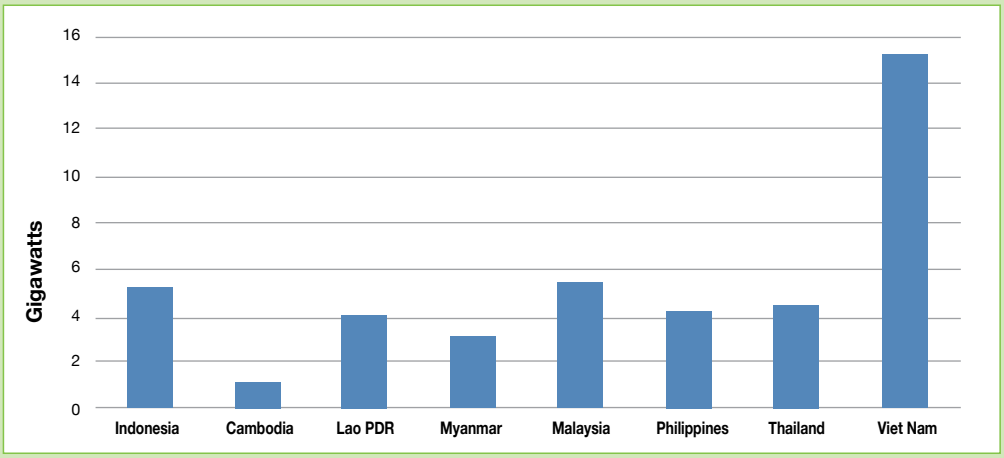
11. http://www.globalforestwatch.org

water, food, energy, transport and infrastructure for solid waste management. Efforts to satisfy these increased demands are posing serious pressures on the environment and causing the reduction of quality and quantity of various environmental and ecosystem services.

The consumption of materials such as biomass, fossil fuel, metal ores and non-metallic mineral in ASEAN is continuously increasing, driven by the demand from Northeast Asia, particularly China and Japan, the expanding middle-class in ASEAN and, to a lesser extent, population growth (UNEP, 2016a). Despite the reduction in domestic material consumption per unit of GDP, ASEAN is still using its materials inefficiently. It takes 3.5 kg of materials to produce one US$ of GDP in ASEAN, compared to the world average of 1 kg for each US$ of GDP (Schandl, West, Baynes, & Hosking, 2016a; 2016b; 2016c; 2016d; 2016e; 2016f; 2016g; 2016h) (see chapter 2.6). This has resulted in increasing the impacts on the environment and the wasteful use of natural resources.

Increasing water consumption

Since 2009, there has been an increase in the total water use in ASEAN by 5%. Figure 9 shows while water-use intensity[12] has decreased by an average of 4.4% per annum in the AMS, indicating improvements in efficiency of use primarily in agriculture and industry, it is still double the world's average because many AMS economies are still dominated by agriculture (UNEP, 2016b) (see chapter 2.4 Freshwater and chapter 2.6 Sustainable Production and Consumption).



Source: World Energy Council 2017

Figure 9. Installed hydropower capacity (in GW) in selected ASEAN Member States

2.8 Climate change

Greenhouse gas emissions from anthropogenic activity worldwide are changing the climate of the ASEAN region, with implications for its ecosystems and biodiversity (see chapter 2.3 Biota).The Asian Development Bank (2009) projects a 4.8 C rise in mean annual temperature and a 70 cm rise in mean sea level by 2100 in Indonesia, the Philippines, Thailand and Viet Nam due to climate change (see also chapter 2.5

12. Water used to produce a monetary unit of GDP (UNEP 2015).

Coasts and Oceans). The whole ASEAN region has been experiencing climate change impacts such as irregular precipitation (UN AquaStat database) and increasing sea level rise (1-3 mm per year) (UNISDR, 2010). Coastal flooding poses the greatest risk to millions of dwellers in the coastal areas of Viet Nam, Thailand, Myanmar, Cambodia, Philippines, Malaysia, Indonesia and Brunei Darussalam.

Climate change poses major threats to agriculture and forest systems as plants are sensitive to variation in temperate and rainfall. Climate change effects on plants are complex and are currently not that well understood, particularly with regard to impacts on species in tropical Southeast Asia. Moreover, the productivity of many plant species would be affected by greenhouse gas emissions (see chapter 2.2 Land). Furthermore, climate change will have serious impacts on the productivity of coasts and oceans in ASEAN, as well as affecting the well-being of coastal inhabitants (see chapter 2.5 Oceans and Coasts).

Freshwater resources are expected to be significantly affected by climate change since changes in weather patterns add a level of uncertainty to water availability as well as leading to increasing frequency of extreme flood and drought events in the ASEAN region. Climate change also causes alteration of river flow regimes, along with the degradation or loss of wetlands and floodplains as well as salinity intrusion due to sea level rise in river deltas (see chapter 2.4 Freshwater).

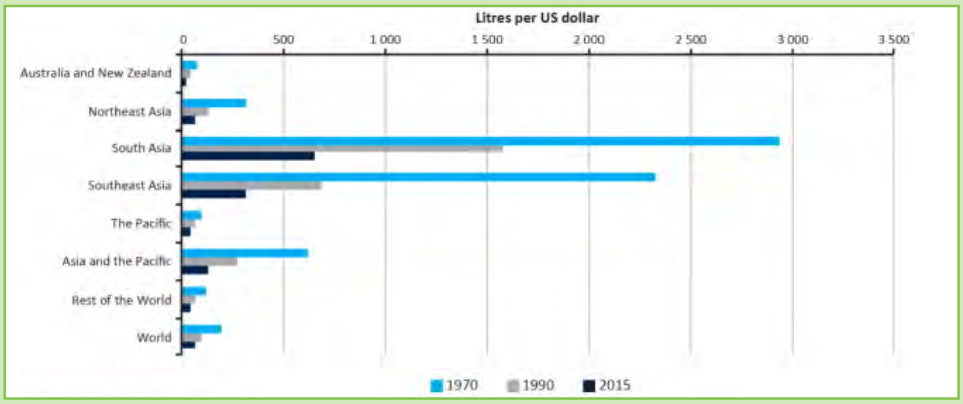
The El Niño-Southern Oscillation (ENSO) is an important global climatic phenomenon which affects the ASEAN region and which is likely to be exacerbated by climate change (Cai et al., 2012). ENSO, which refers to interactions between the ocean and atmosphere in the Equatorial Pacific Ocean, influences global temperatures and precipitation, and can therefore significantly impact human societies and ecosystems. El Niño events, which last a year or more, have a variety of climatological impacts across parts of Africa, North and South America, Australia, Asia, and the Pacific.

The most typical of which are increased temperatures, reduced precipitation leading to drought, and changes to tropical cyclone areas of formation and tracking. These changes have historically had large-scale social and economic impacts on millions of people across the affected regions, including in parts of the ASEAN region (UNESCAP, UNDP, RIMES, 2016).

During 2015-2016, there was a very strong El Niño with serious effects on water availability, farmers and livelihoods, and in particular the rural poor. The 2015–2016 El Niño event is now considered as one of the strongest since 1950, with its effects expected to last into 2017. It has affected the lives and livelihoods of millions of people, damaged crops and killed livestock in the ASEAN region. It has caused both drought by drying up rivers, creeks and streams as well as massive flooding in many areas. As crops are damaged and livelihoods suffer, malnutrition rates go up, and there are increased disease outbreaks. More importantly, the long-term impact of the 2015-2016 El Niño is yet to be fully assessed. The World Meteorological Organization (WMO) in its El Niño/La Niña Update of 28 April estimated that there is a 50-60% chance of El Niño development in the second half of 2017.

Disasters

The ASEAN region is prone to all types of disasters linked to natural hazards, namely floods (hydrological hazard type), tropical storms and heat waves (meteorological hazards), droughts and wildfires (climatological hazards), earthquakes, tsunamis, volcanic eruptions (geophysical hazards) (Gupta, 2010). The most common disasters are floods, tropical storms and landslides (see Figure 10).



Source: CSIRO 2015; UNEP 2015

Figure 10. Comparison of water-use intensity of the economy in 1970, 1990 and 2015 (litres per USD of GDP)

The risk of disasters remains high across the ASEAN region, although disaster events have been unevenly distributed across and within AMS. According to the 2016 World Risk Index, The ASEAN region is a disaster 'hotspot' region (see Table 6). The Philippines, Indonesia, Viet Nam and Thailand, together, accounted for 87% of all disasters occurrences between 1970 and 2016 (CRED, 2016)[13] .

Table 6. The 2016 World Risk Index for Southeast Asian nations (adapted from (UNU-EHS, 2016)

Rank	Nation	Risk Index (%)	Exposure (%)	Vulnerability (%)	Susceptibility %	Lack of coping capacities (%)	Lack of adaptive capacities (%)
3	Philippines	26.70	52.46	50.90	31.83	80.92	39.96
7	Brunei Darussalam	17.00	41.10	41.36	17.40	63.17	43.53
9	Cambodia	16.58	27.65	59.96	37.55	86.84	55.49
12	Timor Leste	15.69	25.73	60.98	49.93	81.39	51.61
18	Viet Nam	12.53	23.53	49.43	24.95	76.67	46.67
36	Indonesia	10.24	19.36	52.87	30.09	79.49	49.04
42	Myanmar	8.90	14.87	59.86	35.63	87.00	56.93
86	Malaysia	6.39	14.60	43.76	19.02	67.52	44.73
89	Thailand	6.19	13.70	45.22	19.34	75.53	40.79
100	Lao PDR	5.59	9.55	58.51	37.41	84.37	53.76
159	Singapore	2.27	7.82	28.99	14.24	49.44	23.28

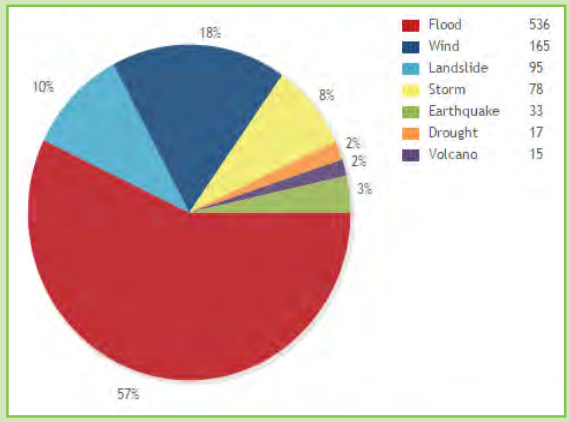
Key: Very High; Medium; High; Low; Very Low

Source: http://hdr.undp.org/en/composite/GII

The frequency and intensity of hydro-, meteoro- and climato-logical disasters has been increasing over the last 50 years (Figure 11) particularly compared to geophysical disasters, partly due to the impact of climate change on disaster frequency and intensity (IPCC, 2012). Disaster risks are further exacerbated by poverty and inequality, demographic change and urbanization, unsustainable natural resources and eco-systems use, and governance structures and processes (Thomalla et al., forthcoming). For instance, UNESCAP (2015) estimates that 46 million people concentrated in

13. A disaster is included in the EM-DAT database when either ten (10) or more people are reported as killed, one hundred (100) or more people are reported as affected, a state of emergency is declared, or there is a call for international assistance (CRED, 2016).

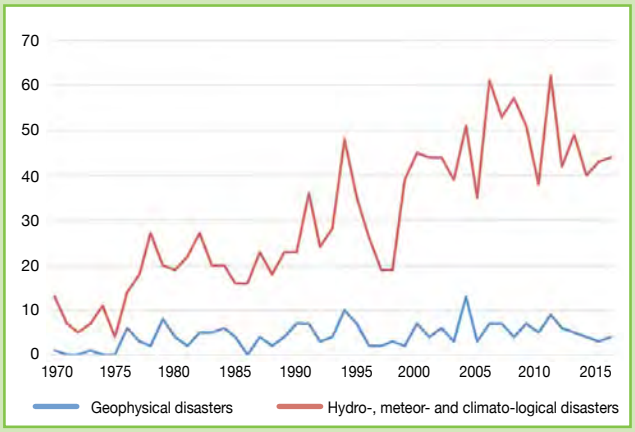
17 Southeast Asian cities were exposed to extreme multi-hazard risk. The urban population at extreme risk is projected to rise to 66 million by 2030.



Source: ADInet AHA Centre

Figure 11. The number of hazard events by hazard type that occurred in the AMS between 28 December 2011 and 27 April 2017.

Multiple major disasters have caused significant loss of life and economic loss and damages across the ASEAN region in recent decades. Over 425,000 people were killed between 1970 and 2016 (CRED, 2016). The Indian Ocean tsunami in 2004 alone resulted in approximately 175,000 deaths in Indonesia, Thailand, Malaysia and Myanmar. Disasters also undermine human security and well-being, and damage ecosystems and ecosystem services, property, infrastructure, livelihoods, economies and cultural places (UNEP, 2015b, IPCC, 2012). Economic losses have dramatically increased in recent decades (Figure 12), particularly in Thailand and the Philippines. For example, Thailand suffered over US$ 45 billion in economic loss and damage as a result of the prolonged, nation-wide, flood in 2011 (World Bank, 2012). In 2013, Typhoon Haiyan (Yolanda) caused US$ 10 billion in loss and damages . The uninsured economic losses caused by disasters is often high and unaccounted for in official records, meaning these figures are likely conservative (UNEP, 2011).

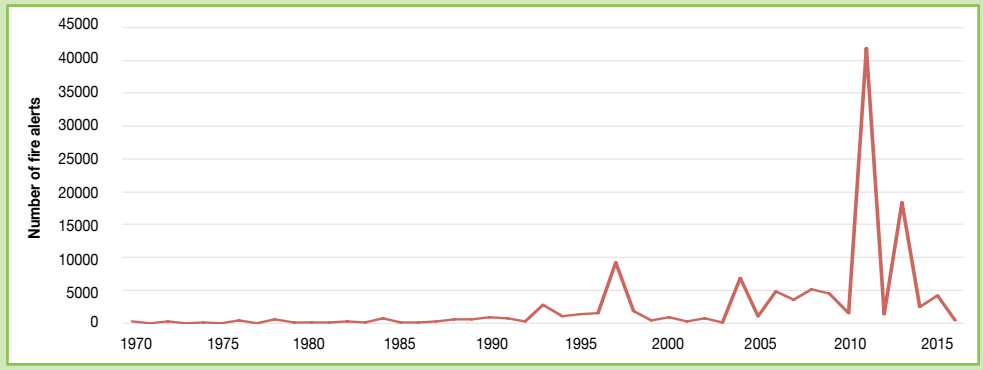


Source: CRED 2016

Figure 12. Total number of disasters [(i) hydro-, meteoro- and climato-logical disasters, and (ii) geophysical disasters] that have occurred in Southeast Asia, 1970 – 2016

Transboundary haze

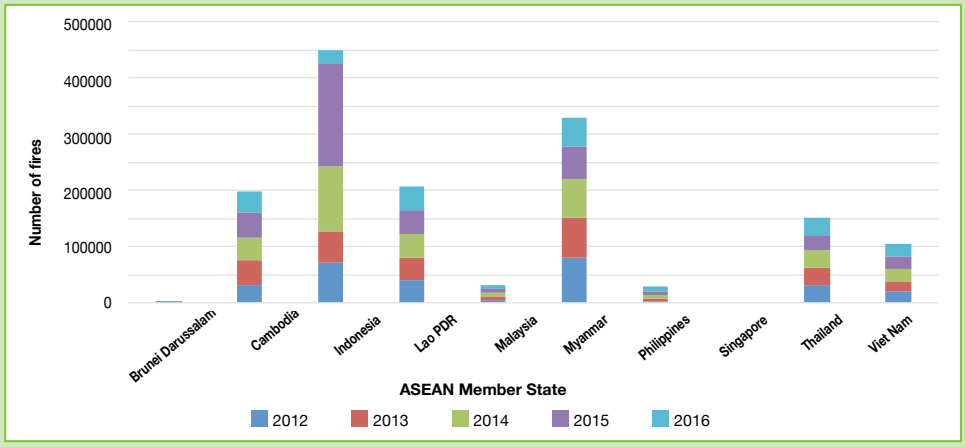
Transboundary haze pollution is a persistent challenge for the ASEAN region. It is caused largely by deliberate land and forest fires to clear land for agriculture crops and tree plantations. Indonesia is the number one fire hotspot in the ASEAN region due to a rapid expansion of pulpwood and oil palm plantations. The Mekong region, i.e. Myanmar, Lao PDR, Cambodia, Thailand and Viet Nam, play more or less of an equal role in causing haze pollution (Figure 13).



Source: CRED 2016

Figure 13. The total economic impact (damages in million US$) of disasters in Southeast Asia, 1970 – 2016.

There have been efforts to tackle the haze pollution problem, including the full ratification of the ASEAN Agreement on Transboundary Haze Pollution (AATHP) which came into force in 2003, and the creation of the recent Roadmap on ASEAN Cooperation towards Transboundary Haze Pollution Control with Means of Implementation (2016). But much more still needs to be done including stronger commitments all AMS to continue tackling the issue in holistic ways, including better land management controls.



Source: The Global Forest Watch using data from the NASA/GSFC/Earth Science Data and Information System (ESDIS)

Figure 14. Fire report for ASEAN Member States, period 2012 - 2016

3. References

ADB. (2009). *The Economics of Climate Change in Southeast Asia: A Regional Review.* Manila, Philippines: Asian Development Bank. Retrieved from http://www.greengrowth.org/?q=publication/adb-economics-climate-change-southeast-asia-regional-review

Aratrakorn, S., Thunhikorn, S., & Donald, P. F. (2006). *Changes in bird communities following conversion of lowland forest to oil palm and rubber plantations in southern Thailand*. Bird Conservation International, 16(1), 71. https://doi.org/10.1017/S0959270906000062

ASEAN Centre for Energy Team. (2015). *The 4th ASEAN Energy Outlook 2013 - 2035*. Retrieved from https://app.box.com/s/tzjb0tc2yoam6tonjv0ujx0xbhnwug3z

ASEAN Secretariat. (2009). *Fourth ASEAN State of the Environment Report 2009*. Jakarta, Indonesia: ASEAN Secretariat.

ASEAN Secretariat. (2013). *ASEAN Investment Report 2012: The Changing FDI Landscape*. Jakarta, Indonesia. Retrieved from http://www.asean.org/storage/images/2013/other_documents/AIR%202012%20Final%20(July%202013).pdf

ASEAN Secretariat. (2014). *ASEAN Investment Report 2013-2014: FDI Development and Regional Value Chains*. Jakarta, Indonesia. Retrieved from http://unctad.org/en/PublicationsLibrary/unctad_asean_air2014d1.pdf

ASEAN Secretariat. (2015). *ASEAN Statistic Yearbook 2015*.

ASEAN Secretariat. (2016). *Projected gender impact of the ASEAN economic community*. Retrieved from http://library.fes.de/pdf-files/bueros/singapur/12676.pdf

Asian Development Bank. (2010). *Key Indicators for Asia and the Pacific 2010*. Retrieved from https://www.adb.org/sites/default/files/publication/27726/key-indicators-2010.pdf

Asian Development Bank. (2014a). *Coral Triangle Marine Resources: Their Status, Economies, and Management*. Manila: Asian Development Bank.

Asian Development Bank. (2014b). *Inequality in Asia and the Pacific: trends, drivers, and policy implications*. London; New York.

Borras, S. M., & Franco, J. C. (2011). *Political dynamics of land grabbing in Southeast Asia: understanding Europe's role*. Amsterdam: Transnational Institute. Retrieved from http://www.tni.org/report/political-dynamics-land-grabbing-southeast-asia-understanding-europes-role

Brühl, C. A., & Eltz, T. (2010). *Fuelling the biodiversity crisis: species loss of ground-dwelling forest ants in oil palm plantations in Sabah, Malaysia (Borneo).* Biodiversity and Conservation, 19(2), 519–529. https://doi.org/10.1007/s10531-009-9596-4

Cai, W., Lengaigne, M., Borlace, S., Collins, M., Cowan, T., McPhaden, M. J., … Widlansky, M. J. (2012). *More extreme swings of the South Pacific convergence zone due to greenhouse warming*. Nature, 488(7411), 365–369. https://doi.org/10.1038/nature11358

CEPF. (2011). I*ndo-Burma Biodiversity Hotspot Ecosystem Profile*. Critical Ecosystem Partnership Fund. Retrieved from http://www.cepf.net/SiteCollectionDocuments/indo_burma/IndoBurma_ecosystemprofile_2011_update.pdf

Colchester, M., & Chao, S. (2011a). *Oil palm expansion in South East Asia: trends and implications for local communities and indigenous peoples*. Bogor: Perkumpulan Sawit Watch.

Colchester, M., & Chao, S. (2011b). *Oil palm expansion in South East Asia: trends and implications for local communities and indigenous peoples*. Bogor: Perkumpulan Sawit Watch.

CRED. (2016). EM-DAT: *The International Disaster Database [Centre for Research on the Epidemiology of Disasters (CRED)]*. Retrieved January 19, 2017, from http://www.emdat.be

Cuberes, D., & Teignier, M. (2015). *Aggregate Effects of Gender Gaps in the Labor Market: A Quantitative Estimate*. Retrieved from http://www.marcteignier.com/research_files/GGLMAP_CT.pdf

Do, K. H. P., Dinar, A., & Joint Institute for Strategic Energy Analysis. (2016). *The linkages of energy, water, and land use in Southeast Asia challenges and opportunities for the Mekong region*. Helsinki, Finland: United Nations University World Institute for Development Economics Research. Retrieved from http://hdl.handle.net/10419/146253

Fitzherbert, E. B., Struebig, M. J., Morel, A., Danielsen, F., Brühl, C. A., Donald, P. F., & Phalan, B. (2008). *How will oil palm expansion affect biodiversity? Trends in Ecology & Evolution*, 23(10), 538–545. https://doi.org/10.1016/j.tree.2008.06.012

Gupta, S. (2010). *Synthesis Report on ASEAN Countries Disaster Risks Assessment - ASEAN Disaster Risk Management Initiative*. World Bank, UNISDR.

Hand, M. (2015). *Malacca Strait traffic hits an all-time high in 2014, VLCCs and dry bulk lead growth*. Retrieved from http://www.seatrade-maritime.com/news/asia/malacca-strait-traffic-hits-an-all-time-high-in-2014-vlccs-and-dry-bulk-lead-growth.html

Hooijer, A., Vernimmen, R., Mawdsley, N., Page, S., Mulyadi, D., & Visser, M. (2015, November). *Assessment of impacts of plantation drainage on the Kampar Peninsula peatland, Riau*. Deltares Report 1207384 to Wetlands International, CLUA and Norad.

International Energy Agency. (2015). *Southeast Asia Energy Outlook 2015*. Retrieved from https://www.iea.org/publications/freepublications/publication/WEO2015_SouthEastAsia.pdf

IPCC. (2012). Summary for Policymakers. In C. B. Field, V. Barros, T. F. Stocker, D. Qin, D. J. Dokken, K. L. Ebi, … P. M. Midgley (Eds.), *Managing the risks of extreme events and disasters to advance climate change adaptation: Special report of the intergovernmental panel on climate change*. Cambridge, UK: Cambridge University Press.

Kripalani, R. H., & Kulkarni, A. (1997). *Rainfall variability over South-east Asia—connections with Indian monsoon and ENSO extremes: new perspectives. International Journal of Climatology*, 17(11), 1155–1168. https://doi.org/10.1002/(SICI)1097-0088(199709)17:11<1155::AID-JOC188>3.0.CO;2-B

Lee, J. S. H., Jaafar, Z., Tan, A. K. J., Carrasco, L. R., Ewing, J. J., Bickford, D. P., … Koh, L. P. (2016). *Toward clearer skies: Challenges in regulating transboundary haze in Southeast Asia*. Environmental Science & Policy, 55, 87–95. https://doi.org/10.1016/j.envsci.2015.09.008

Leonard, R. (2011). *Agrofuels: A boost of energy for the Mekong region?* (*Occasional*

Paper). Thailand: Focus on the Global South. Retrieved from http://focusweb.org/sites/www.focusweb.org/files/Occasional%20Paper%2010%20RL.pdf

Li, Z. (2017, April 10). *City living: ASEAN is urbanizing rapidly, but is it sustainable? - ASEAN*, Environment. Retrieved June 29, 2017, from https://www.thailand-business-news.com/asean/57044-city-living-asean-urbanizing-rapidly-sustainable.html

Mabey, N., & McNally, R. (1999). *Foreign direct investment and the environment*. WWF-UK. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.456.7872&rep=rep1&type=pdf

Mukherjee, I., & Sovacool, B. K. (2014a). *Palm oil-based biofuels and sustainability in southeast Asia: A review of Indonesia, Malaysia, and Thailand*. Renewable and Sustainable Energy Reviews, 37, 1–12. https://doi.org/10.1016/j.rser.2014.05.001

Mukherjee, I., & Sovacool, B. K. (2014b). *Palm oil-based biofuels and sustainability in southeast Asia: A review of Indonesia, Malaysia, and Thailand*. Renewable and Sustainable Energy Reviews, 37, 1–12. https://doi.org/10.1016/j.rser.2014.05.001

OECD. (2013). *Southeast Asian Economic Outlook 2013 With Perspectives on China and India*.

OECD. (2015). *Economic Outlook for Southeast Asia, China and India 2016 - Enhancing Regional Ties*.

Phalan, B. (2009). *The social and environmental impacts of biofuels in Asia: An overview*. Applied Energy, 86, Supplement 1, S21–S29. https://doi.org/10.1016/j.apenergy.2009.04.046

Polack, E. (2012). *Agricultural land acquisitions- a lens on Southeast Asia. IIED*. Retrieved from http://pubs.iied.org/pdfs/17123IIED.pdf

Samdhana Institute. (2016). *Preparation of a biodiversity conservation strategic approach for Asia- GREATER MEKONG REGION* (p. 73). Indonesia: Samdhana Institute.

Savage, V. R. (2006). *Ecology matters: sustainable development in Southeast Asia*. Sustainability Science, 1(1), 37–63. https://doi.org/10.1007/s11625-006-0002-9

Schandl, H., West, J., Baynes, T., & Hosking, K. (2016a). *Natural Resource Use Indicators in the SDGs - Cambodia* (p. 28). UNEP.

Schandl, H., West, J., Baynes, T., & Hosking, K. (2016b). *Natural Resource Use Indicators in the SDGs - Indonesia* (p. 28). UNEP.

Schandl, H., West, J., Baynes, T., & Hosking, K. (2016c). *Natural Resource Use Indicators in the SDGs - Lao PDR* (p. 28). UNEP.

Schandl, H., West, J., Baynes, T., & Hosking, K. (2016d). *Natural Resource Use Indicators in the SDGs - Malaysia* (p. 28). UNEP.

Schandl, H., West, J., Baynes, T., & Hosking, K. (2016e). *Natural Resource Use Indicators in the SDGs - Myanmar* (p. 28). UNEP.

Schandl, H., West, J., Baynes, T., & Hosking, K. (2016f). *Natural Resource Use Indicators in the SDGs - Philippines* (p. 28). UNEP.

Schandl, H., West, J., Baynes, T., & Hosking, K. (2016g). *Natural Resource Use Indicators in the SDGs - Thailand* (p. 28). UNEP.

Schandl, H., West, J., Baynes, T., & Hosking, K. (2016h). *Natural Resource Use Indicators in the SDGs - Viet Nam* (p. 28). UNEP.

Seto, K. C., Güneralp, B., & Hutyra, L. R. (2012). *Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. Proceedings of the National Academy of Sciences*, 109(40), 16083–16088. https://doi.org/10.1073/pnas.1211658109

Sheng, Y. K. (2011). *Urban Challenges in South-East Asia. In UNESCAP, Fifth Asia-Pacific Urban Forum*. Retrieved from https://www.researchgate.net/profile/Kioe_sheng_Yap/publication/236142386_Urban_Challenges_in_South-East_Asia/links/0deec516528532c37d000000.pdf

The ASEAN Secretariat. (2009). *ASEAN Community in Figures (ACIF) 2009* (No. 315.95) (p. 74). ASEAN.

The ASEAN Secretariat. (2015). *ASEAN Community in Figures (ACIF) 2015* (p. 72). ASEAN. Retrieved from http://asean.org/storage/2016/08/FINAL-ACIF-2015-PDF-version-rev-24-Aug.pdf

The Economist Intelligence Unit. (2016). *ASEAN cities: Stirring the melting pot*.

UNEP. (2011). *UNEP Year Book 2011: Emerging Issues in our Global Environment*. Nairobi, Kenya: United Nations Environment Programme.

UNEP. (2015a). *Natural Resource Use Indicators in the SDGs* (p. 6). UNEP.

UNEP. (2015b). *UNEP Annual Report 2014* (p. 66). United Nations Environment Programme.

UNEP. (2016a). *GEO-6 Regional Assessment for Asia and the Pacific*. Nairobi, Kenya.

UNEP. (2016b). *Global Environment Outlook GEO-6 Regional Assessment for Asia and the Pacific*. United Nations Environment Programme (UNEP).

UNESCAP. (2015). *Disasters without Borders: Regional Resilience for Sustainable Development (Asia Pacific Disaster Report 2015)* (p. 232). United Nations Economic Commission for Asia Pacific.

UNESCAP, UNDP, RIMES. (2016). *Assessment of El Niño-Associated Risks: The Step-Wise Process*. Retrieved from http://www.unescap.org/sites/default/files/FINAL_El%20Nino%20Methodology.pdf

UNISDR. (2010). *Synthesis Report on Ten ASEAN Countries Disaster Risks Assessment*. Retrieved from http://www.unisdr.org/files/18872_asean.pdf

World Bank. (2012). *Thai flood 2011: rapid assessment for resilient recovery and reconstruction planning* (Vol. 2 of 2): Final Report (English) (Thai flood 2011: rapid assessment for resilient recovery and reconstruction planning). Bangkok, Thailand: World Bank.

World Energy Council. (2017). *South East Asia & Pacific. Retrieved March 2, 2017*, from https://www.worldenergy.org/data/resources/region/southeast-asia-pacific/hydropower/

Section 2
State and Trends

Section 2: State and Trends

Methodology

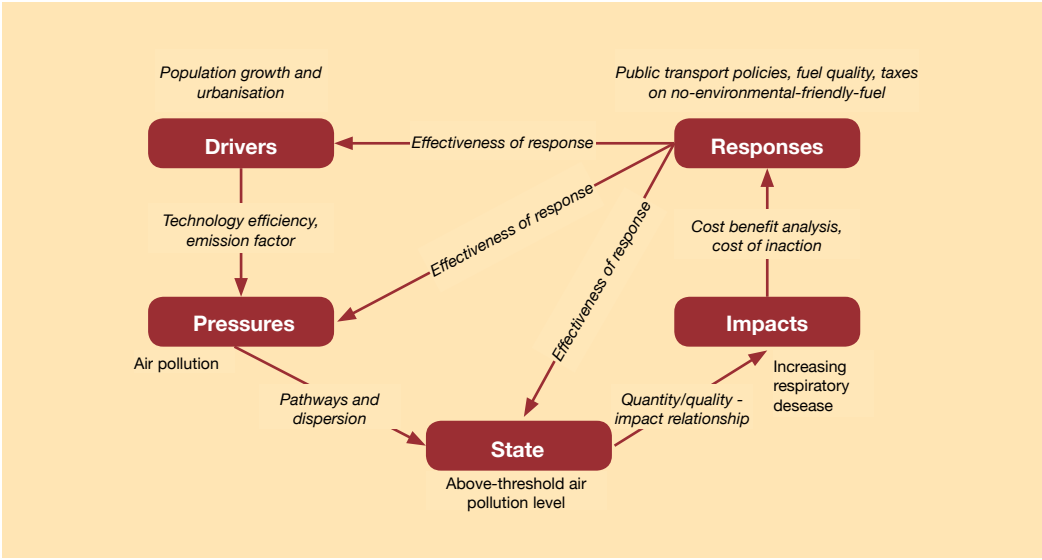


Figure 15. DPSIR assessment framework, adapted from the Europe Environment Agency (EEA)

The Drivers, Pressures, State, Impacts and Response (DPSIR) assessment framework offers a causal framework for describing the interactions between society and the environment. Adopted by the European Environment Agency (EEA), in this framework, social and economic developments exert Pressure on the environment and, as a consequence, the State of the environment changes, such as the provision of adequate conditions for health, resources availability and biodiversity. Finally, this leads to Impacts on human health, ecosystems and materials that may elicit a societal Response that feeds back on the Driving forces or on the state or impacts directly, through adaptation or curative action.

The DPSIR framework is useful in describing the relationships between the origins and consequences of environmental problems. Compared to PSR (Pressure-State-Response), this framework provides a more comprehensive description of the interlinkages among various factors affecting natural resources and environment. The DPSIR includes additional parameters such as Drivers and Impacts into the decision framework, which more accurately reflects the complexity of the environmental systems.

In order to understand this kind of system dynamics, it is also useful to focus on the links between DPSIR elements. For instance, the relationship between the 'Drivers' and the 'Pressures' by economic activities is a function of the efficiency of the technology and related systems in use, with less 'Pressures' coming from more 'Drivers' if efficiency is improving. Similarly, the relationship between the 'Impacts' on humans or eco-systems and the 'State' depends on the carrying capacities and thresholds for these systems. Whether society 'Responds' to impacts depends on how these impacts are perceived and evaluated; and the results of 'Responses' on the 'Drivers' depends on the effectiveness of the Response.

2.1. Atmosphere: air and climate

Poor air quality is causing long-term and wide-ranging health and economic impacts in the region. This chapter looks at the situation of air quality and pollution in the ASEAN countries or ASEAN Member States and the challenges for urbanization, industrialization, transport and energy use to reduce air pollution and for climate change mitigation.

Photo Credit: "Traffic in Ho Chi Minh City (Saigon) - Viet Nam" by Esin Üstün licensed under CC BY 2.0

2.1. Atmosphere: air and climate

Key Messages

- Air pollution levels are increasing in the region with the energy sector being responsible for the largest carbon dioxide (CO2) emissions; it is predicted that energy-related CO2 emission levels could rise in the ASEAN region by 61% from 2014 to 2025.
- As major sources of greenhouse gases, cities across the ASEAN region need to urgently seek low-carbon economies, infrastructure and transport.
- Transboundary haze pollution resulting from land and forest fires in the ASEAN region is a persistent challenge, and impacts most of ASEAN Member States (AMS). Up to 90% of transboundary smoke haze in ASEAN is linked to peat fires related to expansion of large-scale commercial plantations. While responses are in place to tackle the haze pollution, more holistic measures are needed to address the issue at its source by improved land management and controls on the expansion of commercial plantations.
- There is a need for improved air quality monitoring and standards which are consistent across all AMS, so that air quality trends can be more adequately observed and acted upon.

1. Introduction

Efforts to satisfy socio-economic development demands in the ASEAN region are posing serious pressures on the environment and causing the reduction of quality and quantity of various environmental and ecosystem services which are needed for sustaining the livelihoods and well-being of our global citizens. Changing trends and patterns of activity related to economic development, population growth, urbanization and industrialization, transport and energy use, are driving increases in air pollution and degradation currently experienced in the ASEAN region. This is being further amplified by additional pressures linked to fuel quality, burning activity and changing land use practices.

Managing air quality continues to be a major challenge not just in ASEAN but worldwide. According to the latest global assessment conducted by the World Health Organization (WHO) in 2016, more than 80% of people living in urban areas monitored for air pollution are exposed to air quality levels that exceed the WHO recommended limits. Populations in low- and middle-income countries are particularly affected, where 98% of cities (with population >100,000) do not meet WHO air quality guidelines (WHO 2016a). On a regional level, ASEAN Member States (AMS) experience some of the highest levels of urban air pollution, as records show that annual mean levels often exceed 5-10 times the WHO limits and more than two-thirds of cities in the region have seen levels rise by up to 5% between 2008 and 2013 (ibid.).

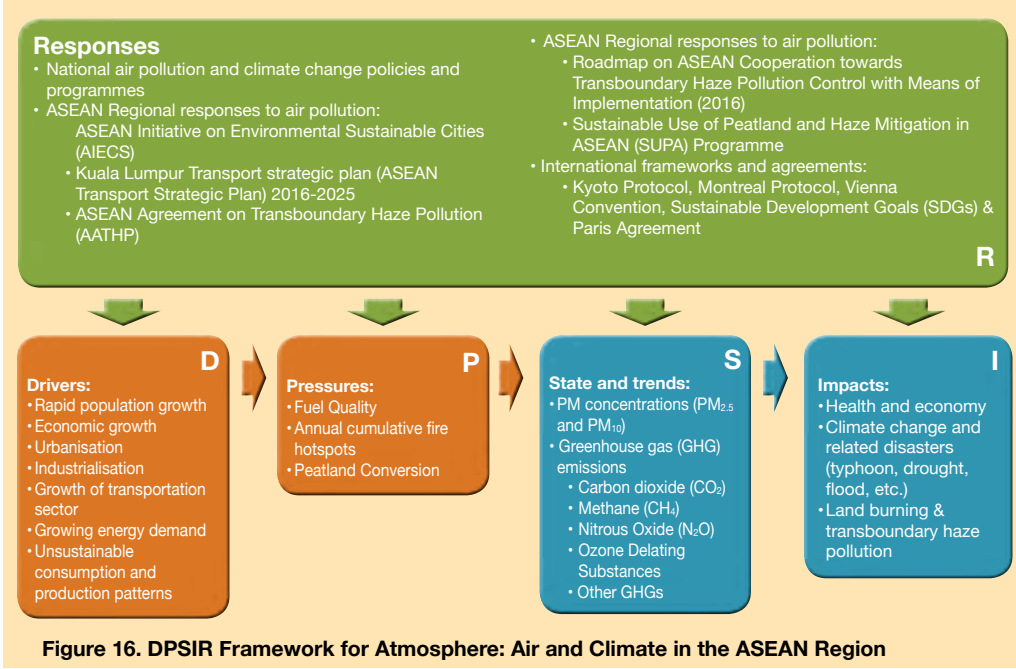


Figure 16. DPSIR Framework for Atmosphere: Air and Climate in the ASEAN Region

Poor air quality is causing long-term and wide-ranging health and economic impacts in the region. Studies have shown that the incidence of premature death and illness resulting from air pollution has increased (WHO 2012). In addition, air pollution is impacting on local and national economies, with costs of outdoor air pollution causing some countries billions of US$ in costs per year (OECD 2014b). Air pollution is also contributing to climate change and intensifying the associated risks and impacts. The number of disasters is increasing in the region and it is predicted that climate change will further impact the frequency, intensity, timing and spatial coverage of climatological and hydro-meteorological hazard-based disasters.

AMS are responding to the threats of air quality degradation and climate change through multiple national and regional level initiatives. AMS are implementing a number of pollution control programmes linked to transport, industry and energy sectors and urban centers. A number of air quality monitoring programmes have also been established to help monitor air pollution and identify current trends and support informed action. National level policies and action plans have been developed to help nations target action towards the reduction of air pollution and address climate change mitigation and adaptation measures. AMS are also engaging in international efforts to reduce air pollution. All ten AMS have submitted Intended Nationally Determined Contributions (INDCs) and targets under the 2015 Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) which indicate national commitments to reducing greenhouse gas (GHG) levels.

Transboundary haze pollution resulting from land and forest fires in the ASEAN region is a persistent challenge, and impacts the majority of AMS. While there have been great efforts to tackle the haze pollution problem, including the full ratification of the ASEAN Agreement on Transboundary Haze Pollution which came into force in 2003, and the creation of the recent Roadmap on ASEAN Cooperation towards Transboundary Haze Pollution Control with Means of Implementation (2016) (ASEAN Secretariat 2016b;

ASEAN Secretariat 2016c), there is still a long way to go. Stronger commitments are needed from all AMS to continue tackling the issue in holistic ways, including better land management controls.

2. Drivers

Industrialization, global-market driven production and international trade and exports have been central to the economic development of the ASEAN region. However, this has led to production and consumption trends that tend to consist of unhealthy, polluting and carbon-intensive lifestyles and practices (IPCC 2014; UNEP 2016). As a result, ASEAN as a whole has some of the highest levels of growth in per person emissions, despite the region also demonstrating big improvements in efficiency levels (IPCC 2014). To accommodate the increasing rates of urbanization and economic development, the number of construction activities has also increased during the past decade. For example, in just one year, the Philippines saw a nearly 7% increase in the total number of new construction projects, from 112,881 in 2011 to 121,051 in 2012 (DENR 2015). Between 2011 and 2013, over 70% of all approved construction projects in the Philippines was for residential purposes (ibid.).

Table 7. Total registered vehicles in ASEAN Member States (2004-2014)

ASEAN Member State	2004	2014
Brunei Darussalam	174	294
Cambodia	38	344
Indonesia	30,769	112,881
Lao PDR	360	1,587
Malaysia	13,747	25,101
Myanmar	960	4,908
Philippines	4,761	8,081
Singapore	727	972
Thailand	19,815	34,682
Viet Nam	532	2,000
Total	71,883	190,850

Source: ASEAN Secretariat, 2015

Increased urbanization and social mobility in the ASEAN region has led to higher demands on all modes of transport (land, water and air transport) (UNEP 2016). The transport sector is amongst those that consume the most energy, particularly fossil fuels. A combination of poor vehicle regulations and maintenance, variable fuel quality and standards, inadequate public transport systems, and limited vehicle inspections have resulted in increasing emissions, particularly of GHGs and particulate matter (PM) from buses, cars, trucks and motorcycles (UNEP 2016).

The number of total vehicles registered in the AMS increased nearly threefold between 2004 and 2014, from 72 million to 191 million (see Table 7) (ASEAN Secretariat 2015a). The steepest rise in land transportation occurred in Indonesia, which had the largest overall increase in number of registered vehicles, with an increase from 30.8 million to 112.9 million in the 10-year period (ibid.). Among all categories of motor vehicles, motorcycles recorded the highest growth (Ministry of Environment, Indonesia 2013a). The largest proportional increase in vehicle registration was in Cambodia, which increased nine-fold between 2004 and 2014, followed by Myanmar, seeing a five-time increase, and Lao PDR and Viet Nam, both seeing approximately a four-fold increase (Table 7). Additionally, there has been an increase in mobility through air travel in the ASEAN region, due to rising incomes and the increase in budget airlines making travel more affordable. Between 2004 and 2014, domestic passenger traffic increased from 88 million to 206 million passengers a year, and international passenger traffic increased from 92 million to 199 million passengers a year (ASEAN Secretariat 2015a; UNEP 2016).

Road transportation generates about 89% of total transport-related emissions in the ASEAN region, and GHG emission levels could increase at a rate of 2.7% per year in

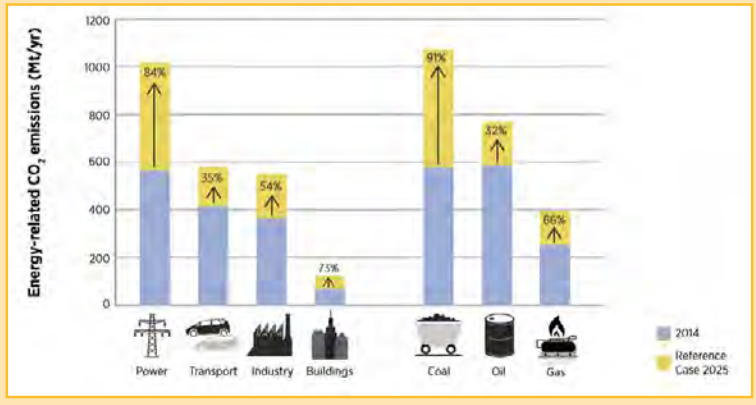
a business-as-usual scenario, with 2050 values being 3.4 times the 2005 values (ITPS 2012). The impacts on air quality can be seen through the spatial variation of emission levels where high concentrations of emissions are typically found around large urban areas where population and transportation numbers are highest (Government of the Philippines 2014). This is seen in, for example Indonesia, where the spatial distribution of nitrous dioxide (NO_2) from fuel usage for personal vehicles is mostly concentrated in the large urban centres of Java, Sumatra, Kalimantan and West Nusa Tenggara (Ministry of Environment, Indonesia 2013a).

Air pollution resulting from energy production is an increasing problem for the ASEAN region. Indoor air pollution from burning solid fuels, including coal and biomass fuels such as wood, dung, and agricultural residue, is a major concern in many AMS (IRENA and ACE 2016). According to the International Energy Agency (IEA 2016), over a third of the ASEAN region population (276 million people) still rely on traditional solid fuels as their primary energy source for heating and cooking at household level. Rural populations, particularly in Indonesia, Lao PDR, and Myanmar have a high reliance (>95%) on solid fuels (Table 8). Outdoor air pollution in AMS is mainly from industrial and power sectors, particularly from electricity generation, as well as transport sectors. Black carbon, PM and GHG such as carbon dioxide (CO_2) and methane (CH4) emitted through fuel combustion are powerful climate change pollutants and have a range of health-damaging properties.

Table 8. Population in ASEAN Member States using solid fuels in rural and urban areas (%)

ASEAN Member States	2013		Total
	Rural	Urban	
Brunei Darussalam	N/A	N/A	<5
Indonesia	>95	50	88
Lao PDR	>95	92	>95
Malaysia	<5	<5	<5
Myanmar	>95	81	93
Philippines	71	34	54
Singapore	N/A	N/A	<5
Thailand	31	13	23
Viet Nam	61	16	47

Source: WHO, 2013



Source: (IRENA and ACE 2016)

Figure 17. ASEAN's energy-related CO_2 emissions by sector and fuel, 2014 and Reference Case 2025

Currently, the energy sector is responsible for the largest CO_2 emissions, and it is predicted that energy-related CO_2 emission levels could rise in the ASEAN region by 61% from 2014 to 2025, primarily due to increases in energy demands from electricity

production, transportation and industry sectors (Figure 17). The energy demands will be met mostly through the combustion of fossil fuels, mainly coal, followed by oil and gas; however a significant growth in renewables and bioenergy is foreseen (IRENA and ACE 2016).

Poorly managed urbanization and economic activities can drive increases in air pollution, and will continue to do so, if planning and environmental management is not improved or if growth outpaces investments and developments in infrastructure to support the demands of economic growth, urbanization and industrialization in the region (UNEP 2016).

3. Pressures

Additional factors which may amplify the impacts of urbanization and industrialization trends and associated developments in the region, are fuel quality and standards, fire hotspots and land use conversion, particularly of forests and peatlands. Up to 90% of transboundary smoke haze in ASEAN is linked to peat fires related to expansion of large-scale commercial plantations of rubber and oil palm.

Fuel quality

Fuel qualities and standards vary across Southeast Asia, but in general terms, they are found to be much lower than other parts of the world (UNEP 2016). Over the past decade, all the AMS have phased out the use of leaded gasoline and have made unleaded gasoline available (ibid.). However, the regulation of other chemicals in gasoline and diesel is far more varied. For example, few AMS have announced a plan for reducing sulphur content in gasoline and diesel to recommended levels (ibid.). In Indonesia, large concentrations of sulphur dioxide (SO_2) resulting largely from diesel consumption in transportation modes related to industrial activities have been measured in municipalities with high levels of urban economic activity (Ministry of Environment, Indonesia 2013a). Alternative fuels, such as biofuels (e.g. ethanol and biodiesel), are also highly variable, and the quality of these fuels needs to be better controlled as, for example volatile organic compounds (VOCs), which are ozone precursors, can be a concern. The consumption of fossil fuels and biofuels in the region continues to have major negative impacts on air quality, especially in urban areas (Ministry of Environment, Indonesia 2013a).

Annual cumulative fire hotspots

Hotspots are areas generally associated with increased ground temperatures quite often correlated with burning on the land surface. During certain seasonal dry periods, there are high numbers of hotspots in AMS which could likely indicate serious fire and burning risks. The ASEAN Specialized Meteorological Center regularly issues advisories for transboundary smoke haze to ASEAN stakeholders, based on a four-level alert system (Table 9) in accordance with the ASEAN Standard Operating Procedure for Monitoring, Assessment and Joint Emergency Response for Transboundary Haze Pollution.

Table 9. Alert Levels for hotspot activity issues by the ASEAN Specialized Meteorological Center

Level 0	Stand down.
Level 1	Dry season.
Level 2	Exceeding 150 hotspots in 2 consecutive days with dense smoke plumes; dry weather persisting; and prevailing winds blowing towards ASEAN countries.
Level 3	Exceeding 250 hotspots in 2 consecutive days with dense smoke plumes; dry weather persisting; and prevailing winds blowing towards ASEAN countries.

Source: ASEAN Specialized Meteorological Center 2016

ASEAN is working to reduce the number of hotspots in the region in an attempt to reduce haze pollution. Efforts include close and continuous monitoring of hotspots, and enhanced coordination among local, national and regional governments, the private sector and local communities, to prevent and suppress land and forest fires (see section on responses). Table 10 shows the hotspot counts over the past years. It is important to note that hotspots may go undetected due to cloudy conditions or partial satellite pass, hence actual figures may be higher than recorded.

Table 10. Annual Hotspot Count in ASEAN Member States (2010-2016)

Country	2010	2011	2012	2013	2014	2015	2016
Brunei Darussalam	-	-	-	-	-	-	-
Cambodia	14,701	14,270	14,992	19,033	17,349	18,171	8,567
Indonesia	9,415	25,275	31,476	18,028	28,553	19,774	4,227
Lao PDR	22,819	12,707	17,679	15,770	11,540	7,751	9,005
Malaysia	2,516	2,330	3,637	2,967	4,327	2,379	1,111
Myanmar	38,359	27,976	52,033	44,397	37,926	26,657	16,158
Philippines	2,894	952	1,167	1,462	1,946	1,896	974
Singapore	-	-	-	-	-	-	-
Thailand	18,503	13,920	27,033	22,817	19,120	15,589	6,747
Viet Nam	12,537	9,448	13,981	12,442	13,201	9,657	5,442
TOTAL	121,744	106,878	161,998	136,916	133,962	101,874	52,231

Source: (ASEAN Specialized Meteorological Center 2016) NOAA-18 satellite (2010-2015) and NOAA-19 for 2016

Land use conversion

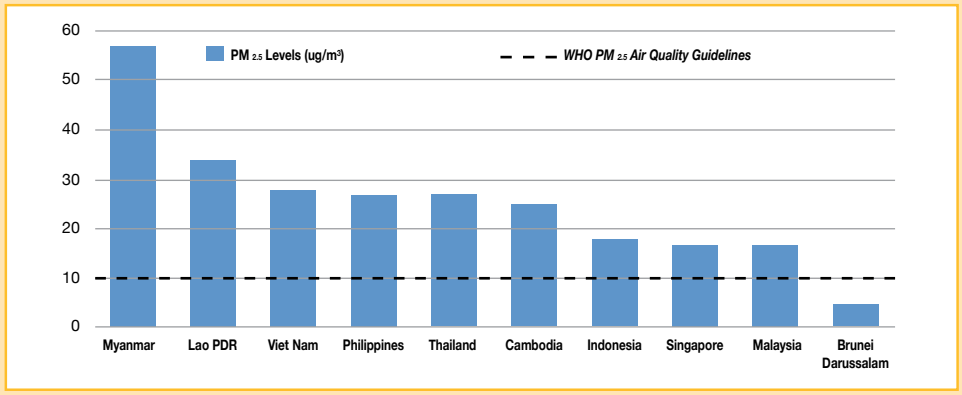
In Southeast Asia, transboundary smoke haze is a serious environmental and health problem caused by land and forest fires, mostly to clear vegetation to establish commercial plantations of corn, rubber and oil palm (Sunchindah 2015; UNEP 2016).

The burning of peatlands is a major contributor to the transboundary air pollution problem. More than 60% of the world's tropical peatlands, or 6% of the entire extent of peatland resources, are found in Southeast Asia (see also Chapter 2.2 Land). Despite their natural values and benefits to AMS, many peatlands areas are being affected by increased development, exploitation and unsustainable management practices (ASEAN Secretariat 2014). On the islands of Borneo and Sumatra in archipelagic ASEAN and mainland Southeast Asia (Thailand, Myanmar, Cambodia, Lao PDR and Viet Nam), improper land-use practices linked to extensive vegetation clearance, draining of peatlands, and peat burning are increasing the number of fires and transboundary smoke haze events in the region, causing major concerns both regionally and globally due to their wide-ranging economic, ecological and health impacts (UNEP 2016).

In fact, up to 90% of transboundary smoke haze in ASEAN is linked to peat fires (NEA 2015), and the region has experienced a number of severe haze events in recent years, including extensive fires in mid-2013 and 2015 resulting in transboundary haze pollution that spread across the south of the region affecting Indonesia, Malaysia, Singapore, and Thailand, as well as in early 2015, portions of Lao PDR, Myanmar, and Thailand (Sunchindah 2015).

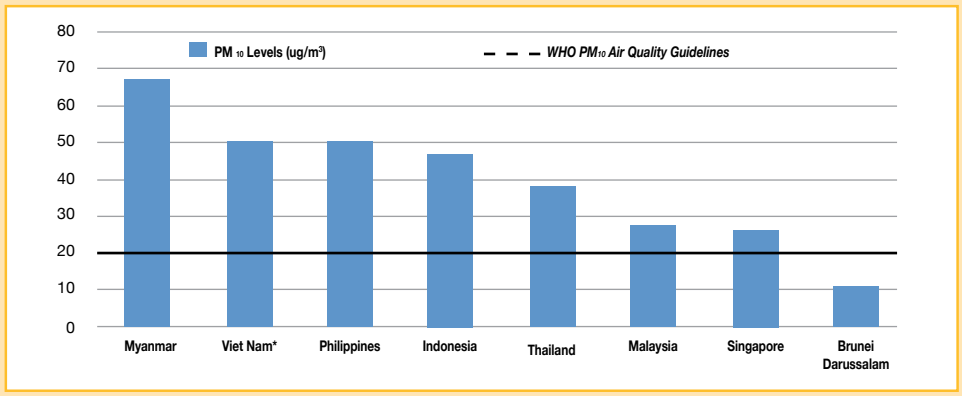
4. State and trends

Particulate Matter (PM) concentrations ($PM_{2.5}$ and PM_{10})



Source: Author's calculations based on (WHO 2016a)

Figure 18. Annual mean concentrations of fine particulate matter ($PM_{2.5}$) in urban areas (ug/m^3) in ASEAN Member States for 2014



*Source: OECD (2014) and WHO (2016). *Viet Nam State of the Environment Report 2011-2015 (2015). Data is not available for Cambodia and Lao PDR.*

Sources: (OECD 2014b; WHO 2016a)

Figure 19. Annual mean concentrations of fine particulate matter (PM_{10}) in urban areas (ug/m^3) in ASEAN Member States for 2014

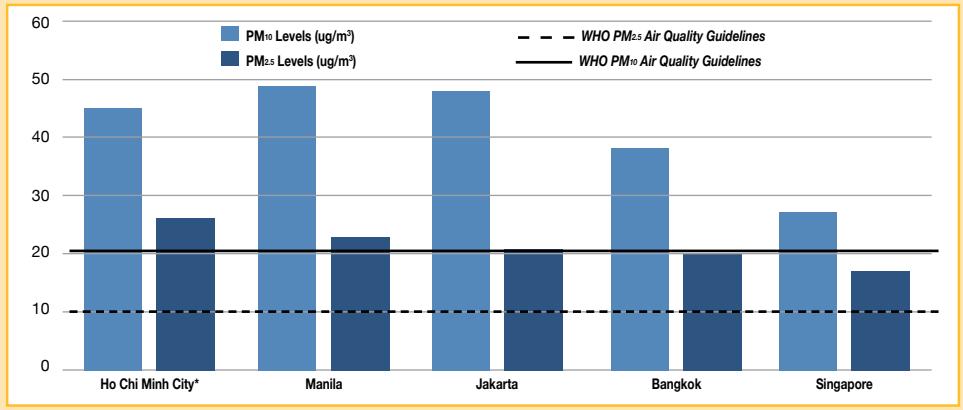
Particulate matter (PM, also called particle pollution) consists of a mixture of solid particles and liquid droplets found in the air. PM, which includes particles with diameters of approximately 10 micrometers and smaller (known as PM_{10}) and 2.5 micrometers and smaller (known as $PM_{2.5}$), are emitted directly from sources such as construction sites and fires, or form as a result of a reaction between chemicals (e.g. SO_2 and N_2O) from industries, power plants and vehicles.

According to the WHO, 92% of the world's population live in places where annual mean levels of $PM_{2.5}$ exceed air quality guidelines (WHO 2016a)[17]. Measurements in 2014 showed that annual mean concentration levels of $PM_{2.5}$ exceeded the annual WHO air

17. WHO guideline limits the annual mean of $PM_{2.5}$ to no more than 10 $\mu g/m^3$

quality guidelines in all but one of the AMS. Nations with the highest levels included Myanmar (57 μg/m^3), Viet Nam (28 μg/m^3), and Thailand and the Philippines (both 27 μg/m^3) (Figure 18). Brunei Darussalam, with a $PM_{2.5}$ level at 5 μg/m^3, was the only AMS with levels below the WHO guidelines.

In ASEAN, measurement between 2009 and 2012 of annual mean concentration of PM10 showed that, similar to $PM_{2.5}$ levels, all AMS exceeded the annual WHO air quality guidelines of 20 μg/m^3, except again for Brunei Darussalam (Figure 19).



*Source: OECD (2014) and WHO (2016). *Viet Nam State of the Environment Report 2011-2015 (2015)*

Figure 20. Pollution levels in the region's largest cities - Annual mean concentration (micrograms/m3) of PM_{10} and $PM_{2.5}$ in cities over 5 million inhabitants (2009-2012)

Levels of $PM_{2.5}$ and PM_{10} have been rising due to increased development and industrialization, and unsustainable environmental management practices. PM is a major air quality problem in Asian urban areas, and data shows that large urban areas tend to have relatively higher PM concentrations than areas with smaller population and that these areas often do not comply with quality standards. Figures show that major ASEAN cities with populations over 5 million inhabitants, tend to have $PM_{2.5}$ and PM_{10} levels above the WHO recommended levels (WHO 2016a). As shown in Figure 20, $PM_{2.5}$ levels in Ho Chi Minh City (Viet Nam), Manila (the Philippines), Jakarta (Indonesia) and Bangkok (Thailand) are over the recommended levels by two-fold or more, and PM_{10} levels by similar degrees.

Greenhouse gas (GHG) emissions

GHGs are a group of compounds that trap heat in the atmosphere contributing to global warming and climate change, and are typically generated from the combustion of fossil fuels (e.g. coal and petroleum) in energy, industry, transportation and household sectors, or from land-used change and domestic waste. Major GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), water vapour (H_2O), chlorofluorocarbons (CFCs), and hydrofluorocarbons (HFCs).

According to the World Resources Institute (WRI), in 2013, the total GHG emissions levels including those from land-use change and forestry (LUCF) in ASEAN amounted to 3,414 million tons of carbon dioxide equivalent ($MtCO_2e$), an apparent decrease (improvement) from the 2009 emissions level of 3580.8 $MtCO_2e$ (Table 11). The Philippines and Malaysia saw the biggest overall decrease in GHG levels by approximately 37.6% and 34.7% respectively between these years, followed by Brunei Darussalam (7.5%) and Indonesia

(5.5%). AMS which saw the largest proportional increase in GHG emission levels were Thailand (19.7%), Singapore (15.5%), Myanmar (12.2%) and Lao PDR (12.1%).

Table 11. Total GHG emissions, including land-use change and forestry (LUCF), in ASEAN Member States (2009-2013)

ASEAN Member State	GHG Emission ($MtCO_2e$)				
	2009	2010	2011	2012	2013
Brunei Darussalam	21.0	20.2	19.0	19.2	19.4
Cambodia	48.5	49.7	51.3	50.7	51.7
Indonesia	2285.2	1994.8	2135.2	2143.5	2160.6
Lao PDR	26.7	32.9	26.8	29.7	30.0
Malaysia	250.2	263.4	140.1	142.2	163.2
Myanmar	179.5	186.7	192.5	198.2	201.5
Philippines	178.2	184.6	96.5	101.3	111.3
Singapore	45.9	50.0	52.8	52.4	53.0
Thailand	321.1	343.8	353.6	376.2	384.4
Viet Nam	224.5	242.1	227.7	226.3	239.1
TOTAL	3580.8	3368.2	3295.4	3339.8	3414.1

Source: ASEAN Specialized Meteorological Center, 2016); Figures from NOAA-18 satellite (2010-2015) and NOAA-19 for 2016

On a sector level, the largest areas of emission growth have been due to energy-using activities, industrial processes and bunker fuels (fuel oil used aboard vessels) (Table 12), which are sectors associated with the region's structural transition away from agriculture (ADB 2015) (see also Section 1).

Driven by rapid economic and demographic changes, the energy and industrial demands in ASEAN have increased in the last decade. As a result, the energy sector had the largest rise in emissions of GHGs, with emission levels increasing by over 177 $MtCO_2e$ or 15% between 2009 and 2013 across ASEAN (World Resources Institute 2017). All AMS saw an increase in total GHG emissions, with the biggest increase seen in Indonesia (43.6 $MtCO_2e$), Thailand (41.9 $MtCO_2e$) and Malaysia (39.7 $MtCO_2e$). However, Myanmar saw the biggest proportional increase in emissions from energy-using activities of over 44% across the five-year period. This could be due to Myanmar recently opening up its borders to the global economy and the rise in investments and development in the nation (Government of Myanmar 2015).

The industrial sector is also a growing source of GHG emissions in ASEAN. The sector experienced a proportional increase in GHG emission levels of 31.3% between 2009 and 2013, the largest of any sectors, which may reflect the increasing industrial development in the region (UNEP 2016).

In Indonesia, the largest GHG emission levels are resulting from LUCF, which accounted for 1416.3 $MtCO_2$ or over 52% of the Indonesia's share of 2013 emissions. Most of this originated from deforestation and land degradation of peatlands, a major carbon store (ADB 2015). Drainage of peatlands causes a process of oxidation and CO_2 release, while fire events cause major emissions (ibid.). Other AMS saw a reduction in GHG emission levels from LUCF. In Malaysia and the Philippines, there was a decline by approximately 1190% and 300%, respectively, between 2009 and 2013, making these nations a net sink for GHG emissions. This could explain the decrease in total GHG levels seen during this period (Table 13).

Table 12. Total GHG emissions by sector in ASEAN Member States (2009-2013)

Country	Year	GHG Emission per Sector					
		Energy ($MtCO_2e$)	Industrial Processes ($MtCO_2e$)	Agriculture ($MtCO_2e$)	Waste ($MtCO_2e$)	Land-use change and forestry ($MtCO_2e$)	Bunker Fuels ($MtCO_2e$)
Brunei Darussalam	2009	18.37	0.18	0.12	0.14	2.17	0.53
	2013	18.48	0.26	0.14	0.15	0.38	0.51
Cambodia	2009	6.33	0.55	18.18	0.36	23.10	0.09
	2013	7.30	0.63	18.78	0.39	24.57	0.19
Indonesia	2009	445.55	20.00	153.93	61.80	1603.93	2.45
	2013	489.11	30.23	160.28	64.72	1416.30	3.09
Lao PDR	2009	-	0.51	7.06	0.45	17.11	-
	2013	-	0.76	7.85	0.49	18.47	-
Malaysia	2009	194.62	13.64	16.82	35.94	-10.85	5.22
	2013	234.33	16.71	13.65	38.46	-139.91	8.31
Myanmar	2009	15.27	0.35	63.43	11.14	89.29	0.06
	2013	22.05	0.33	64.66	11.71	102.70	0.13
Philippines	2009	77.15	10.56	51.22	9.80	29.50	3.55
	2013	95.92	14.44	50.67	10.57	-60.32	3.80
Singapore	2009	41.33	2.99	0.10	1.39	0.07	128.56
	2013	47.38	3.93	0.10	1.54	0.04	154.33
Thailand	2009	222.75	20.84	67.41	9.90	0.20	14.20
	2013	264.64	27.04	67.62	10.13	14.94	14.13
Viet Nam	2009	134.03	24.92	63.69	8.86	-7.02	2.45
	2013	153.74	29.84	63.93	9.25	-17.67	2.73

GHG=greenhouse gas;$MtCO_2e$ = million tons of carbon dioxide equivalent.
Bunker fuel is fuel oil used aboard vessels.
Note: Data not available for energy and bunker fuel sectros of Lao PDR
SourceL World Resources Institute (2017)

Co_2 = Carbon dioxide; $MtCO_2e$ = Million tons of dioxide equivalent; Excl. / Incl. LUCF = excluding / including Co_2 emission for land-use change and forestry

CO_2 is the most significant GHG in Earth's atmosphere, produced mainly through the combustion of fossil fuels (coal, oil and natural gas), biomass (e.g. trees, vegetation and wood products) and solid waste. When not considering LUCF, CO_2 emissions have risen in ASEAN by 17.5%, from 1077.0 $MtCO_2$ in 2009, to 1265.9 $MtCO_2$ in 2013 (Table 12). However, if you consider LUCF, there has been an apparent decrease (improvement) in CO_2 emission levels in the region by 5.5% in this time. This is because of the Philippines, Malaysia and Indonesia, acting as net sinks for GHG emission (as mentioned above), specifically of carbon.

Other GHGs include CH_4, also known as a short-lived climate pollutant (SLCP), and N_2O. They are emitted during agricultural and industrial activities, as well as through the combustion of fossil fuels (coal, natural gas, and oil) and solid waste. These pollutants are major climate change contributors, and can have major impacts on human health (WHO 2012).

Table 13. Total CO_2 emissions in ASEAN Member States, including and excluding land-use change and forestry (2009-2013)

ASEAN Member State	Including / Excluding LUCF	CO_2 emission ($MtCO_2$)				
		2009	2010	2011	2012	2013
Brunei Darussalam	Excl. LUCF	7.5	7.0	7.2	7.1	7.2
	Incl. LUCF	9.6	9.0	7.5	7.5	7.5
Cambodia	Excl. LUCF	4.8	5.0	5.3	5.5	5.7
	Incl. LUCF	27.5	27.7	28.0	28.3	28.4
Indonesia	Excl. LUCF	392.6	402.3	416.8	416.9	440.2
	Incl. LUCF	489.11	30.23	160.28	64.72	1416.30
Lao PDR	Excl. LUCF	1.3	1.6	1.6	2.2	2.2
	Incl. LUCF	17.5	17.8	17.8	18.4	18.4
Malaysia	Excl. LUCF	182.7	201.9	204.4	203.8	222.0
	Incl. LUCF	168.8	184.1	62.7	61.6	80.8
Myanmar	Excl. LUCF	7.5	8.3	8.6	11.7	13.7
	Incl. LUCF	86.2	87.6	102.8	106.5	109.1
Philippines	Excl. LUCF	79.2	85.4	86.3	90.2	100.1
	Incl. LUCF	108.7	114.9	26.0	29.9	39.8
Singapore	Excl. LUCF	40.3	44.3	46.7	46.0	46.2
	Incl. LUCF	40.4	44.3	46.8	46.0	46.3
Thailand	Excl. LUCF	223.9	241.6	240.0	259.4	268.5
	Incl. LUCF	222.9	240.6	253.6	273.0	282.1
Viet Nam	Excl. LUCF	137.0	155.4	255.6	152.4	160.1
	Incl. LUCF	129.8	148.4	135.9	132.7	141.6

Co_2 = Carbon dioxide; $MtCO_2e$ = Million tons of dioxide equivalent; Excl. / Incl. LUCF = excluding / including Co_2 emission for land-use change and forestry

SourceL World Resources Institute (2017)

CH_4 levels across ASEAN have risen considerably since the start of the 2000s, with the region seeing a CH_4 emission level rise of 170,350 thousand tons of carbon dioxide equivalent ($TtCO_2e$) or 33.9%, from 502,958 $TtCO_2e$ in 2000, to 673,308 $TtCO_2e$ in 2012 (Table 14). All AMS saw a rise in CH4 levels, with those seeing the highest proportional increase between these years being Cambodia (139.7%) and Lao PDR (107.9%). However, Indonesia saw the highest total increase of 53,284 $TtCO_2e$, with a total 2012 CH_4 emission level of 223,316 $TtCO_2e$, making up just under a third of total regional levels for that year.

Table 14. Concentrations of selected atmospheric pollutants in ASEAN Member States (2000-2012)

Country	Nitrous Oxide (N2O) Emissions ((TtCO2e)		Methane (CH4)) Emissions ((TtCO2e)		Other Greenhouse Gases* ((TtCO2e)	
	2000	2012	2000	2012	2000	2012
Brunei Darussalam	395	342	3,882	4,539	101	427
Cambodia	3,295	16,685	14,985	35,915	23,021	73,300
Indonesia	94,933	93,129	170,032	223,316	63,048	2,556
Lao PDR	3,265	8,987	7,219	15,011	13,588	136,841
Malaysia	13,822	15,310	29,309	34,271	5,144	3,866
Myanmar	31,300	26,783	66,942	80,637	78,176	405,274
Philippines	12,365	2,762	49,911	57,170	12,487	3,891
Singapore	6,635	1,909	1,684	2,386	1,410	3,299
Thailand	18,677	30,833	83,564	106,499	8,756	45,556
Viet Nam	19,746	34,494	75,430	113,564	5,782	25,707

** Other greenhouse gas emission refer to hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride;TtCO₂e = thousand tons of carbon dioxide equivalent.*

SourceL ADB (2017)

Table 15. Ozone-Depleting Substances Consumption in ASEAN Member States between 2009 and 2013

ASEAN Member States	Ozone-Depleting Substance Consumption (ODP Tons)				
	2009	2010	2011	2012	2013
Brunei Darussalam	5.8	6.9	8.1	5.9	4.3
Cambodia	17.1	12.6	13.7	10.1	9.5
Indonesia	374.8	433	337.5	329.4	310.5
Lao PDR	3	2.5	2.7	2.8	1.6
Malaysia	604.5	542.8	485.8	737.6	449.9
Myanmar	4.1	4.5	5.8	9.7	3
Philippines	403.4	222	164.9	195.7	136.7
Singapore	226.9	207	111.6	169.3	116.7
Thailand	1012	1088.8	832	1171.6	863.3
Viet Nam	289.3	311.7	292.9	269.9	252.9

ODP Tons = Metris tons of ODS weighted by their Ozone Depletion Potential (ODP)

Source: UNEP Ozone Secretariat, 2017

N_2O levels in ASEAN have also been increasing since 2000, rising by 18% from 204,433 $TtCO_2e$ in 2000, to 241,244 $TtCO_2e$ in 2012 (Table 14). Recently, N_2O has also been recognized as a major ozone-depleting substance (ODS) and, due to its rising levels over the past few decades, is expected to become one of the largest throughout the 21st century (Ravishankara et al. 2009). CFCs and other halogenated ODS, emitted from man-made halocarbon refrigerants, solvents, and propellants, are also responsible for ozone depletion. Records show that, as a whole, there has been an apparent decrease (i.e. improvement) in ODS emission levels in ASEAN of 26.9% between 2009 and 2013, with levels dropping from 2,940.9 to 2,248.4 ODP tons (Table 15). All AMS recorded decreases in levels, with the Philippines, Malaysia, Thailand and Singapore seeing the biggest total reductions of 266.7, 154.6, 148.7 and 110.2 ODP tons respectively.

The decrease in ODS emission levels in ASEAN is largely due to the regional commitments to reducing ODS through the Montreal Protocol on Substances that Deplete the Ozone

Layer (see Response Section). However, with a decrease in ODS in the region, there has been a huge rise in emission levels of other GHG pollutants that are commonly used in place of CFCs and other ODS, such as HFCs and PFCs (Table 15).

5. Impacts

Health and economy

The degrading air quality in ASEAN is causing long-term and wide-ranging impacts on the environment and populations across AMS, particularly relating to health and the economy. In 2012, an estimated 6.5 million deaths (11.6% of all global deaths) were associated with indoor and outdoor air pollution together globally (WHO 2016a).

Figure 21 shows a global view of the mortality rate attributed to household and ambient air pollution in 2012; in ASEAN specifically, the mortality rate was 665.4 people per 100,000 population (WHO 2016b).

The number of deaths and disability adjusted life years (DALYs)[18] attributed specifically to ambient air pollution on a national level in 2012, resulting from emissions from industrial activity, households, cars and trucks, can be seen in Table 16. PM_{10} is a big contributor to the health impacts experienced in the region, and has led to increases in cases of cardiovascular and respiratory diseases, cancer, stroke and premature death (OECD 2012a; UNEP 2016). In urban areas where there are higher concentrations of people and air pollutants, poorer air quality is posing increased detrimental health risks to residents, with the most exposed people being those working in the transport sector, such as traffic patrollers, as well as car drivers, passengers and daily commuters (DENR 2015).

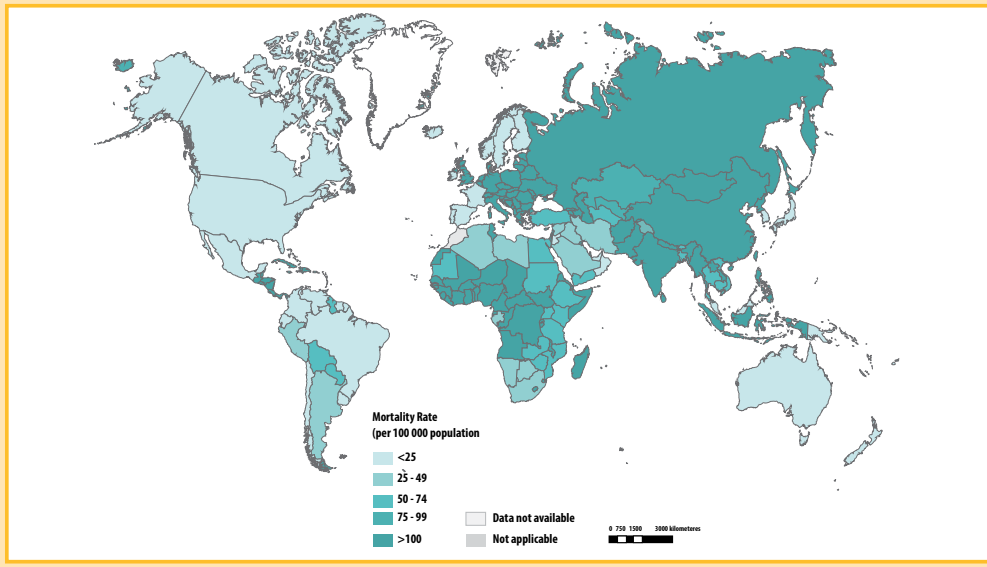
Table 16. Number of disability adjusted life years (DALYs) and deaths attributed to ambient air pollution in ASEAN Member States in 2012

ASEAN Member States	DALYs	Deaths
Brunei Darussalam	21	1
Cambodia	105,261	2,934
Indonesia	1,769,100	51,792
Lao PDR	74,641	1,857
Malaysia	165,821	6,251
Myanmar	718,432	22,664
Philippines	1,015,174	28,696
Singapore	26,600	1,094
Thailand	542,214	22,375
Viet Nam	688,818	27,340
Total:	5,106,082	175,004

Source: WHO (2017).

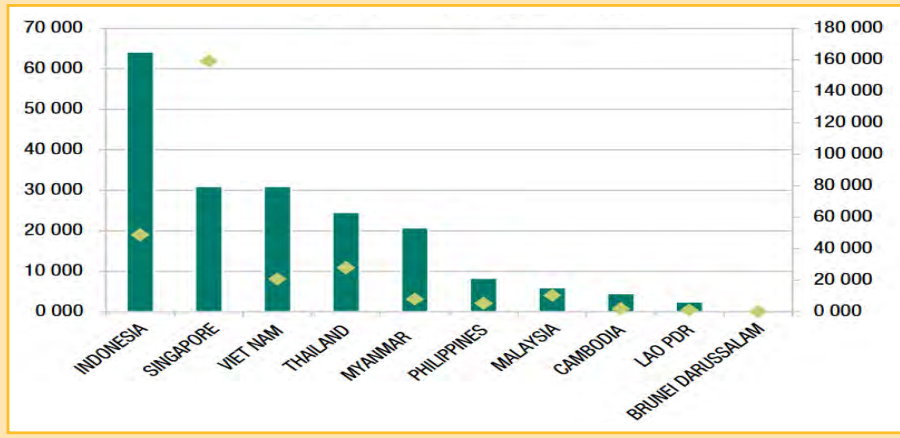
The impacts of air pollution on local and national economies can be estimated through linking premature death, willingness to pay to reduce the risk of death and national Gross Domestic Product (GDP) levels (OECD 2012b; OECD 2014a). In 2010, the costs of outdoor air pollution were over US$ 280 billion, with highest costs found in Singapore (US$ 160 billion), Indonesia (US$ 50 billion), Thailand (US$ 27 billion) and Viet Nam (US$ 20 billion) (Figure 22). It is worth noting that Singapore's high share of urban deaths from air pollution and associated costs may be explained in part by the fact that its entire population is urban.

18. One DALY can be thought of as one lost year of "healthy" life. The sum of these DALYs across the population, or the burden of disease, can be thought of as a measurement of the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability.



Source: (WHO 2016b)

Figure 21. Mortality rate attributed to household and ambient air pollution in 2012, by country



Note: Pollution includes ambient PM10 pollution and ambient ozone pollution; costs based on the value of a statistical life using methodology from (OECD 2014a).

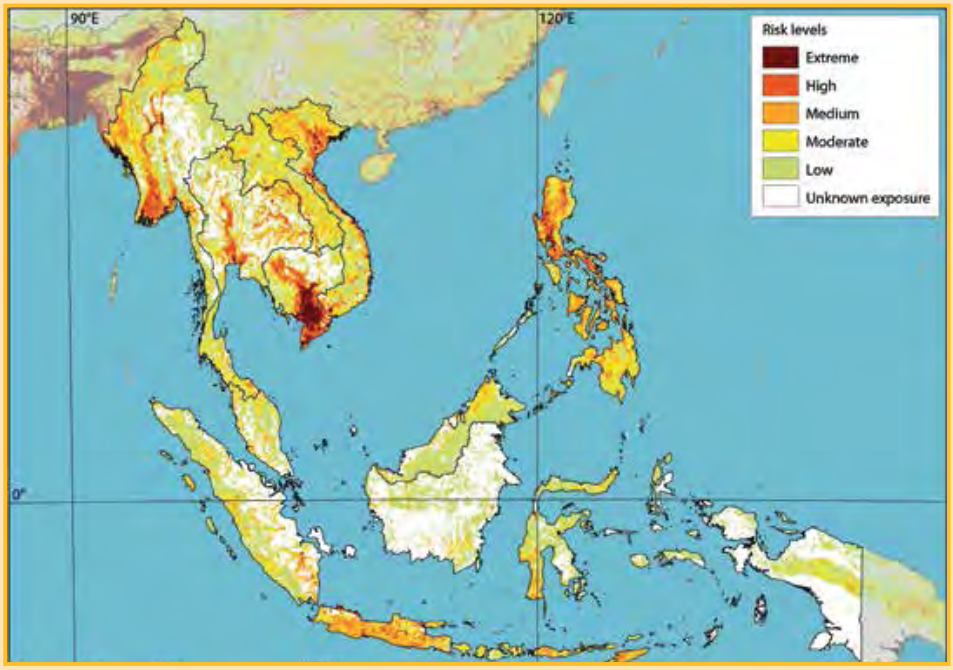
Sources: (OECD 2014b). Author's calculations based on data extracted from (Institute for Health Metrics and Evaluation 2013)

Figure 22. Deaths from outdoor pollution and associated costs, 2010

Climate change and related disasters

Some forms of air pollution, such as GHG (e.g. CO_2) and PM (e.g. $PM_{2.5}$), have been linked to changes in the climate through trapping the heat from the sun in the Earth's atmosphere thus causing a warming in surface temperatures. Impacts have included warmer air and ocean temperatures, increases in intensity and frequency of heat waves and heavy rainfall events, cases of coral bleaching and ocean acidification (IPCC 2014; UNEP 2016), as well as sea level rise. As temperatures increase, it also promotes the formation of O_3 caused by N_2O compounds, which can further exacerbate atmospheric pollution and its health effects (ibid.).

Average temperature trends in Southeast Asia have been increasing, rising by 0.1-0.3°C per decade over the last five decades (USAID 2010). Temperature projections show that temperatures will continue to rise, potentially reaching 2-4°C by the end of the century, with largest rises predicted for Thailand, Indonesia and Viet Nam (ibid.). While air pollution is not the only driver of climate change, the need to reduce air pollution, particularly GHGs, as a way of reducing global warming has been recognized internationally (see Responses Section).



Source: (UNESCAP and UNISDR 2012)

Figure 23. Mortality risk distribution of selected hydro-meteorological hazards (tropical cyclone, flood, rain-triggered landslide) in Southeast Asia

Climate change is impacting the frequency, intensity, timing and spatial coverage of climatological and hydro-meteorological hazard-based disasters (IPCC 2012). Climate change is resulting in an increase in frequency of heat waves, heavy precipitation, sea level rise, and increasing intensity of floods, tropical cyclones and droughts (ibid.). Southeast Asia is one of the most at risk regions in the world to the impacts on climate change, with forecasted rankings showing six of the twenty countries most vulnerable to climate change worldwide being Indonesia, Thailand, Myanmar, Malaysia, Viet Nam and the Philippines (UNEP 2014). Specific multi-hazard hotspots (particularly hydro-meteorological hazards) include many of the populated Indonesian islands; the Chao Phraya Delta in Thailand; the Ayeyarwady (Irrawaddy) Delta in Myanmar; the Mekong Delta in Cambodia and Viet Nam; the eastern coastline of Viet Nam up to the Red River Delta; and Manila and other zones across the Philippines (Figure 23) (UNESCAP and UNISDR 2012; 2015) (see also Section 1.1 for more details).

Sea level projections for 2050, from UNEP's report, suggests that populations across AMS are at increasing risk to sea level rise resulting from climate change, particularly Indonesia (20 million people at risk), the Philippines (15 million people at risk), and Viet Nam (10 million people at risk), and to a lesser extent, Malaysia, Myanmar and Thailand

(UNEP 2014). There are also observed changes and increasing risks associated with the Asian monsoon, with the Indian summer monsoon impacting the variability and intensity of rainfall and the onset of monsoons in Southeast Asia (Loo et al. 2015).

In recent years, the unpredictability and increased intensity of the monsoon rainfall, particularly during the harvest or post-harvest stages, has led to crop and land damage, as well as loss of property and livelihoods, damage to infrastructure and huge economic impacts (IPCC 2014; Loo et al. 2015). There is also an increased probability of drought in the region, and higher risks of wildfires and smoke exposure as well as associated morbidity and mortality (IPCC 2014).

Box 2. Impacts of land burning and transboundary haze pollution in ASEAN

Economic Impacts

Fires and smoke haze have caused the ASEAN region to suffer serious economic losses, resulting from disrupted businesses and services, reductions in tourism and a decline in trade and investment (ASEAN Secretariat 2016c). The transport sector has also been adversely affected. Road travel, flights and marine traffic are usually disrupted due to dangerous conditions resulting from the deteriorated visibility from the haze, and there is often an increase in the number of accidents (ibid.) As well as material losses, the region suffers damages to agricultural productivity, and affects the livelihoods of millions of people across ASEAN (ibid.).

The 1997-1998 fire and haze episode in Indonesia had major economic impacts on the region. For Singapore, it is estimated that the economic cost was between US$ 163.5 and 286.2 million, with greatest losses occurring in the tourism sector (US$ 136.6 - 210.5 million), followed by recreation (US$ 23.2 - 71.2 million) and health sectors (US$ 3.8 - 4.5 million) (Islam et al. 2016). In Indonesia, economic costs have been estimated to be between US$ 9 to 20 billion (Islam et al. 2016). Tourism greatly suffered in Indonesia following the event, as many popular tourism spots were affected by the fire and haze. Kalimantan suffered more than six million hectares (ha) of damage from the fires, including Kutai National Park in East Kalimantan (ADB 2001).

Ecological and environmental impacts

Forest fires and haze pollution has caused ecological impacts in the region, by damaging soil quality and productivity, polluting rivers and other water bodies, eroding biodiversity, degrading vegetation and crops, and threatening wildlife and their habitats (ADB 2001). Additionally, forest fires contribute to climate change due to emissions of GHGs and other hazardous pollutants from the burning biomass. It is recognized that biomass burning significantly contributes to the global warming trends, contributing to as much as 10% of the total CO2 and 38% of tropospheric ozone (ibid.).

Health impacts

Following haze events, studies in Malaysia have shown an increase of up to 31% of inpatient cases relative to normal days (Othman et al. 2014). Exposure to smoke haze can lead to substantial increases in cases of upper respiratory tract infections, conjunctivitis, and asthma, and can have immediate and delayed effects on mortality, particularly of children and adult females (e.g. Sahani et al. 2014). In a study on the health impacts of the haze episode in 2015, the number of excess deaths from smoke exposure is estimated to be 91,600 in Indonesia, 6,500 in Malaysia, and 2,200 in Singapore (Koplitz et al. 2016). The figure is more than double that of the episode in 2006. Other health impacts include skin ailments, cardiovascular diseases, cancer, and other respiratory and lung problems (ASEAN Secretariat 2016c).

In the last 45 years, the most economically damaging events in Southeast Asia that occurred were the 2011 floods in Thailand, which caused over US$ 45 billion worth of damage in the Bangkok Metropolitan Area and Central Thailand, and Typhoon Yolanda (known internationally as Typhoon Haiyan) in the Philippines in 2013, which resulted in US$ 10 billion worth of damage (Thomalla et al. 2017). Given the increased risk of climatological and hydro-meteorological hazards owing to climate change in the region, AMS can expect greater disaster impacts if future climate change is not considered in national development and disaster risk reduction (DRR) policies and strategies.

Land burning and transboundary haze pollution

Forest fires and burning biomass, and the resulting smoke haze, has had serious direct and indirect impacts across AMS and beyond, resulting in economic, ecological and environmental, health and social repercussions of varying levels (Box 2). Following concerns of the severity and geological spread of the recent smoke haze event in 2015, ASEAN decided to commission a study on the economic, health and social impacts of the event, which is due to be completed in 2017 (see Responses Section).

6. Responses

In the effort to tackle the drivers and impacts of air quality degradation, including the resulting climate change, AMS are undertaking multiple actions at national, regional, and global levels. These demonstrate the commitment of ASEAN to reducing air pollution, but there is still a long way to go.

National responses to air pollution and climate change in selected AMS

Many AMS have initiated multiple national programmes and policies, and have enacted a number of air pollution control laws and environmental quality standards, to support the monitoring and management of air quality in their respective nations. A few examples are highlighted below.

Indonesia is increasingly recognizing the importance of GHG reduction in the transportation sector and has outlined a number of strategies to achieving its goal of a low carbon society, namely through supporting the integration of public transport systems and reduction of private vehicle ownership (ESDM 2012; Sukarno et al. 2016). Additionally, recent notable efforts to reduce exhaust emissions from the motor vehicles include the LangitBiru (Blue Sky) Programme and Awards (announced in 2013) under the Ministry of Environment, which encouraged urban air quality improvement from vehicle emissions through the adoption of sustainable transport and innovative efforts to reducing fuel consumption (Ministry of Environment, Indonesia 2013b).

Indonesia's Evaluation of Urban Air Quality (EKUP) Programme further supports the reduction of emissions (such as CO_2, N_2O, O_3, and SO_2) produced from gasoline and diesel vehicles through testing vehicle emissions and monitoring traffic and air quality (Ministry of Environment, Indonesia 2013a). In 2013, Indonesia's Programme for Pollution Control, Evaluation, and Rating (PROPER), a national-level public environmental reporting initiative to promote industrial compliance with pollution control regulations and a shift to "clean technology", was successful in lowering air pollution and GHG emission levels from 65 companies (ibid.). Indonesia also has a presidential decree on the National Action Plan for Reducing Greenhouse Gas Emissions, signed in 2011, which outlines activities for governments, private sector and civil society that aim to reduce GHG emissions, namely in Forestry and Peatland, Agriculture, Energy, and Transportation Sectors (Nachmany et al. 2014).

Another important recent development was the establishment of the Peatland Restoration Agency (BRG) at the beginning of 2016. The BRG is tasked with creating and implementing an action plan supporting the restoration of 2 million hectares (ha) of drained peatland damaged by fire in Indonesia, which was major source of air pollution in the region in 2015 (Badan Restorasi Gambut 2017).

Since the enactment of the "Philippine Clean Air Act of 1999" (RA 8749), the Department of Environment and Natural Resources (DENR) Environmental Management Bureau (EMB) has been active in managing air quality in the Philippines, with key accomplishments including the establishment and operationalization of the Air Quality Management fund, the designation of 22 air sheds (as of 2015), and the establishment of emissions inventories for mobile and stationary emission sources and Ambient Air Quality Networks nationwide (DENR 2015). In 2011, the Philippines launched the National Environmentally Sustainable Transport (EST) Strategy, with a main aim of reducing the annual growth rate of energy consumption and associated air pollutant emissions (e.g. GHGs) from the transport sector in urban areas (DOTC and DENR 2011). The strategy sets national guidelines which aim to contribute towards achieving the Sustainable Transport Goals as set in the Bangkok 2020 Declaration and provide the basis to developing relevant nationally appropriate mitigation actions (NAMAs) related to Environmentally Sustainable Transport to support international efforts of addressing climate change (ibid.). Additional efforts from multiple government agencies have further supported the reduction of emissions, particularly from mobile sources, through promoting improvements of fuel standards, for example, the recent order by DENR EMB on the adoption and implementation of new vehicle emission limits for EURO 4/IV and standards (effective 1 January 2016); the use of alternative fuels, such as the use of compressed natural gas (CNG) and liquefied petroleum gas (LPG) in public and private transport, and conversion to electric vehicles; and motor vehicle emissions inspections and monitoring (DENR 2015).

Thailand has taken steps to strengthen its air pollution control institutional infrastructure through the establishment of the Thailand Greenhouse Gas Management Organization (TGO) tasked with promoting low carbon activities and investments in GHG emission reductions (Nachmany et al. 2014). Other notable policy initiatives include the Alternative Energy Development Plan (2008-2021), which sets renewable energy targets and promotes tariff schemes for renewable energy generation, the Energy Efficiency Development Plan (2011-2030), which aims to reduce Thailand's energy consumption, and the creation of the National Carbon Fund, which provides technical and financial assistance to Clean Development Mechanism projects (ibid.). Additionally, Thailand's Environmental Quality Management Plan (2012-2016), supports strategies aimed at tackling the degradation of natural resources, pollution, reduced environmental quality, GHG emissions and climate change impacts in Thailand (MONRE Thailand 2012).

In Malaysia, the Ministry of Energy, Green Technology and Water (KeTTHA) has embarked on low carbon mobility as one initiative towards promoting green growth. The National Electric Mobility Blueprint has been developed to chart the future of a low carbon mode of transportation Malaysia, and the Green Technology Master Plan has a dedicated chapter on transportation detailing the low carbon modal shift for both public and private transportation (KeTTHA 2015).

Singapore is working hard to increase its fleet of cleaner and greener vehicles. To reduce vehicular emissions and improve Singapore's ambient air quality, the Government of Singapore is supporting a number of schemes and technologies (see Box 3).

Box 3. Introduction of greener vehicles and carbon tax in Singapore

In 2013, the Government of Singapore introduced the Early Turnover Scheme (ETS) which aims to encourage Category C diesel vehicles owners to switch their older and higher-polluting diesel vehicles with newer and cleaner models, from Euro 1 diesel fuel vehicles to Euro 4-compliant vehicles. An extension on the scheme was announced in March 2017 with plans to provide incentives for vehicles owners with Euro 2/3 emissions standards to turnover to Euro 6 (or equivalent) vehicles. As of the end of 2016, about 27,000 Pre-Euro/ Euro 1/2/3 vehicles have been replaced under the scheme.

Also in 2013, the Government introduced the Carbon Emissions-based Vehicle Scheme (CEVS) to encourage the purchase of low carbon emission vehicles through the introduction of taxes and surcharges. Currently, cars can incur a registration surcharge of between S$ 5,000 and S$ 30,000 if they emit more than 186g CO_2/km of carbon emissions. There are plans to replace the CEVS with the Vehicular Emissions Scheme (VES) at the start of 2018, which, in addition to the CO_2 criteria in the existing scheme, will focus on four other pollutants hydrocarbons (HC), carbon monoxide (CO), nitrous oxides (N_2O) and particulate matter (PM)..

In recent years, the National Environment Agency (NEA) in Singapore has supported the implementation of new or higher vehicular emissions standards and, from 2017, is planning to introduce new regulations on the composition of petrol and fuel supplied in the nation.

Type of Vehicle	Current Standard	Date
Diesel Vehicle	Euro V	1 January 2014
	Euro VI	(expected: 1 September 2017)
Petrol Vehicle	Euro IV	1 April 2014
	Euro VI	(expected: 1 September 2017)
Motorcycle and Scooters	Euro III	1 October 2014

To support consumers in making more informed decisions around car purchasing, Singapore's Land Transport Authority (LTA) is administering the mandatory Fuel Economy Labelling Scheme for cars and light goods vehicles. This is helping buyers select vehicles which have better fuel efficiency and emit lower carbon emissions.

Source: (MEWR and MND 2014; NEA 2017; LTA 2017; CSIS 2017)

All AMS have recognized the need to support action on mitigation and adaptation to climate change. Together with the international commitments to reducing GHG emissions (e.g. INDCs, see below on international responses), AMS have adopted national level plans specific to climate change, for example, Viet Nam's National Climate Change Strategy (2011-2020) and Action Plan for Adaptation to Climate Change in the Agriculture and Rural Development Sector (2008-2020) (Nachmany et al. 2014), and Myanmar's Climate Change Strategy and Action Plan (2016-2030) (MoNREC 2016).

In addition, AMS are developing their national climate change institutional infrastructure by establishing teams or platforms dedicated to handling climate change activities. For example, Cambodia's National Climate Change Committee (NCCC), oversees the preparation, coordination, implementation and monitoring of climate change policies, strategies and programmes in the nation (NCCC 2013). The NCCC is supported by the Climate Change Technical Team (CCTT) and the Climate Change Department (CCD) (ibid.).

ASEAN regional responses to air pollution and climate change

Collective efforts by AMS to tackle air pollution and air quality degradation are also being implemented across the ASEAN region. AMS are working together to support environmentally sustainable transport and urban development, and respond to transboundary issues, such as transboundary haze pollution. Many measures are in place targeting environmental sustainability in cities, clean air, land and water, and to increase energy efficiency and the use of cleaner fuels. For example, under the ASEAN Project on Clean Air for Smaller Cities in the ASEAN Region (CASC) implemented between

January 2009 and December 2015 with support from the Government of Germany, technical support was provided to medium-sized cities in ASEAN in the development and implementation of Clean Air Plans (CAPs), including air quality monitoring strategies and emission inventories, aiming to improve air quality and support sustainable urban development (ASEAN-German Technical Cooperation 2015) (for more details on other similar initiatives, see Section 1.1 and Chapter 2.6: Production and consumption).

Through the recent endorsement of the Kuala Lumpur Transport Strategic Plan (ASEAN Transport Strategic Plan) 2016-2025, AMS have agreed to actively pursue sustainable transport through formulating a regional policy framework on sustainable transport supporting low carbon modes of transport, energy efficiency, user friendly transport initiatives, integration of transport and land use planning (ASEAN Secretariat 2015b). More specifically, to reduce emissions from the transportation sector, ASEAN aims to initiate and support the development and implementation of fuel economy policies and standard as well as policies towards cleaner fuels, vehicles and vessels, and develop monitoring frameworks and harmonized approaches for indicators on energy and GHG emissions in the transport sector (ibid.).

Strategy 1	Implementation of the ASEAN Agreement on Transboundary Haze Pollution (AATHP)
Strategy 2	Sustainable Management of Peatlands for Peatland Fires Prevention
Strategy 3	Sustainable Management of Agricultural Land and Forest for Large Scale Forest and/or Land Fires Prevention
Strategy 4	Strengthening Policies, Laws, Regulation and their Implementations, including to facilitate exchange of experience and relevant information among enforcement authorities of the Parties in accordance with the AATHP Article 16 (f)
Strategy 5	Enhancing cooperation, Exchange of Information and Technology, and Strenghthening of capacity of Institutions at All Levels
Strategy 6	Enhancing Public Awareness and Cross-Sectoral and Stakeholders Participation
Strategy 7	Securing Adequate Resources from Multi-Stakeholders for Transboundary Haze Prevention
Strategy 8	Reducing Health and Environmental Risks and Protection of Global Environment

Figure 24. Key strategic components as highlighted in the Roadmap on ASEAN Cooperation towards Transboundary Haze Pollution Control with Means of Implementation

ASEAN has recognized the issue of transboundary haze pollution for more than two decades and started to formally address the problem in 1995 with the establishment of the Haze Technical Task Force (under the ASEAN Senior Officials on the Environment) and the Regional Haze Action Plan, along with other institutional setups to prevent, monitor, and mitigate fires and haze especially the potential adverse transboundary impacts on neighbouring AMS (Sunchindah 2015). The ASEAN Agreement on Transboundary Haze Pollution (AATHP), signed in 2002, has been ratified by all 10 AMS and forms the only piece of ASEAN legislation pertaining to the environmental sector (ASEAN Secretariat 2016b). There has been significant progress in the implementation of the work programme under the AATHP, including concrete on-the-ground activities such as multi-national cooperation to fight fires; and implementation of the ASEAN Peatland Management Strategy (2006-2020) (ASEAN Secretariat 2014).

To further operationalize the implementation of AATHP, AMS adopted the Roadmap on ASEAN Cooperation towards Transboundary Haze Pollution Control with Means of Implementation at the 12th Meeting of the Conference of the Parties (COP-12) in August 2016 (ASEAN Secretariat 2016c). The Roadmap serves as a strategic, action-oriented and time-bound framework for the implementation of collaborative actions to control transboundary haze pollution in the ASEAN region with the overall goal of eliminating regional transboundary haze pollution through intensifying collective actions to prevent and control forest and/or land fires (p. 2, ASEAN Secretariat 2016c). Concrete and collective actions will be developed and implemented under key strategic components highlighted in the Roadmap that translate the principles of the AATHP (Figure 24).

AMS have implemented several sizeable projects focusing on peatlands and control of air pollution, lately under the umbrella of the ASEAN Programme on Sustainable Management of Peatland Ecosystems (APSMPE; 2014-2020). For instance, the programme on the Sustainable Use of Peatland and Haze Mitigation in ASEAN (SUPA; 2016-2019), a joint ASEAN-EU initiative, is focusing on improving sustainable peatland management, managing risks of forest fires and reducing transboundary haze in ASEAN, and consequently mitigating the adverse impact of climate change (ASEAN Cooperation on Environment 2017a). (See chapter 2.2 Land for more details.)

A regional study is underway on the impacts of the 2015 smoke haze episode on the ASEAN region. The main objective of the study is to assess the implication of the 2015 haze incident to ASEAN and enable AMS to have baseline economic, health and social data to understand the impact of transboundary haze (ASEAN Cooperation on Environment 2016). The study is funded by the ASEAN Transboundary Haze Pollution Control Fund and is expected to be ready for the 13th Meeting of COP AATHP in Brunei Darussalam in 2017 (ibid.).

AMS have shown commitment to addressing issues of climate change in the region. Since 2007, AMS leaders have regularly issued Joint Statements related to climate change at the UNFCCC COPs, which highlight ASEAN's common views and concerns towards a global solution to the challenges of climate change and their resolve to achieve an ASEAN community resilient to climate change through national and regional actions. ASEAN have also hosted several side events to the COPs, for instance, the event "*Towards A Low Carbon and Climate Resilient ASEAN Community Post-2015, with Focus on Sustainable Solutions for Peatland Fires and Haze*" at COP-21 in 2015 and "*Sustainable City through Sufficient Ways and Climate Change Challenges*" at COP-22 in 2016.

In addition, ASEAN is working with key dialogue partners on several climate change-related initiatives focusing on strengthening urban climate resilience and adaptation, and building multi-stakeholder partnerships and platforms to promote awareness, exchange experiences, share successful approaches and innovation and initiate collaborative action to address climate resilience, for example, the USAID-funded CityLink Pilot Partnership, EU Support to Low-Carbon, Environmentally Sustainable and Climate Resilient ASEAN Cities project, and ASEAN City Leaders on Climate Resilience supported by UNDP.

ASEAN has also worked with India on two major initiatives related to climate change: the ASEAN-India Project on Enhancing Climate Change Adaptation in Southeast Asia, which supported a scoping study on the needs of AMS related to climate change adaptation; and the ASEAN-India Project on Climate Change Projections and Assessment of Impacts: Modelling and Capacity Building Programme for India and ASEAN region, which focused on building capacity of climate experts from AMS to analyze the current climate variability and project future climate change using the latest climate modeling applications.

Achieving internationally agreed environmental goals

AMS have been actively engaging in several international mechanisms and agreements supporting the reduction of air pollution and degradation, and the impacts and drivers of climate change.

All AMS have shown their full commitment to major multilateral environmental agreements (MEAs). All have ratified the Kyoto Protocol under the UNFCCC that commits State Parties to internationally binding targets to reduce GHG emissions. The AMS have also made agreements under the Montreal Protocol on Substances that Deplete the Ozone Layer (a protocol to the Vienna Convention), which directs efforts on protecting the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion.

The AMS have already met their commitments to most of the relevant conventions. For example, all AMS have significantly reduced the use of ozone depleting CFCs to less than 1,000 ton per year since 2006 from as high as 9,000 tons in 1995 (ASEAN Cooperation on Environment 2017b). Many AMS are also several years ahead of internationally agreed deadlines to end the production and consumption of ozone-depleting substances (ibid.).

Recently, many AMS are developing and undertaking activities contributing to the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs). The SDGs cover a broad range of issues and are expected to result in stronger commitments leading to an ambitious agreement and implementation framework. In relation to air pollution and climate change, it is hoped that the SDGs might lead to the revival of a global carbon market and other legal and regulatory instruments, promote innovation in CO_2 emission-reduction techniques and renewable energy generation, as well as moves towards a low-carbon society (UNEP 2016). Some of the relevant goals and targets are linked to health, urban development, energy, sustainable consumption and production and climate change (Table 17).

Table 17. Select Sustainable Development Goals and Targets relevant to atmospheric pollution

Goals	Targets
3. Ensure healthy lives and promote well-being for all at all ages (air pollution)	3.9 By 2030, substantially reduce the number of deaths and illness from hazardous chemicals and air, water and soil pollution and contamination
7. Ensure access to affordable, reliable, sistainable and modern energy for all (energy efficienacy)	7.2 By 2030, increase substantially the share of renewable in the global energy mix 7.3 By 2030, double the global rat of improvement in energy efficeinacy 7.4 By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy techonolgy.
11. Make cities andhuman settelements inclusive, safem resilient and sustainable (sustainable cities)	11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
12. Ensure sustainable comsumption and production pattern (fuel sibsidies)	12.c Rationalise inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumtances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into acoount the specific needs and condtions of developing countries and minimising the possible adverse impacts on their development in a manner that protects the poor and the affected communities
13. Take urgent action to combat climate change and its impact	13.2 Integrate climate change measures into national policies, strategies and planning 13.a Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annualy by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the FGreen Climate Fund through its capitalization as soon as possible

Source: UNEP, 2015.

The recent adoption of the Paris Agreement in 2015, which deals with climate change mitigation, adaptation and finance, was an important moment for the world in recognizing the pressing need to address the current and future impacts of climate change (UNFCCC 2016). As of June 2017, nine of the ten AMS have fully ratified the Agreement, with Myanmar still in the process of ratification. All AMS have submitted INDCs and a range of voluntary targets to reduce CO_2, which act as a foundation for the implementation of the Paris Agreement (Table 18). All INDCs also include adaptation strategies, plans and actions for low GHG emission development. This is a significant milestone particularly for Lao PDR, Myanmar and Cambodia, as this is their first time to develop strategies that support efforts to reduce GHG emission levels (ASFN and NTFP-EP 2016). Of the submitted INDCs, many identify the transportation and energy sectors as targets for emission reduction, and propose sectoral mitigation measures (ASEAN Secretariat and GIZ 2016).

Table 18. Submission status of intended nationally determined contributions (INDCs) in ASEAN Member States

Country	Emission reduction (unconditional)	Emission reduction (conditional)	Reference Year	Tsrget Year
Brunei Darussalam	Activity related targets: **Energy**: reduce enrgy consumption by 65% increase share of renewables to 10% **Land transport**: reduce morning peak due hour CO2 emissions from vehicles by 40% **Forests**: increase total gazetted forest reserves from the current 41% to 55% of total land area		BAU	2035
Cambodia	-	27% (+land use, land-use change and forestry)	BAU	2030
Indonesia	29%	41%	BAU (2010-)	2030
Lao PDR	Activity related targets: **Forests**: increase forest cover to 70% of total land area **Energy**: reduce renewables energy to 30% of its energy consumption		2000-2015	2015-2030
Malaysia	35% (per unit of GDP)	45% (per unit of GDP)	2015	2030
Myanmar	Sectors are identified for mitigation but without specific emition targets			
Philippines	-	70%	BAU (2000-)	2030
Singapore	36% (per unit GDP)		2005	2030
Thailand	20%	25%	BAU (2005-)	2030
Viet Nam	8%	25%	BAU (2010-)	2030

BAU = bussiness-as-usual scenarion as reference for emission reduction.
Source: UNFCCC (2014) and UNEP (2016)

7. References

ADB (2015). *Southeast Asia and the Economics of Global Climate Stabilization*. Asian Development Bank: Manila, Philippines.

ASEAN Cooperation on Environment (2017b). *ASEAN Cooperation on Chemicals and Waste ASEAN Facts and Figures*. ASEAN Secretariat: Jakarta. http://environment.asean.org/asean-working-group-on-multilateral-environmental-agreements-awgmea/.

ASEAN Cooperation on Environment (2017a). *ASEAN, EU launch 40th anniversary of partnership; commit to new programmes on environment*. ASEAN Secretariat: Jakarta, March 2017. http://environment.asean.org/asean-eu-launch-40th-anniversary-of-partnership-commit-to-new-programmes-on-environment/. Press Release.

ASEAN Cooperation on Environment (2016). 18th Meeting of the Sub-Regional Ministerial Steering Committee (MSC) on Transboundary Haze Pollution. *ASEAN Secretariat: Singapore*, May 2016. http://haze.asean.org/2016/05/media-release-18th-meeting-of-the-sub-regional-ministerial-steering-committee-msc-on-transboundary-haze-pollution/.

ASEAN Secretariat (2016b). *ASEAN Agreement on Transboundary Haze Pollution*. ASEAN Secretariat., Jakarta: July 2016.

ASEAN Secretariat (2015a). *ASEAN Statistical Yearbook 2015*. ASEAN Secretariat., Jakarta, September 2015.

ASEAN Secretariat (2015b). *Kuala Lumpur Transport Strategic Plan (ASEAN Transport Strategic Plan) 2016-2025*. ASEAN Secretariat., Jakarta, December 2015.

ASEAN Secretariat (2016c). *Roadmap on ASEAN Cooperation towards Transboundary Haze Pollution Control with Means of Implementation*. ASEAN Secretariat., Jakarta: August 2016.

ASEAN Secretariat (2014). *ASEAN Peatland Management Strategy 2006-2020. Strategy and Action Plan for Sustainable Management of Peatlands in ASEAN Member States 2006-2020*. ASEAN Secretariat, Jakarta, Updated September 2013.

ASEAN Secretariat and GIZ (2016). *Sustainable Transport Indicators on Energy Efficiency and GHG Emissions in the ASEAN Region: Background Paper*. ASEAN Secretariat., Jakarta.

ASEAN Specialized Meteorological Center (2016). Hotspot Information*. Association of Southeast Asian Nations*. http://asmc.asean.org/asmc-haze-hotspot-annual#Hotspot.

ASEAN-German Technical Cooperation (2015). *Clean Air for Smaller Cities in the ASEAN Region -Report on Project Activities 2014/2015*. ASEAN and German Technical Cooperation., Bangkok, April 2015.

ASFN and NTFP-EP (2016). *Intended Nationally Determined Contributions from Forestry in ASEAN Countries. ASEAN Social Forestry Network (ASFN) & on-Timber Forest Products – Exchange Programme (NTFP-EP) Asia*. http://ntfp.org/wp-content/uploads/2016/06/Policy-Paper-INDCs.pdf. Policy Paper.

Badan Restorasi Gambut (2017). *Peatland Restoration in Indonesia. Presentation for Café Crossfire Debate: Deforestation - A Sustainable Dilemma, Brussels, 21 March 2017*, Badan Restorasi Gambut, Republic of Indonesia.

DENR (2015). *State of the Brown Environment (2008-2015): The Philippines*. Department of Environment and Natural Resources, Republic of the Philippines.

DOTC and DENR (2011). *Formulation of a National Environmentally Sustainable Transport Strategy for the Philippines*. Department of Transportation and Communications & Department of Environment and Natural Resources. Final Report.

ESDM (2012). *Assessment of Greenhouse Emissions: Transport Sector*. Ministry of Energy and Mineral Resources, The Republic of Indonesia.

Government of Myanmar (2015). *Myanmar State of the Environment Report 2014/2015*.

Government of the Philippines (2014). *Second National Communication to the United Nations Framework Convention on Climate Change*: Philippines.

IEA (2016). Energy Access Database - World Energy Outlook*. International Energy Agency*. http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/.

IPCC (2012). *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (No. A Special Report of the Intergovernmental Panel on Climate* Change Working Groups I and II (Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley). Cambridge University Press, Cambridge, UK, and New York.

IPCC (2014). *Climate Change 2014: Synthesis Report*. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Intergovernmental Panel on Climate Change., Geneva.

IRENA and ACE (2016). *Renewable Energy Outlook for ASEAN: A RE Map Analysis. International Renewable Energy Agency (IRENA*), Abu Dhabi and ASEAN Centre for Energy (ACE), Jakarta.

ITPS (2012). *Asia Study of Transport System in a Low Carbon Society*. Institution for Transport Policy Studies and Clean Air.

KeTTHA (2015). *LaporanTahunan, 2014*. Kementerian Tenaga, Teknologi Hijau Dan Air., Malaysia.

Loo, Y. Y., Billa, L. and Singha, A. (2015). Effect of climate change on seasonal monsoon in Asia and its impact on the variability of monsoon rainfall in Southeast Asia. *Geoscience Frontiers*, 6(6). 817–823.

Ministry of Environment, Indonesia (2013b). *Blue Sky Programme Generates Evaluation of Urban Air Quality 2013*. Ministry of Environment, Republic of Indonesia., Jakarta.

Ministry of Environment, Indonesia (2013a). *State of the Environment Report of Indonesia 2013: Environmental Security of Indonesia*. Ministry of Environment, Republic of Indonesia., Jakarta.

Ministry of Natural Resources and Environment, Viet Nam (2015). *State of the Environment Report 2011-2015*. Ministry of Natural Resources and Environment, Viet Nam, Ha Noi.

MONRE Thailand (2012). *The National Environmental Quality Management Plan, 2012-2016*. Ministry of Natural Resources and Environment, Thailand.

MoNREC (2016). *Myanmar Climate Change Strategy and Action Plan (MCCSAP).* Ministry of Natural Resources and Environment Conservation, The Republic of the Union or Myanmar.

Nachmany, M., Fankhauser, S., Townshend, T., Collins, M., Landesman, T., et al. (2014). *The GLOBE Climate Legislation Study: A Review of Climate Change Legislation in 66 Countries*. Fourth Edition. GLOBE International and the Grantham Research Institute, London School of Economics., London.

NCCC (2013). *Draft Cambodia Climate Change Response Strategic Plan 2014–2023*. National Climate Change Committee., Phnom Penh.

NEA (2015). *ASEAN Guidelines of Peatland Fire Management*. National Environment Agency, Republic of Singapore.

OECD (2012b). *Mortality Risk Valuation in Environment, Health and Transport Policies*. Organisation for Economic Co-operation and Development. OECD Publishing.

OECD (2012a). *OECD Environmental Outlook to 2050L The Consequences of Inaction*. Organisation for Economic Co-operation and Development. OECD Publishing.

OECD (2014b). *OECD Green Growth Studies: Towards Green Growth in Southeast Asia*. Organisation for Economic Co-operation and Development. OECD Publishing.

OECD (2014a). *The Cost of Air Pollution: Health Impacts of Road Transport*. Organisation for Economic Co-operation and Development. OECD Publishing.

Ravishankara, A. R., Daniel, J. S. and Portmann, R. W. (2009). *Nitrous Oxide (N2O): The Dominant Ozone-Depleting Substance Emitted in the 21st Century*. Science, 326(5949). 123–5.

Sukarno, I., Matsumoto, H. and Susanti, L. (2016). Transportation energy consumption and emissions - a view from city of Indonesia. *Future Cities and Environment*, 2. 6. DOI:10.1186/s40984-016-0019-x.

Sunchindah, A. (2015). *Transboundary Haze Pollution Problem in Southeast Asia: Reframing ASEAN's Response*. Economic Research Institute for ASEAN and East Asia. Discussion Paper Series.

Thomalla, F., Boyland, M. and Calgaro, E. (2017). Disasters and development in Southeast Asia: Towards equitable resilience and sustainability. In *Routledge Handbook of Southeast Asian Development*. A. McGregor, L. Law, and F. Miller (eds.). Routledge.

UNEP (2014). *Keeping Track of Our Changing Environment in Asia and the Pacific*. United Nations, Bangkok, Thailand.

UNEP (2016). *GEO-6 Regional Assessment for Asia and the Pacific*. United Nations Environment Programme., Nairobi, Kenya.

UNESCAP (2015). *Disasters without Borders: Regional Resilience for Sustainable Development (Asia Pacific Disaster Report 2015).* United Nations Economic Commission for Asia Pacific.

UNESCAP and UNISDR (2012). *The Asia-Pacific Disaster Report 2012: Reducing Vulnerability and Exposure to Disasters*. United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP); United Nations International Strategy for Disaster Reduction (UNISDR)., Bangkok, Thailand.

UNFCCC (2016). *Aggregate Effect of the Intended Nationally Determined Contributions: An Update. Synthesis Report by the Secretariat*. United Nations Framework Convention on Climate Change (UNFCCC)., 22nd Conference of Parties, Marrakech.

USAID (2010). *Final Report: Findings and Recommendations. Asia- Pacific Regional Climate Change Adaptation Assessment*. United States Agency for International Development, Washington DC.

WHO (2016a). Global Urban Ambient Air Pollution Database. *World Health Organization*.

WHO (2016b). *World Health Statistics 2016*. World Health Organization.

WHO (2012). Public Health and Environment (PHE): Ambient air pollution. DALYs attributed to ambient air pollution & Deaths attributed to ambient air pollution. *World Health Organization*. http://apps.who.int/gho/data/node.main.156?lang=en.

WHO (2013). WHO Global Health Observatory data repository: Population using solid fuels (estimates), Data by country. *World Health Organisation*. http://apps.who.int/gho/data/view.main.1701?lang=en.

World Resources Institute (2017). CAIT Climate Data Explorer. *World Resources Institute*. http://cait.wri.org.

2.2. Land

This chapter examines the status of the land resource in the ASEAN region which includes the current status of forest cover and soil quality. The chapter also seeks to understand factors affecting the land's status by exploring how global and regional consumption trends for food, fiber and fuel have created pressures that subsequently impact the quality and availability of land in the region.

2.2. Land

Key Messages

- Between 1990 and 2012, most ASEAN Member States (AMS) experienced a decline in forest cover mainly due to the expansion of rubber and oil palm commercial plantations into forest areas.
- Peat and mangrove forests are the most vulnerable forest types and are disappearing at a faster rate than other forest types. This is of significant concern for climate change mitigation due to the high carbon sequestration capacity of these forest types.
- Growing demand for forest and agriculture products like rubber and palm oil has led to poor land management such as the burning and draining of peat swamps for agriculture, the clear cutting for timber harvesting and the illegal conversion of forest land.
- There is an increase in soil degradation caused by deforestation and agricultural expansion. Land erosion and soil fertility loss from forest conversion as urgent concerns that need to be addressed in policy; A comprehensive and updated study of soil status within the region is needed to better understand soil status and the availablity of cultivable land.

1. Introduction

This chapter explores the status of land and forest resources and the drivers and pressures in the ASEAN region which significantly affect the quality and availability of resources. The ASEAN region's forests are rich in biodiversity and the ecosystem services that they provide support the livelihoods of many people in the region (FAO 2011). However, urbanization, and socioeconomic and demographic changes as well as regional consumption patterns (see also section 1: regional context and priorities) are exerting tremendous pressure on land and forest resources.

Pressures upon land resources within the ASEAN region cause land-use changes primarily in the form of change in forest cover and deforestation. The ASEAN region has some of the highest rates of forest cover loss globally with the greatest losses occurring in peat and mangrove forests (Hughes 2017). Former major drivers such as rotational clearing of farmland and fallow forest areas have now been superseded by forest conversion for commercial agriculture (Stibig and Stolle 2007). While some concerted conservation efforts have reversed forest clearing trends in some areas, it is unable to reverse the decline in primary and natural forests (FAO 2011).

Deforestation is also occurring due to infrastructure development for energy. Energy demand in the region is rising and leading to the increased extraction of fossil fuels such as coal along with development of other sources of energy such as hydropower (IEA 2015). (Energy demand within the ASEAN region is further explained in section 1). (See also section 1: regional context and priorities)

Deforestation impacts soil quality and also leads to soil erosion as soils become destabilised (Fox et al. 2014). Other associated impacts include the loss of soil fertility (FAO 2015).

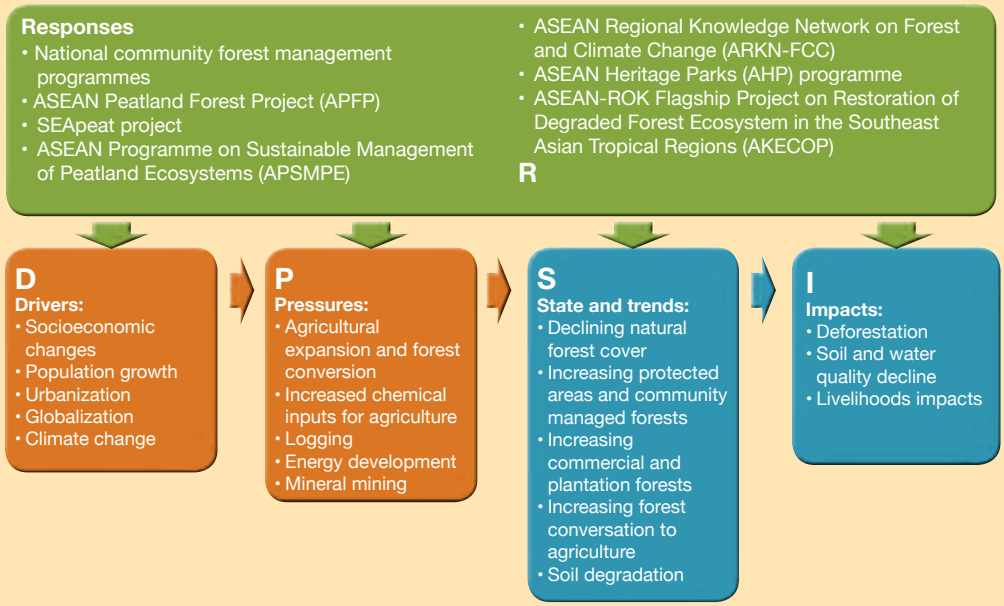


Figure 25. DPSIR framework for Land in the ASEAN region

ASEAN Member States (AMS) are responding to deforestation and land management issues through better forest management, conservation finance schemes such as payment for ecosystem services or REDD+[19] programs, strategic partnerships for technical and financial assistance and through local programs such as community forestry, and by taking steps to improve natural resource governance (Costenbader et al. 2015).

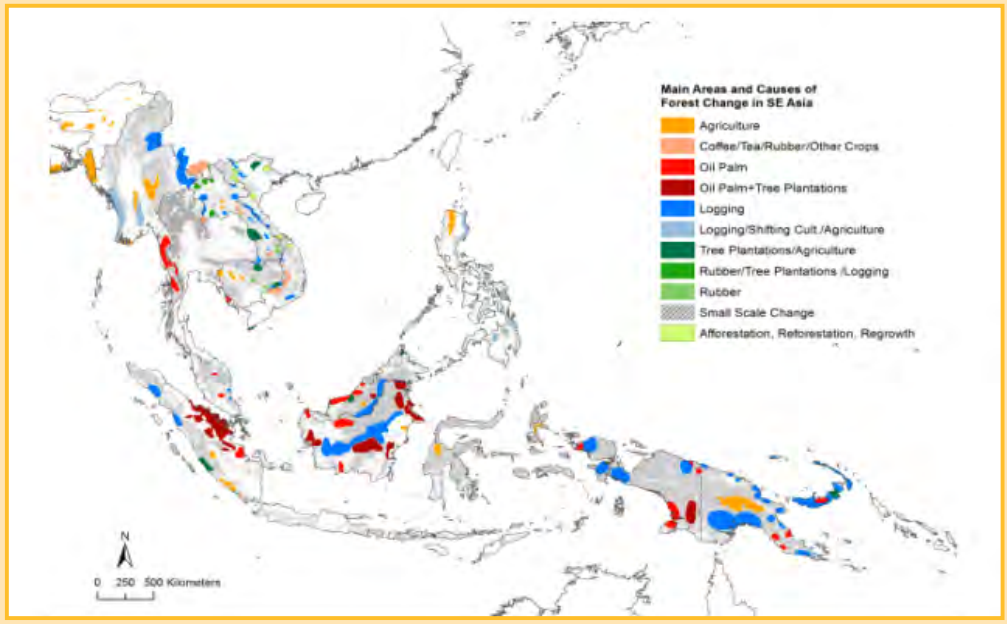
2. Drivers

The most significant drivers of land-use changes are demographic and socio-economic changes including population growth, urbanization, global demand for food, and globalization that increase the consumption of food, fuel and fibre products (Figure 25). Additionally, socio-economic changes such as an increased middle-income population and improved living standards drive the consumption demand for higher value products such as timber and minerals. Increases in consumption drive agricultural expansion and energy development. Section 1: regional context and priorities and section 2.6: production and consumption)

The ASEAN region is a major producer of food and fuel. Within the food and fuel sectors, ASEAN had the highest production of cereals and palm oil fruit in 2013. The livestock sector, although still small in AMS, is growing. Food demand in the ASEAN region is expected to increase, and along with it, the need for agricultural land to produce food, fuel and fiber. Within the ASEAN region, protein and fat supply have risen steadily since 1993 (FAO 2014). From 2010-2014, the growth rate of sheep and chickens were the highest within ASEAN. The highest rates of increase (from 2010 to 2014) in the chicken population were in Myanmar at 47%, Indonesia at 32% and Brunei Darussalam at 28%.

19. REDD+ is a global initiative in which organizations or nations are paid for protecting forest and reducing carbon dioxide (CO_2) emissions (RECOFTC 2010)

Sheep population increased with the highest growth rate in Viet Nam at 21% followed by Indonesia and Myanmar at 15% (The ASEAN Secretariat 2015b).



Source: Stibig and Achard 2014

Figure 26. Main areas and causes of forest change in ASEAN Member States in 2000

Energy demand is increasing due to pressures associated with improved living standards amongst AMS, urbanization, and industrialization (see section 1: regional context and priorities). Between 2000 and 2013, the demand for energy increased by over 50% in the ASEAN region (IEA 2015).

Climate change drives pressures upon land by creating temperature increases, changes in rainfall patterns and rainfall intensity, the onset of drought, floods and storms and seasonal changes such as delayed onset or shortening seasons (e.g. the wet season). In the ASEAN region, climate change poses major threats to agriculture and forest systems. These threats include crop damage, impacts on forest tree species and loss of forest cover due to variation in temperature, rainfall, floods, droughts, forest fires and storms (ASFN 2014). Additionally, the productivity of some species of plants may be affected by greenhouse gas emissions such as carbon dioxide (CO_2) (Hughes 2017). Climate change may also potentially affect soils as it impacts the inputs of carbon to soil from vegetation which is sensitive to the effects of climate change (Karmakar et al. 2016).

3. Pressures

The growing demand caused by the increasing consumption of more food, fuel, fiber and other goods is creating considerable pressures on land resources, particularly on natural forest cover (Figure 25). The main pressures within the ASEAN region causing forest change are agricultural expansion, logging and energy development and to a lesser extent, mineral mining, which leads to land degradation and deforestation (Costenbader et al. 2015).

Agricultural expansion

The changing socio-economic circumstances in ASEAN are leading to a greater demand for food and animal products, creating a supply response based on agricultural expansion. Figure 26 shows that forest conversion for commercial plantations of oil palm is a major contributor to forest change (Boucher et al. 2011; Stibig and Achard 2014).

The region has a long-standing history of forest to agricultural conversion. Since the period between the 1980s and the 1990s, 60% of new agricultural lands in the ASEAN region relied on intact forest as sources of new agricultural land (Gibbs et al. 2010). Now, across the ASEAN region agroforestry is undertaken at different scales mainly for planting fruit, oil palm and rubber trees. At present, rubber and oil palm plantations are the greatest contributors to deforestation (Hughes 2017).

Table 19. Use of fertilizers and pesticides in selected ASEAN Member States in metric tons (Brunei Darussalam; Lao PDR, Malaysia, Myanmar, and Thailand)

ASEAN Member States	Pesticeides used (metric tons)					
	2009	2010	2011	2012	2013	2014
Brunei Darussalam	3.74	6.16	0.54	0.57	0.26	1.20
Lao PDR	0.49	0.05	-	19.53	54.07	0.20
Malaysia	16607.77	21636.26	3532.83	4098.35	4902.35	4053.45
Myanmar	591.84	1812.27	2369.76	1677.34	1245.10	2220.90
Thailand	8112.00	9995.00	10671.00	4770.00	1675.00	6838.00

ASEAN Member States	Herbicides use (metric tons)					
	2009	2010	2011	2012	2013	2014
Brunei Darussalam	23.58	31.10	7.34	0.70	11.10	17.30
Lao PDR	23.17	0.10	43.80	23.48	68.27	1.97
Malaysia	34084.40	36132.04	36322.56	41667.78	53514.96	41060.98
Myanmar	149.88	294.30	478.54	471.10	873.90	1950.30
Thailand	53615.00	51900.00	67608.00	60231.00	1220.00	11091.00

Source: FAO (2014)

An important issue related to forest conversion are land management practices that have negative impacts on the environment. Such practices include excessive chemical inputs on agricultural land, monoculture plantations, illegal and unsustainable logging, unrestrained clear cutting and other forms of environmentally damaging land use practices. For example, plantations such as rubber and oil palm depend on large-scale land clearing as they are typically grown in monoculture plantations where the optimal economy of scale size is 30,000 to 50,000 hectares (ha) (Hughes 2017). Another example of a detrimental environmental practice is the draining and burning of peatland for converting to oil palm and pulpwood plantations (Carlson et al. 2015).

Increased chemical inputs into soils to boost agricultural productivity and improve yields negatively impact soil quality. Pesticide and herbicide use within most AMS have decreased between 2009 and 2014, except for Myanmar[20] (see Table 19). Some crops require more chemical inputs than others. A comparative look at chemical treatment

20. Data unavailable for other AMS.

in rice fields in AMS shows that a huge area of total rice cultivated area, respectively, were treated with insecticides: Viet Nam (99%), Philippines (95%), and Indonesia (75%) (Gianessi 2014). In Thailand, the import of pesticides, herbicides, insecticides has increased from 30,000 tons in 2000 to nearly 120,000 tons in 2010 (Panuwet and Siriwong 2012).

Logging

Increasing demand for timber and forest products is leading to land use changes and deforestation. Figure 26 shows that logging is a major cause of land use change in the ASEAN region. The region's rates of timber extraction exceed that of other tropical regions; timber exports from Borneo alone amounted to more than those from all of tropical Africa and Latin America (Edwards et al. 2011). In recent years, the percentage of major losses in forest cover have been linked to international demand for timber and agricultural products (UNEP 2012a).

Logging (both legal and illegal) of timber can take a variety of forms and has a range of impacts. The frequency of harvest cycles and the quantity and intensity of harvests determine how detrimental the impacts of logging are on the environment, and on subsequent forest recovery. In the ASEAN region, the standard tree removal allowance of 9 trees per ha is higher than in other parts of the world where the norm is 1 to 2 trees per ha. The method of clear cutting, which involves clearing large areas of forest, is highly detrimental for the environment can lead to and biodiversity loss (Hughes 2017).

Energy development

Energy development requires the extraction of the resource (in the case of fossil fuels) and the installation of infrastructure for energy generation and transmission. Infrastructure causes both direct and indirect land use changes. A direct change occurs when a forest is cleared to put infrastructure in place. An indirect change occurs when chemicals used in extractive processes pollute the soil and water. In the case of biofuel production, land needs to be converted to energy crop plantations. The production of oil and gas, coal, shale gas, and biofuels which together comprise the largest share of the energy portfolio for AMS (see Section 1: regional context and priorties), cause severe impacts on land use (Sovacool 2014).

The ASEAN region relies strongly on traditional fossil fuel based energy systems. In 2014, 76% of the power capacity generated in ASEAN was based on oil, coal and natural gas (Pranadi 2017). Some AMS have large fossil fuel reserves. For instance, Indonesia has some of the largest coal resources and is the largest exporter of coal in the ASEAN region. In 2013, 89% of coal produced in ASEAN was from Indonesia. Indonesia is also the largest producer of oil and gas in the region, followed by Malaysia (IEA 2015).

Hydropower's share of energy generating capacity is increasing (see also section 1: regional context and priorties). In 2014, hydropower accounted for the largest share of renewable energy capacity in the region. In Lao PDR, Myanmar and Viet Nam, hydropower is currently the main source of installed generation capacity (IEA 2015).

Some AMS are also experiencing an increasing demand in biofuel because of new energy policies. This creates pressure, for instance, to produce more palm oil which is blended with traditional fuels. For example, in 2015, Indonesia increased its biodiesel subsidy and increased the biodiesel blending rate from 10 to 15%. Similarly, Malaysia announced its intention to increase blending from 7% in 2014 to 10% in 2015 (IEA 2015).

Energy development comes with the development of energy infrastructure, not only for the production and transmission of power, but also for the transport of machinery and goods from production to refinery sites. These include large networks of roads, railways and transmission lines. The East-West Economic Corridor supported by the Asian Development Bank (ADB), linking Myanmar, Lao PDR, Thailand and Viet Nam is an example of a transboundary road network that is intended to connect people and goods while developing energy infrastructure, tourism and tele-communications within AMS (Costenbader et al. 2015; ADB 2010).

Within the ASEAN region, there are plans to expand energy infrastructure to improve transboundary grid connectivity. The ASEAN Power Grid will connect power grids between Lao PDR, Thailand and Malaysia (LTM Project) and the Trans-ASEAN Gas Pipeline (TAGP project) will connect existing gas pipelines across the region (ASCOPE 2015; Pranadi 2017).

Another contributor to deforestation in the ASEAN region is the high percentage of populations in some AMS using traditional biomass fuel such as charcoal and fuel wood (IEA 2015). Myanmar, Cambodia and Lao PDR have the largest shares of populations relying on traditional biomass for cooking at 93,88 and 65% respectively (IEA 2015). While not a direct contributor of deforestation, fuel wood harvesting and charcoal production can put additional pressures on fragile ecosystems such as mangroves, which are favored for charcoal production (Miettinen et al. 2014). However, rural electrification, urbanization and improvements in the quality of life have led to a decline in fuelwood consumption between 2000 to 2010 (Costenbader et al. 2015).

Mineral mining

As the demand for minerals is on the rise in the ASEAN region, the sector is developing rapidly and posing a range of environmental impacts that are similar to that from fossil fuel extraction. The total value of the mineral trade within ASEAN has increased from US$ 14 billion in 2004 to US$ 44 billion in 2013. Within the ASEAN region, trade in minerals such as gold, copper, nickel, tin, iron, bauxite, zinc, coal and gemstones was worth US$ 57 billion in 2013 (The ASEAN Secretariat 2015a). Indonesia and Malaysia are among the largest exporters of minerals globally, ranking 7th and 15th respectively (Hughes 2017). The processes used in mining, such as the use of heavy machinery, explosives and land clearing are severely detrimental to water and soil quality. Since mineral deposits are often found in forest areas, mining also leads to loss of forests.

4. State and trends

Forests

The total land area in the ASEAN region is 3% or 449 million ha (The ASEAN Secretariat 2012). Indonesia occupies the largest land mass in the ASEAN region comprising 191 million ha. Singapore has the smallest land mass at 71,900 ha (The ASEAN Secretariat 2016b).

The ASEAN region has a variety of forest cover types. In the continental area, which includes Myanmar, Thailand, Lao PDR, Cambodia and Viet Nam, the most common forest types are seasonal mixed deciduous forests types such as teak forests. Very dry forests and woodlands are found in plateaus with shallow soils and limited water. Mangrove forests occupy the delta regions of Thailand and Myanmar (Stibig and Stolle 2007).

Box 4. Land tenure in the ASEAN region

A major factor contributing to land use change is the lack of secure land tenure for many communities living in the AMS. Land tenure or a lack of mechanism to secure the rights of land users and owners may lead to poor land management. These mechanisms can be customary, legal or statutory means to ensure that individuals or groups of individuals have access to land and its related resources (UN-Habitat 2014). Without secure land tenure, communities that are dependent on the land are impacted unequally as they have little or no say in decisions on how the land should be used. Thus, without ways to prove their stake in the land they inhabit they are more prone to have their lands expropriated or give in to commercial pressures for land conversion (UN-Habitat 2014).

Within the ASEAN region, tenure security in rural areas is affected by a decreasing availability of agricultural land (UN-Habitat 2015). As agricultural land becomes more scare, the demand for large areas of agricultural land grows. As a result, more and more landless, and land insecure people such as smallholder farmers, lose their share of land to large-scale commercial farmlands. In Lao PDR for example, land conflicts have arisen over lost access to land because of economic land concessions for wood, biofuel and cash crop plantations. Similar acquisitions of land are occurring within the forestry, mining and infrastructure sectors across the region (UN-Habitat 2015).

Moist evergreen tropical rainforest is the predominant forest type in the insular/maritime area of the ASEAN region, which includes Malaysia, Singapore, Indonesia, Brunei Darussalam and the Philippines. Indonesia has a large variety of forest types ranging from coastal and lowlands, to high mountain forests, with a very high diversity of ecosystems and species (The Government of the Republic of Indonesia 2013). Mangrove forests occupy the coastlines along with peat and swamp forests especially in Sumatra and Borneo. The Papua Province in Indonesia also has tropical mountain forests (Stibig and Stolle 2007).

Table 20. Forest areas within ASEAN (ha and %)

Country	Total Forest Area (000 Ha)			Forest areas as a percentage of land areas (%)			
	1990	2000	2012	1990	2000	2012	Annual Change 1990-2012
Brunei Darussalam	413	397	376	78.4	75.3	71.4	-0.5
Cambodia	12,944	11,546	9,839	73.3	65.4	55.7	-1.5
Indonesia	118,545	99,409	93,062	65.4	54.9	52.4	-1.3
Lao PDR	17,314	16,532	15,596	75.0	71.6	67.6	-0.6
Malaysia	22,376	21,591	20,282	68.1	65.7	61.7	-0.5
Myanmar	39,218	34,868	31,154	22.0	23.9	26.1	0.9
Philippines	6,570	7,117	7,775	22.0	23.9	3.3	-0.2
Singapore	2.3	2.3	2.3	3.4	3.4	3.3	-0.2
Thailand	19,549	19,004	19,002	38.3	37.2	37.2	-0.2
Viet Nam	9,363	11,725	14,085	28.8	37.7	45.4	2.6
ASEAN	246,294	222,191	211,172				

The ASEAN Secretariat (2015b)

In 2012, Indonesia had the largest forest area with 51.4% (93.1 million ha) of total land area covered by forest. This was followed by Myanmar with 47.7% (31.2 million ha) and Malaysia with 61.7% (20.3 million ha) (The ASEAN Secretariat 2015b) (see Table 20). Brunei Darussalam had the highest proportion of land area covered by forest with 71.4%

(376,000 ha) followed by Lao PDR with 67.6% (15.6 million ha) and Malaysia with 61.7% (28.3 million ha). Singapore had the lowest proportion of forest cover of the AMS with 3.3% (23,000 ha). This was followed by the Philippines with 26.1% (7. 8 million ha) and Thailand with 37.2% (19,002 ha) (The ASEAN Secretariat 2015b).

Between 1990 to 2012, Cambodia had the highest annual rate of forest cover[21] loss of 1.5% while Indonesia and Myanmar each lost forest cover at an annual rate of 1.3%. The lowest forest cover losses were in Singapore, Thailand, Malaysia and Brunei Darussalam, which experienced losses at rates of 0.2, 0.2, 0.5 and 0.5% respectively. Viet Nam experienced the highest annual forest cover gain of 2.6%, followed by the Philippines with 0.9% (Table 21). More recent forest cover data from the Philippines shows a continuing trend of gaining forest cover. Between 2013 and 2016, the Philippines has annually gained 1.0% in forest cover, going from 25.0% in 2013 to 28.0% in 2016 (The Government of Philippines 2017).

Both the number and total area of protected forests[22] within the ASEAN region have increased since 2008 (The ASEAN Secretariat 2016b; The ASEAN Secretariat 2010). In 2014, Cambodia had the highest proportion of protected areas with 26.0% (17.7 million ha) of land area protected. This was followed by Thailand at 18.8% (51.1 million ha) and Malaysia with 18.4% (32.9 million ha) (The ASEAN Secretariat 2016b). Between 2008-2014, Brunei Darussalam was the only AMS whose protected area percentage out of the total land area decreased from 22.7 to 18.2%. Viet Nam and Indonesia had the greatest increases in protected areas adding 9.2% and 8.3% to the protected area system, respectively. (See Table 21) In 2014, protected areas constituted around 14% of the total forest area in the ASEAN region (The ASEAN Secretariat 2016b).

Table 21. Protected areas (PA) as a percentage of total land area within ASEAN Member States, as of 2014

Country	Land Area (1000 Ha)	% of PA to total Land Area (as of 2014)
Brunei Darussalam	527	18.2
Cambodia	17,652	26.0
Indonesia	181,157	14.7
Lao PDR	23,080	16.7
Malaysia	32,855	18.4
Myanmar	65,308	7.2
Philippines	29,817	11.0
Singapore	71	5.8
Thailand	52,089	18.8
Viet Nam	31,007	6.5
ASEAN	**432,563**	**14.0**

Note: Terrestrial protected areas are totally or partially protected areas of at least 1,000 hectares that are designated by national authorities as scientific nature reserves or wildlife sanctuaries, protected landscapes, and areas managed mainly for sustainable use. Marine areas, unclasified areas, littoral (intertidal) areas, and sites protected under local or provincial law are excluded. United Nations Environmental Program and the World Conservation Monitoring Center, as complied by the world Resources Institute, based on data from national authorities, national legislation and international agreements. Brunei Darussalam figure in 2008.

The ASEAN Secretariat (2016b)

The total area of production forest in the ASEAN region has increased significantly from 38% in 1990 to 49% in 2010 (ASFN 2014). In Indonesia, the area of production forest accounts for 43.6% of the total forest area. Production forests are further differentiated into limited production forest comprising 11.9% (22.3 million ha) and permanent production forest comprising 19.6% (36.7 million ha). Indonesia also has 15.3% (20.9 million ha) of converted production forest, which is forest land allocated for conversation to agricultural production and

21. Forest cover includes closed, open and mangrove forest types(FAO 2012).
22. FAO defines a terrestrial protected area as a "totally or partially protected area of at least 1000 ha that is designated as scientific reserves." These areas have limited public access and are tightly managed (The ASEAN Secretariat 2016b).

infrastructure development (The Government of the Republic of Indonesia 2013). The dominant types of tree crop in the ASEAN region are eucalyptus and acacia, planted for pulp and paper production. In 2008, 8.3 million ha of the global total of 19.6 million ha eucalyptus were planted in the region (Hughes 2017). Some of the largest eucalyptus plantations in the ASEAN region are in Indonesia, Malaysia, Viet Nam and Thailand (Harwood et al. 2014).

Box 5. Threatened wetlands: The ASEAN region's peatlands and mangrove forests.

The ASEAN region is home to some of the largest peat and mangrove forests in the world, which support a large diversity of species and provide a variety of important ecosystem services. These unique ecosystems are severely under threat from land use changes.

Around 60% of the world's tropical peatlands are in the ASEAN region. Over 70% of the peatlands within the ASEAN region are in Indonesia. Major peatlands are also found in Malaysia, Brunei Darussalam and Thailand (USDA 2013). Under the ASEAN Peatland Forest project (APFP) Project, new peatlands have been inventoried since 2010 in Cambodia, Lao PDR and Myanmar (GEC 2015).

Peatlands are invaluable for the habitat and ecosystem services that they provide. They act as habitats for many rare and endemic species. Additionally, peatlands store 70 Gt of carbon, making them the most important carbon sink in the region (APFP-SEAPeat 2014).

Peatlands are under severe threat from agricultural expansion and logging. Only 34% of peat in the region remain intact and 20% have been converted to commercial plantations. The most common practice for peatland conversion to plantations is through draining and burning (APFP-SEAPeat 2012). ASEAN records estimate that 13 million ha of peat have been impacted over the last 30 years with 5 to 7 million cleared and drained for palm oil, pulpwood, rice and other crops (GEC 2014). The resulting transboundary air pollution issues caused by burning peat are described in more detail in section 2.1:atmosphere.

Similarly, mangrove forests in the ASEAN region, home to 42% of the world's mangrove forests, are also under severe threat from being converted into plantations. Indonesia has 22.6% and the largest share of mangroves of the ASEAN region (Hughes 2017).

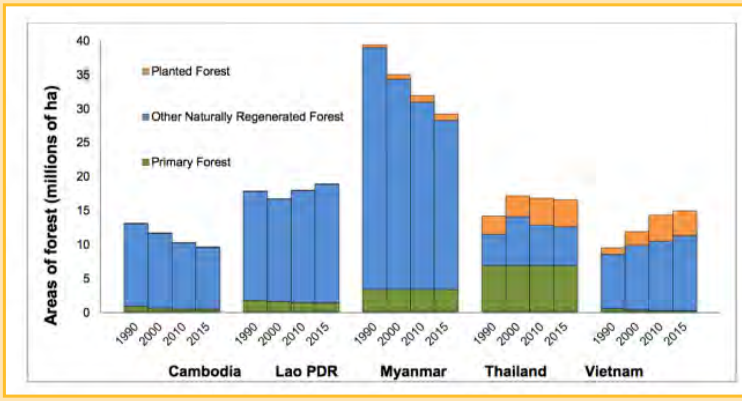
Mangroves are important habitats for many marine species and migratory birds. They act as natural buffers for coastal areas and reduce the risk of floods and tsunamis. They also serve as major sources of fish protein for local communities (Hughes (2017). Mangroves also act as major carbon sinks as they are able to store three times more carbon than tropical land forests (Gassner 2014).

Despite their importance, mangrove forests are cleared at rates three to five times higher than other forest types. Within AMS, severe mangrove forest loss has already occurred. In Thailand for example, 90% of mangroves had already been lost by 2007. Across the ASEAN region, pressure to produce more food is driving the conversion of mangroves to agriculture, aquaculture, and sea-salt production (Hughes 2017).

Figure 27 shows the changes in forest types under FAO's classifications of "Planted Forest", "Other Naturally Regenerated Forest" and "Primary Forest" in Cambodia, Lao PDR, Myanmar, Thailand and Viet Nam. The data indicate that between 1990 and 2015, the area of Planted Forests increased in all AMS except Viet Nam. The ASEAN region's pulp production plantations[23] constituted 8.7% of the global total in 2010 and 5.1% of global industrial round wood production (FAO 2011). The area of planted forests was

23. FAO defines production forest as "forest area designated primarily for production of wood, fiber, bio-energy and/or non-wood forest products."(FAO 2012).

highest in Thailand and Viet Nam and accounted for 85% of all planted forests in the five AMS (Costenbader et al. 2015).



Source: Costenbader et al. (2015).

Figure 27. Changes in forest types in selected ASEAN Member States (Cambodia; Lao PDR; Myanmar; Thailand and Viet Nam) since 1990

Agricultural land

In 2013, the total agricultural land[24] area within ASEAN was 30.3% (131 million ha) of the total land area. The total agricultural land area consists of areas categorized as arable land, permanent crops, and permanent pasture. Thailand has the largest area of agricultural land at 43.3% (22.1 million ha) followed by Viet Nam at 35.1% (10.9 million ha) and Cambodia at 32.9% (5. 8 million ha) (Table 22) (The ASEAN Secretariat 2015b).

Table 22. Agricultural land Area within ASEAN in 2013 (ha and %)

Country	Total Area (000 Ha)	Land area						Rural Population (000)
		Total Land area (000 Ha)	Agricultural area					
			Arable Land (000 Ha) 4	Permanent Crops (000 Ha) 5	Permanent Pasture (000 Ha) 6	Total Agrc. area (000 Ha) (4)+(5)+(6)	% of Agriculture area to land area	
Brunei Darussalam	577	527	5	6	3	14	2.7	97
Cambodia	18,104	17,652	4,145	155	1,500	5,800	32.9	12,423
Indonesia	190,457	181,157	23,500	22,500	11,000	57,000	31.5	118,309
Lao PDR	23,680	23,080	1,489	169	677	2,335	10.1	4,308
Malaysia	33,080	32,856	954	5,600	285	7,839	23.9	7,541
Myanmar	67,659	55,308	10,772	1,509	306	12,587	19.3	35,245
Philippines	30,000	29,817	5,590	5,350	1,500	12,440	41.7	51,068
Singapore	71	71	1	0		1	0.9	0
Thailand	51,312	51,089	16,810	4,500	800	22,110	43.3	43,384
Viet Nam	33,096	31,007	6,410	3,822	642	10,874	35.1	62,003
ASEAN	**448,036**	**432,563**	**69,675**	**44,611**	**16,713**	**131,000**	**30.3**	**334,378**

Source: FAO (2014).

Commercial agriculture is the greatest driver of deforestation as forest lands are converted to commodity plantations in the tropics for the production of cash crops such as rubber,

24. This constitutes arable land, permanent crops and permanent pastures. (FAO 2012).

oil palm, sugarcane, tea, coffee, cashew nuts and cacao (Stibig and Stolle 2007). The expansion of logging, and the establishment of tree plantations and other types of agriculture, also lead to forest cover change and deforestation (Stibig and Achard 2014). Table 23 shows that between 2000-2012, an estimated 30-80% of the deforestation in Cambodia, Lao PDR, Myanmar and Viet Nam was due to forest conversion to commercial agriculture. The majority of this conversion was illegal, constituting an estimated 43-90% of the total forest conversation (Costenbader et al. 2015)[25].

Table 23. Estimates of deforestation due to conversion for commercial agriculture for selected ASEAN Member States (Cambodia; Lao PDR; Myanmar; Thailand and Viet Nam) in percentage

Country	% Of 2002-2012 deforestation occuring due to conversion for commercial agriculture	% Of commercial agricultural conversion that is illegal	% Of timber sourced from forest areas converted to commercial agriculture
Cambodia	40 - 80 %	90 %	Not available
Lao PDR	73%	43.4 - 86.7 %	55-75%; 82% (Estimate)
Myanmar	33%	43.4 - 86.7 %	50% (But data inadequate)
Thailand	Not available	Not available	<4%
Viet Nam	40-80%	43.4 - 86.7 %	No data available

Source: Costenbader et al. (2015).

Of the commercial crops, cereals and oil palm production were the highest with 255 million and 229 million metric tons produced, respectively (The ASEAN Secretariat 2015b). Indonesia, Malaysia and Thailand produce most of the palm oil fruit within AMS, with Indonesia being the greatest producer of palm oil fruit at 120 million metric tons (The ASEAN Secretariat 2014). In 2014, Malaysia and Indonesia contributed to nearly 86% of the global palm oil supply (USDA 2014).

Forests all over the ASEAN region have been converted from forest to commercial agriculture (Figure 26). In Sumatra, Sarawak and central and west Kalimantan, much of this land has been converted for oil palm plantations, often on former peatlands (Stibig and Achard 2014). Large areas of land in Indonesia and Malaysia, are dedicated to oil palm production. For instance, in Indonesia, an estimated 10.8 million ha of total land area is used for oil palm (Stibig and Achard 2014). Between 2011 and 2013, private firms and smallholder farmers increased oil palm cultivation areas at an average of 630,000 ha annually. This is in stark contrast from the 500,000 ha growth experienced over the entire previous 10 years (USDA 2013). In Malaysia, an estimated 5.4 million ha (69% of agricultural land or 16% of Malaysia's total land area) was used for oil palm plantations in 2014. This is a 60% increase compared to 2000. Malaysia is also rapidly running out of land for oil palm plantation expansion (Malaysian Palm Oil Board 2017). By 2014, the Philippines and Thailand had also expanded their oil palm plantation area by 3.4 times and 2.9 times, respectively (USDA 2013).

In Indonesia, land clearing for oil palm trees has led to permanent deforestation. Land for oil palm production is typically converted from forested land, which is cleared for planting oil palm after all commercially viable timber has been harvested (USDA 2013). Other AMS are undergoing similar trends in the commercialization of agriculture. In Cambodia, Lao PDR and Myanmar, the conversation of forests to cash crop plantations is a major driver of deforestation (Stibig and Stolle 2007). The expansion of rubber

25. Data are provided in ranges as reliable data is not widely available.(Costenbader et al. 2015)

plantations is responsible for forest losses in Lao PDR, Cambodia, and Viet Nam. The commercialization of coffee and tea has caused forest land conversion in Lao PDR, Viet Nam and Thailand (Stibig and Stolle 2007).

Soils

The chemical inputs used in processes and to increase agricultural production affect soil and water quality. The increase in the use of chemicals in agriculture can also cause nutrient leaching from soils, which is a major problem for AMS. Harvesting crops without replacing nitrogen, phosphorus and other nutrients threatens the nutrient balance in soils. Nitrogen fertilizers are widely used in the region to promote plant growth because they are cheap and accessible. However, the improved plant growth from nitrogen fertilizers rapidly leaches nutrients from the soil and soil can become nutrient deficient (FAO 2015). Aside from nutrient leaching, the application of chemical inputs also degrades soils. Globally, the over-use of nitrogen chemicals accelerates decomposition of soil organic matter and soil acidification which leads to soil degradation (FAO 2015).

A 1991 assessment of soils in Asia found that human induced soil degradation affected 31% of the region's total inhabited area (FAO 2015). A 2000 study looking at the degradation of different soil types in Asia found that water erosion was the greatest contributor to soil degradation affecting 58% of the total land area, followed by chemical degradation[26] at 10%. For example, in the Philippines, water erosion affected 38% of the total area. In 2010, the Philippines classified 24% of its total land area as degraded (The Government of Philippines 2017)[27]. In other AMS, the impact of water erosion is less extreme, affecting 15% of the land area in Thailand and 10% in Viet Nam (FAO 2015).

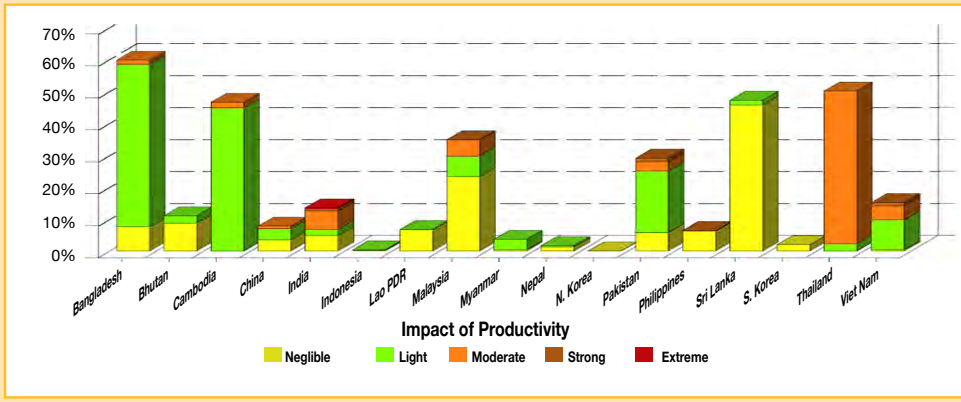
Loss of soil fertility, another form of soil degradation with reductions in soil organic matter and depletion of nutrients, making plants less responsive to fertilizers, has been identified as a widespread concern in Asia (Syers 1997). In 1997, 53% of Thailand's total land area was affected by soil fertility loss, of which 50% was classified as having a strong impact on productivity (Limtong 2012). In Cambodia, 42% of soils suffered fertility loss, however only 2% had strong impact on productivity. In Viet Nam, 12% of soils suffered fertility loss and 4% had strong impact on productivity (Van Lynden and Oldman 1997) (Figure 28). A more recent figure from Thailand in 2012 found 31 million ha or 60% of land was classified as having low levels of organic matter with declining fertility (Limtong 2012). Deforestation, agricultural activities and over-grazing were identified as major factors leading to this decline (FAO 2015).

Land conversion from intact forests to plantations (e.g. oil palm and rubber) may also cause losses in soil fertility and stability "which can be measured by soil organic carbon, which indicates the amount of organic matter in soils (Clemens et al. 2010; Griffin 2016). Further, as a consequence of conversion to commercial plantations, altered land can become highly susceptible to erosion (Clemens et al. 2010). In Myanmar, soil erosion poses a serious issue as around 30% of cultivated land is affected (Government of Myanmar 2014). In 2001, around 50% of Viet Nam's soils were considered depleted, jeopardizing future agricultural use (Stibig and Achard 2014).

Other agricultural practices have also impacted soil quality: 20 million ha of soil in the ASEAN region are affected by salt because of the use of brackish water in irrigation and

26. Chemical degradation is the accumulation of toxic chemicals and chemical processes that then impact on the chemical properties that regulate life processes in the soil (Logan 1990).
27. There is no data available for the period 2011-2016.

the increasing expansion of irrigation areas (UNEP 2012b). Further, 10 million ha of land in Asia are impacted by soil compaction mainly due to loss of, or insufficient, top soil cover (FAO 2015).



Source: Van Lynden and Oldeman 1997

Figure 28. Relative distribution of chemical deterioration (as % of total land area per Asian nation)

5. Impacts

Land use changes such as deforestation, land clearing and agricultural expansion can lead to a variety of impacts on the soil, water, environment as well as human health and livelihoods.

The processes used in mining are severely detrimental to water and soil quality. The use of heavy machinery, explosives and land clearing is often a necessary part of accessing underground minerals. Exposing rocks that have previously lain unexposed can bring up radioactive elements, heavy metals and other toxic materials. One common phenomenon associated with mineral and coal mining is acid mine drainage which leads to soil and water contamination (Sovacool 2014). Chemicals used in mining can also affect soil and water quality. In artisanal and small-scale mining (ASGM) for instance, many operators use heavy metals such as mercury and cyanide for recovering gold. These metals ultimately end up in the soils and water (FAO 2015).

Further, mining can severely scar terrestrial systems. In Indonesia, coal mining has led to major land use changes. Coal mining is the 4th largest driver of deforestation in Kalimantan and Sumatra and has resulted in large forest cover loss in these areas (Hughes 2017). Mining for fossil fuels causes major land use changes and environmental impacts (IEA 2015). Coal mining for example causes massive landscape-scale changes as it requires the removal of vegetation and the use of explosives to break rocks in order to gain access to the coal seams (EIA 2017).

Energy development projects also have major impacts on the terrain. A major direct consequence of hydropower development is the loss of forests due to the flooding of water reservoirs (Hughes 2017). In Lao PDR alone, an estimated 13,100 ha of forest are destroyed every year due to hydropower construction (Thomas 2015). The Ministry of Agriculture and Rural Development in Viet Nam reported that 19,792 ha of forest in 29 provinces and cities were cleared between 2005 and 2012 for the purpose of

developing 160 hydropower projects. This included 3,060 ha of protected forest; 4,411 ha of special use forest[28] and 12,321 ha of production forest (GreenID 2013). An indirect impact of hydropower projects is the resettlement of communities to make way for the construction of dams, which can lead to deforestation and the conversion of forests into agricultural land in the newly settled areas (Berndes 2011).

The construction of roads also causes deforestation, habitat loss and fragmentation. Roads bring new national and international investments and human settlements to formerly inaccessible forest areas, which leads to further deforestation (Costenbader et al. 2015; OECD 2008). In Lao PDR, infrastructure development causes deforestation at a rate of approximately 1,000-2,000 ha per annum (Thomas 2015). Similarly, the construction of natural gas pipelines connecting Myanmar to Yunnan province in China has led to rainforest degradation (Costenbader et al. 2015).

Agricultural expansion into natural forest areas leads to the destruction of permanent forest habitat of different species and land degradation. The scale of impact of plantation forests on natural forest cover is typically large. For instance, 76% (7 million ha) of pulpwood and palm oil plantations in Borneo between the periods 1973-2015 were sourced from species-rich old growth forests (Gaveau et al. 2016). A major consequence of the loss of natural forests and even other land cover types such as secondary forests, mixed agroforests and degraded forests for oil palm expansion is biodiversity loss (see chapter 2.4: biota and ecosystems). Land clearing and road construction in preparing for plantation forests also lead to soil erosion. Further the use of pesticides and herbicides for plantations, particularly by the oil palm industry which typically requires around 354 kg of nitrogen fertilizers/ ha in the first five years, leads to extreme soil and water pollution (Sheil et al. 2009).

Further, loss of soil carbon is a major consequence of deforestation (FAO 2015). This has global impacts as large amounts of CO_2 are released into the atmosphere when forests are cleared or destroyed. In 2000, the ASEAN region accounted for almost 51% of global land use change emissions mainly due to deforestation, logging, fuelwood collection and forest conversion (ADB 2009). The destruction of peatlands is a major contributor to emissions from the ASEAN region. In 2015, fires from the burning of peat released 1.2 billion tons of CO_2 into the atmosphere over the ASEAN region (Huijnen et al. 2016).

Soil erosion is another impact of deforestation. For example, planting rubber on steep slopes leads to soil erosion, which in turn causes greater surface water run-off and a decline in soil quality as the erosion process exposes subsoils that have less water holding capacity. This sequence of events also increases the risk of landslides (Fox et al. 2014).

More commercialized and large-scale forms of agriculture are changing the livelihoods of forest and agriculture dependent communities. Since 1995, most AMS have experienced a decline in the number of people employed in the agriculture, fishery and forestry sectors (The ASEAN Secretariat 2015b). The decline of the agriculture sector particularly affects women as 45% of economically active women in the ASEAN region are working in agriculture. The impact on women is exacerbated as women often own less land than men, and land title is not often in their name. Women are thus more vulnerable to being victims of land grabbing, eviction and other consequences associated with insecure land tenure (UN Habitat 2015).

28. In Viet Nam, a special use forest is an area under ecological restoration, and protection. The area is under management by a forest board which oversees household access to the forest (Phuong 2005).

Large scale logging and plantation concessions also threaten the livelihoods of the rural poor. In Indonesia for example, mining, forest and timber expansion have caused landlessness (UN Habitat 2015). The environmental and social impacts associated with large monoculture plantations are particularly severe as this type of farming may lead to loss of customary land, deforestation and water shortages (Hughes 2017).

6. Responses

National responses to land issues in selected AMS

Efforts to improve the livelihoods of forest dependent communities have focused on improving access to forests for communities through community forestry schemes. Community forestry is the management of public forests involving local, forest-dependent communities. In securing communities' access to forests, communities are better able to manage forest use through enhanced decision-making (ASFN 2014).

Local access and control over forestlands is increasing. In 2013, over 8.8 million ha (or 3.5% of the land area) of forest land within ASEAN was managed by local people. Viet Nam and the Philippines have the highest amount of land managed under the community forestry schemes at 3.8 million ha (11.5% of total land area) and 4.1 million ha (13.9% of total land area), respectively (Table 24). Cambodia, Indonesia, Myanmar, Philippines and Viet Nam have set national targets on the area of forest land to be transferred to local communities for community forestry (ASFN 2014). In the Philippines 0.3% (51,800 ha) is designated as communal land/forest and 23.7% (3.7 million ha of forest land) of land area is designated as open access (The Government of Philippines 2017). In 2016, there were 9,780 forest communities in Thailand managing 730,071 ha of land (3.3% of forest area[29]) (The Government of Thailand 2016).

Table 24. Forest areas in ASEAN Member States in ha (excluding Brunei Darussalam and Singapore) under community forest agreements

Country	2010 area (ha) with community foresty agreements	2013 area (ha) with community foresty agreements
Cambodia	113,544	183,725
Indonesia	3,300	143,065
Lao PDR	Not Available	Not Available
Malaysia	Not Available	Not Available
Myanmar	41,000	42,148
Philppines	2,985,000	4,128,212
Thailand	196,667	500,000
Viet Nam	3,300,000	3,809,320
Total	**6,639,511**	**8,806,470**

Source: Source is ASFN 2014

AMS have generally experienced positive outcomes of community forestry projects, such as improving forestry quality and community livelihoods. In Myanmar, for example, a community-based mangrove management project supported by the Ministry of Environmental Conservation and Forestry and Food and Agriculture Organization (FAO) restored five acres of mangrove forest, registered 25 acres of degraded area as community forest and established fuel and timber lots to reduce pressure on the mangrove

29. Designated forest land area of 22,4 million ha is based on ASEAN Social Forestry Network numbers (ASFN 2014).

areas. The project also improved local livelihoods, increased the security of food and water supplies and empowered local women through the development of business skills (ASFN 2014).

A number of afforestation schemes are also taking place throughout the ASEAN region. Although Viet Nam's forest cover declined from 43% in 1943 to 27% in 1990, it has now increased to 46% of total land area. This has been attributed to major national reforestation efforts and to policies that incentivize community forestry (ASFN 2014).

Regional responses to land issues in selected AMS

AMS have made efforts to improve land management practices, particularly for peatlands. The ASEAN Peatland Forest Project (APFP), funded by Global Environment Facility through the International Fund for Agricultural Development (IFAD) from 2010-2014, was implemented in Indonesia, Malaysia, the Philippines and Viet Nam with the aim to sustainably manage peatland. The project resulted in a strategy for managing and protecting peatlands within ASEAN and led to the development of improved management policies in Indonesia, Malaysia and the Philippines. It also lead to the discovery of new peatlands (Box 6), enhanced research on peatlands, and peatland protection measures at the local level (GEC 2015). The related SEApeat project, which was conducted between 2010-2014 and was funded by the European Union through the Global Environment Centre (GEC), sought to reduce deforestation and greenhouse gas (GHG) emissions caused by the degradation of peatland forests in the ASEAN region (GEC 2015).

Following the completion of both the APFP and SEApeat projects in 2015, the ASEAN Environment Ministers in September 2013 endorsed the ASEAN Programme on Sustainable Management of Peatland Ecosystems (APSMPE). APSMPE is a scaled-up cooperation framework with six agreed targets (Figure 29) that supports the collaboration of various stakeholders to achieve the goal of the ASEAN Peatland Management Strategy (APMS 2006-2020), namely to promote sustainable management of peatlands through enhanced cooperation. ASEAN is in consultation with many partners for developing and implementing a number of coordinated projects under the umbrella of APSMPE.

The Six Targets of the ASEAN Programme on Sustainable Management of Peatland Ecosystems (APSMPE)

1. **All peatland areas identified and inventorised;**
2. **Zero-burning uniformly practiced preventing any uncontrolled wildfires on peatlands, and eliminate any widespread smoke haze;**
3. **Fire prone sites rehabilitated by focusing on root causes of fire;**
4. **Peatlands sustainability managed, sustainable livelihoods enhanced, and sustainable economic use mainstreamed;**
5. **Peatlands conserved to contribute to significanly reduced emissions of greenhouse gases and increased peatland biodiversity in the region; and,**
6. **APMS and NAPPs implemented; national and regional capacity enhanced.**

Source: The ASEAN Secreatariat (2016).

Figure 29. The Six Targets of the ASEAN Programme on Sustainable Management of Peatland Ecosystems (APSMPE)

Box 6. The ASEAN region's newly-discovered peatlands

Since 2010, ASEAN's programmes on peatlands have contributed to the discovery of new peatlands in the Philippines, Cambodia, Lao PDR and Myanmar. In the Philippines, 15,000 ha of additional peatlands were identified between 2010 and 2014. In Cambodia, while there were no known peatlands in 2010, 9,849 ha of new mangrove peatlands were mapped by 2015. In Lao PDR, 670 ha of peatlands were confirmed, including 94 ha of floating peatland in Ban Dong, Naxaythong, Vientiane Province. In Myanmar, significant peatland sites were identified, which include unique peat forests on Kauk Ye Island in the Tanintharyi Region, as well as a rare spring mound peatland near Inle lake in Shan State. In 2015, 2 ha of untouched peatland forest with 4m peat depth was discovered in Nga Yant Chaung Village in Mandalay State. It is being protected by the local community (GEC 2015).

Achieving internationally agreed environmental goals

ASEAN recognizes the need for climate change mitigation, adaptation, and the conservation of natural resources by reducing emissions caused by deforestation and forest degradation. Strategies to address these issues include the conservation and sustainable management of forests and the enhancement of forest carbon stocks through REDD+ projects (The ASEAN Secretariat 2008).

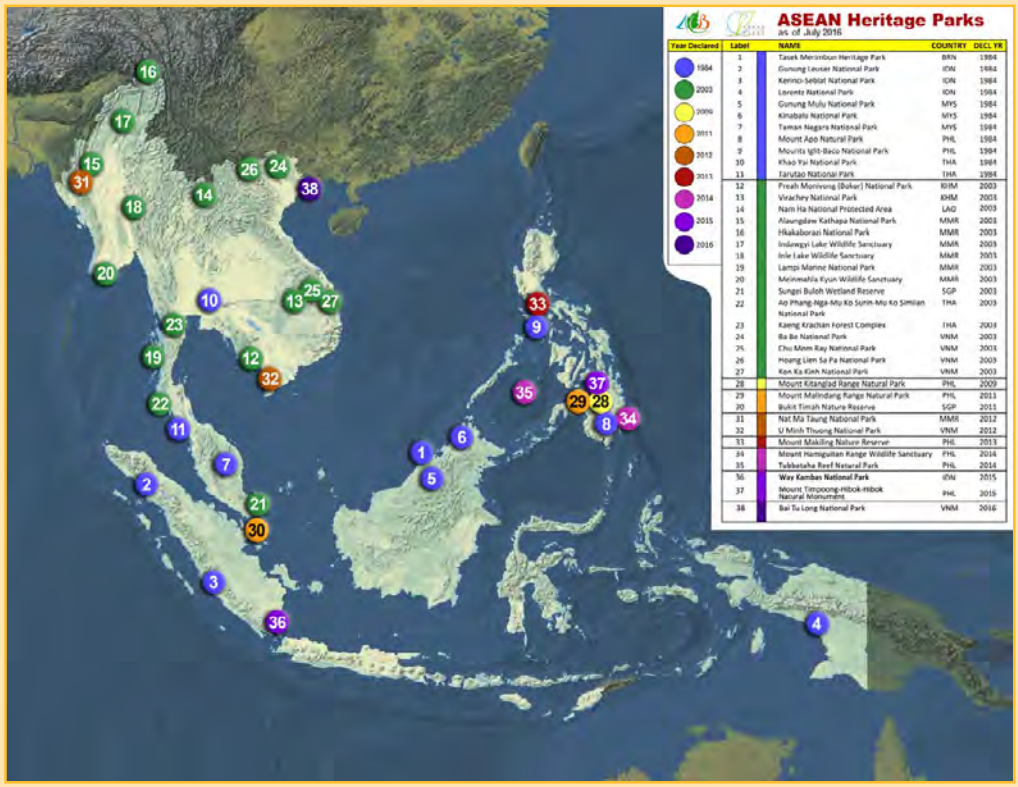
The ASEAN Regional Knowledge Network on Forests and Climate Change (ARKN-FCC) was established in 2008 to undertake joint initiatives on REDD+. The ARKN-FCC's role is to build capacity and to coordinate activities on forest, climate change and mitigation (RECOFTC 2015). With United States Agency for International Development , Lower Emissions in Asia's Forests program, (USAID-LEAF), ARKN-FCC helps to convene senior forestry experts from AMS to exchange knowledge on the regional drivers of deforestation and to understand regional policy issues (USAID-LEAF 2013). Nationally, AMS are implementing REDD+ activities. For instance, Cambodia aims to maintain its forest cover at 60%. Viet Nam is involved with UN-REDD and the Forest Carbon Partnership Facility and also works with the Government of Norway to build REDD+ capacity at the grassroots level. Other AMS, including Indonesia, Lao PDR, Myanmar, the Philippines and Thailand also have activities for REDD+ under various programs such as UN-REDD and other bilateral and multilateral programs (RECOFTC 2011).

Further, as part of efforts to expand protected areas, ASEAN created the ASEAN Heritage Parks (AHP) Programme in 1984 to highlight exemplary protected areas. In 2015, a total of 38 ASEAN Heritage Parks existed in the AMS (ACB 2010). Protected areas are established as AHPs with the aim to generate greater awareness, pride, appreciation, enjoyment, and conservation of ASEAN's rich natural heritage. The ASEAN Centre for Biodiversity (ACB), as the Secretariat of the AHP Programme, regularly organizes an ASEAN Heritage Parks Conference that brings together the heads and staff of protected areas (PAs) and AHP management authorities; officials and representatives of international and local non-government organizations, and other protected area practitioners to share experiences, best practices and to review the status of PA management.

In 2000, ASEAN also established the ASEAN-Republic of Korea (ASEAN-ROK) Flagship Project on Restoration of Degraded Forest Ecosystem in the Southeast Asian Tropical Regions (AKECOP). This project aims to address the degradation of land and forest in ASEAN and to conserve ecosystems through research and capacity building activities between AMS and the Republic of Korea. AKECOP is a regional collaborative partnership which supports AMS in generating scientific knowledge, sharing information and experiences, and enhancing human and institutional capacity. The program provides training on environment and natural resource management to ASEAN practitioners and researchers in related fields (The ASEAN Secretariat 2017).

ASEAN, through inter-ASEAN, multilateral and bilateral programme on forests and peatland conservation and management is striving to achieve the Sustainable Development Goals (SDGs). ASEAN's responses to land use changes and improved natural resource management address SDG 15: Life on Land, SDG 13: Climate Action, and SDG 17: Partnerships. The ASEAN Heritage Parks and APSMPE programmes address SDG 13 and SDG 15 directly and are initiatives to reduce the climate and land impacts caused by deforestation and the destruction of peatlands and forest through improved land management, capacity building, and research. ASEAN uses bilateral, multilateral and other forms of partnerships to contribute to SDG 17 on partnerships, as exemplified by the ASEAN-ROK cooperation programme.

Figure 30. Map of ASEAN Heritage Parks



Source: ASEAN Centre for Biodiversity, 2016

7. References

ACB (2016) *'ASEAN Heritage Parks'*. ACB. http://chm.aseanbiodiversity.org/templates/regionalchm/initiatives/pa/ahp/images/Hi_Res_AHP2016_38.jpg.

ACB (2010) *The ASEAN Heritage Parks: A Journey to the Natural Wonders of Southeast Asia*. Dolmar Press, Inc, Los Baños, Philippines.

ADB (2010) *Strategy and Action Plan for the Greater Mekong Sub-Region East-West Corridor*. ADB, Manila, Philippines. https://www.adb.org/sites/default/files/publication/27496/gms-action-plan-east-west.pdf.

ADB (2009) *The Economics of Climate Change in Southeast Asia: A Regional Review*. Asian Development Bank, Manila, Philippines. http://www.greengrowth.org/?q=publication/adb-economics-climate-change-southeast-asia-regional-review.

APFP-SEAPeat (2014) *Enhancing Sustainability of Forestry Practices on Peatlands*. The ASEAN Secretariat, Bogor, Indonesia.

ASCOPE (2015) '*Trans ASEAN Gas Pipeline Project (TAGP)'*. ASEAN Council on Petroleum, 29 December. http://www.ascope.org/Projects/Detail/1060.

ASFN (2014) *Current Status of Social Forestry in Climate Change Mitigation and Adaptation in the ASEAN Region*. ASEAN, Bangkok, Thailand. http://dev.recoftc.org:4080/publications/uploads/current%20status%20of%20social%20forestry%20in%20climate%20change_book_2014_eng.pdf.

Berndes, G. (2011) *Bioenergy, Land Use Change and Climate Change Mitigation*. IEA Bioenergy, Rotorua, New Zealand. http://www.qibebt.ac.cn/xscbw/yjbg/201109/P020110921318859603976.pdf.

Boucher, D., Calen, M.-T. and Lininger, K. (2011) T*he Root of the Problem: What's Driving Tropical Deforestation Today*. Union of Concerned Scientists, Cambridge, United States. http://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/UCS_RootoftheProblem_DriversofDeforestation_FullReport.pdf.

Carlson, K. M., Goodman, L. K. and May-Tobin, C. C. (2015) '*Modeling relationships between water table depth and peat soil carbon loss in Southeast Asian plantations*'. Environmental Research Letters, 10(7). 74006. doi:10.1088/1748-9326/10/7/074006.

Clemens, G., Fiedler, S., Cong, N. D., Van Dung, N., Schuler, U. and Stahr, K. (2010) '*Soil fertility affected by land use history, relief position, and parent material under a tropical climate in NW-Viet Nam*'. CATENA, 81(2). 87–96. doi:10.1016/j.catena.2010.01.006.

Costenbader, J., Varns, T. and Vidal, A. (2015) *Drivers of Forest Change in the Greater Mekong Subregion: Regional Report*. USAID, Washington, D.C., USA.

Edwards, D. P., Larsen, T. H., Docherty, T. D. S., Ansell, F. A., Hsu, W. W., Derhé, M. A., Hamer, K. C. and Wilcove, D. S. (2011) '*Degraded lands worth protecting: the biological importance of Southeast Asia's repeatedly logged forests*'. Proceedings of the Royal Society of London B: Biological Sciences, 278(1702). 82–90. doi:10.1098/rspb.2010.1062.

EIA (2017) '*Coal and the Environment - Energy Explained, Your Guide To Understanding Energy - Energy Information Administration*'. U.S. Energy Information Administration, 1 February. https://www.eia.gov/energyexplained/?page=coal_environment.

FAO (2015) *Status of the World's Soil Resources: Main Report*. FAO, Rome, Italy.

FAO (2014) 'FAOSTAT'. *FAO Statistical Database*.

FAO (2012) *FRA 2015 Terms and Definitions*. FAO, Rome, Italy. http://www.fao.org/docrep/017/ap862e/ap862e00.pdf.

FAO (2011) *Southeast Asian Forests and Forestry to 2020: Subregional Report of the Second Asia-Pacific Forestry Sector Outlook Study*. FAO, Bangkok, Thailand.

Fox, J., Castella, J.-C., Ziegler, A. D. and Westley, S. B. (2014) '*Expansion of rubber mono-cropping and its implications for the resilience of ecosystems in the face of climate change in Montane Mainland Southeast Asia*'. Global Environmental Research, 18(2). 145–150.

Gaveau, D. L. A., Sheil, D., Husnayaen, Salim, M. A., Arjasakusuma, S., Ancrenaz, M., Pacheco, P. and Meijaard, E. (2016) '*Rapid conversions and avoided deforestation: examining four decades of industrial plantation expansion in Borneo*'. Scientific Reports, 6. 32017. doi:10.1038/srep32017.

GEC (2015) APFP-SEApeat *Key Achievements 2010-2015 Under the Framework of the ASEAN Peatland Management Strategy 2006-2020*. ASEAN, Jakarta, Indonesia.

Gianessi, L. (2014) '*Importance of Pesticides for Growing Rice in South and South East Asia*'. CropLife International. https://croplife.org/case-study/importance-of-pesticides-for-growing-rice-in-south-and-south-east-asia/.

Gibbs, H. K., Ruesch, A. S., Achard, F., Clayton, M. K., Holmgren, P., Ramankutty, N. and Foley, J. A. (2010) '*Tropical forests were the primary sources of new agricultural land in the 1980s and 1990s*'. Proceedings of the National Academy of Sciences, 107(38). 16732–16737.

Government of Myanmar (2014) *Myanmar First State of Environment Report*. Government of Myanmar, [no place].

GreenID (2013) *Analysis of Environmental and Social Costs and Risks of Hydropower Dams with a Case Study of Song Tranh 2 Hydropower Plant*. UNDP, Ha Noi, Viet Nam. http://www.vn.undp.org/content/dam/Viet Nam/docs/Publications/Hydropower_Research_final%20Oct%202013.pdf.

Griffin, E. (2016) '*What is soil organic carbon*?' 18 November. https://www.agric.wa.gov.au/climate-change/what-soil-organic-carbon.

Harwood, C. E., K.S. *Nambiar and Australian Centre for International Agricultural Research (2014) Sustainable Plantation Forestry in South-East Asia*. Australian Centre for International Agricultural Research, Canberra, Australia.

Hughes, A. C. (2017) '*Understanding the drivers of Southeast Asian biodiversity loss*'. Ecosphere, 8(1).

Huijnen, V., Wooster, M. J., Kaiser, J. W. and Gaveau, D. L. A. (2016) '*Fire carbon emissions over maritime southeast Asia in 2015 largest since 1997*'. Scientific Reports, 6(1). doi:10.1038/srep26886.

IEA (2015) *Southeast Asia Energy Outlook 2015*. OECD/ International Energy Agency, Paris, France. http://www.iea.org/publications/freepublications/publication/WEO2015_SouthEastAsia.pdf.

Karmakar, R., Das, I., Dutta, D. and Rakshit, A. (2016) '*Potential Effects of Climate Change on Soil Properties: A Review*'. Science International, 4(2). 51–73. doi:10.17311/sciintl.2016.51.73.

Lawson, S. (2014) *Consumer Goods and Deforestation: An Analysis of the Extent and Nature of Illegality in Forest Conversion for Agriculture and Timber Plantations*. Forest Trends. http://www.forest-trends.org/documents/files/doc_4718.pdf.

Limtong, P. (2012) '*Status and Priorities of Soil Management in Thailand*'. http://www.fao.org/fileadmin/user_upload/GSP/docs/WS_managinglivingsoils/Limtong_Thailand.pdf.

Logan, T. J. (1990) '*Chemical Degradation of Soil*'. Advances in Soil Science, R. Lal and B. A. Stewart (eds.). Advances in Soil Science. Springer New York. 187–221.

Malaysian Palm Oil Board (2017) '*Malaysian Palm Oil Conession Area*'.

Miettinen, J., Stibig, H.-J. and Achard, F. (2014) '*Remote sensing of forest degradation in Southeast Asia—Aiming for a regional view through 5–30 m satellite data*'. Global Ecology and Conservation, 2. 24–36. doi:10.1016/j.gecco.2014.07.007.

OECD ed. (2008) *OECD Environmental Outlook to 2030*. OECD, Paris, France.

Panuwet, P. and Siriwong, W. (2012) '*Agricultural pesticide management in Thailand: status and population health risk*'. Environmental Science & Policy, 17. 72–81. doi:10.1016/j.envsci.2011.12.005.

Phuong, P. X. (2005) '*People's Participation in Forest Management in Viet Nam*'. FAO Corporate Document Repository, February. http://www.fao.org/docrep/003/X6898E/x6898e03c.htm.

Pranadi, A. (2017) 'What is the Status of Energy Infrastructure in ASEAN Power Sector?' ASEAN Center for Energy, 7 March. http://www.aseanenergy.org/blog/what-is-the-status-of-energy-infrastructure-in-asean-power-sector/.

RECOFTC (2015) *Forests and Climate Change after Lima: An Asia-Pacific Perspective-Implications of the UNFCCC COP 20 on Forest Policy and Practice*. RECOFTC and FAO, Bangkok. www.recoftc.org/recoftc/download/39734/2654.

RECOFTC (2011) *Community Forestry and Opportunities for REDD+ in the ASEAN Region*. RECOFTC, Bangkok, Thailand.

RECOFTC (2010) '*What is REDD+?'* RECOFTC, 14 October. https://www.recoftc.org/basic-page/what-redd.

Sheil, D., Casson, A. and Meijaard, E. (2009) *The Impacts and Opportunities of Oil Palm in Southeast Asia: What Do We Know and What Do We Need to Know*? CIFOR, Jakarta.

Sovacool, B. K. (2014) '*Environmental Issues, Climate Changes, and Energy Security in Developing Asia*'. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2479725.

Stibig, H. J. and Stolle, F. (2007) '*Forest cover change in Southeast Asia–the regional pattern*'. JRC Scientific and Technical Reports, EUR, 22896.

Stibig, H.-J. and Achard, F. (2014) '*Change in tropical forest cover of Southeast Asia from 1990 to 2010*'. Biogeosciences, 11(2). 247–58. doi:10.5194/bg-11-247-2014.

Syers, J. K. (1997) '*Managing soils for long-term productivity*'. Philosophical Transactions of the Royal Society of London B: Biological Sciences, 352(1356). 1011–21. doi:10.1098/rstb.1997.0079.

The ASEAN Secretariat (2017) '*Overview of ASEAN-Republic of Korea Dialogue Relations*'. http://asean.org/storage/2012/05/Overview-ASEAN-ROK-Dialogue-Relations-As-of-8-March-2017.pdf.

The ASEAN Secretariat (2016a) '*ASEAN program on sustainable management of peatland ecosystems 2014-2020 (APSMPE)'*. https://environment.asean.org/asean-programme-on-sustainable-management-of-peatland-ecosystems-2014-2020/.

The ASEAN Secretariat (2016b) *ASEAN Community in Figures 2016*. ASEAN, Jakarta, Indonesia. http://asean.org/storage/2012/05/25Content-ACIF.pdf.

The ASEAN Secretariat (2015a) *ASEAN Minerals Cooperation Action Plan 2016-2025* (AMCAP-III). Senior Officials Meeting on Minerals. The ASEAN Secretariat, Vientaine, Lao PDR. http://www.asean.org/storage/2015/12/AMEM/AMCAP-III-(2016-2025)-Phase-1-(Final)2.pdf.

The ASEAN Secretariat (2015b) *ASEAN Statistical Year Book 2015*. ASEAN, Jakarta, Indonesia.

The ASEAN Secretariat (2014) *A Closer Look at Trade Performance and Dependency, and Investment*. ASEAN, Jakarta, Indonesia.

The ASEAN Secretariat (2012) '*Overview of ASEAN Cooperation on Environment*'. ASEAN Cooperation on Environment. http://environment.asean.org/about-us-2/.

The ASEAN Secretariat (2010) *Asean Statistical Yearbook (2010*). ASEAN, Jakarta, Indonesia.

The ASEAN Secretariat (2008) '*ASEAN Common Position Paper On Reducing Emission from Deforestation and Forest Degradation (REDD) in Developing Countries*'. http://unfccc.int/files/kyoto_protocol/application/pdf/indonesiaaseanredd060608.pdf.

The Government of Philippines (2017) *The Phillippines 2016 Forestry Data*. The Government of Philippines, [no place]].

The Government of Thailand (2016) *Thailand State of the Environment 2016*. The Government of Thailand, [no place].

The Government of the Republic of Indonesia (2013) *State of the Environment Report Of Indonesia 2013 : Environmental Security Indonesia.* The Government of the Republic of Indonesia, Jakarta, Indonesia.

Thomas, I. L. (2015) *Drivers of Forest Change in the Greater Mekong Subregion:Drivers of Deforestation in the Greater Mekong Subregion Lao PDR Country Report*. USAID-LEAF. http://www.leafasia.org/sites/default/files/public/resources/Lao%20PDR%20Final-Revised-Nov2015.pdf.

UN Habitat (2015) *Land Tenure in Asia and the Pacific: Challenges, Opportunities and Way Forward*. UN Habitat, Nairobi, Kenya. http://www.gltn.net/index.php/component/jdownloads/send/2-gltn-documents/2219-land-tenure-in-asia-and-the-pacific-challenges-opportunities-and-way-forward?option=com_jdownloads.

UN Habitat (2014) *Land Tenure Security in Selected Countries: Synthesis Report*. UN Habitat, Nairobi, Kenya.

UNEP (2012a) *GEO 5: Global Environment Outlook : Environment for the Future We Want*. UNEP, Nairobi, Kenya.

UNEP (2012b) *GEO 6: Global Environment Outlook : Regional Assessment for Asia and the Pacific*. UNEP, Nairobi, Kenya.

USAID-LEAF (2013) '*What USAID LEAF Does*'. USAID-ASIA LEAF, 8 November. http://www.leafasia.org/what-leaf-does.

USDA (2014) '*Southeast Asia: Post-2020 Palm Oil Outlook Questionable*'. Foreign Agricultural Service: Commodity Intelligence Report, 22 September. https://pecad.fas.usda.gov/highlights/2014/09/SEAsia/index.htm.

USDA (2013) '*INDONESIA: Palm Oil Expansion Unaffected by Forest Moratorium*'. Foreign Agricultural Service: Commodity Intelligence Report, 26 June. https://www.pecad.fas.usda.gov/highlights/2013/06/indonesia/.

2.3. Biota and ecosystems

The ASEAN region, despite covering only three percent of the Earth's land, has incredibly rich biodiversity with exceptionally high levels of species endemism, four biodiversity hotspots and three of the world's 17 mega-diverse countries. The region's biodiversity and ecosystems are essential to the economic, social and environmental wellbeing of the ASEAN people, contributing to agriculture, food security and livelihoods of millions, and the preservation of indigenous cultures. This chapter explores the status and trends of biota and ecosystems in the ASEAN region, and the variety of pressures that pose threats to them.

2.3. Biota and Ecosystems

Key Messages

- The ASEAN region is a major contributor to global biodiversity, containing four of the world's 34 biodiversity hotspots and three mega-diverse nations.
- Biota and ecosystems of all types are under threat in the region from various pressures including deforestation and other land-use changes, habitat degradation and alteration, invasive alien species, genetic erosion, and over-exploitation of certain wildlife species. The economic growth-driven development of the ASEAN Member States (AMS) is fueling most of the increase in natural resource exploitation and ensuing biodiversity loss.
- Biodiversity loss and ecosystem degradation have substantial impacts on people's livelihoods, food security, and well-being in the region.
- The importance of ecosystem and biodiversity conservation is increasingly recognized in the region. AMS have taken measures at international, regional and national levels to respond to biodiversity loss and ecosystem degradation and have reported progress. But there remains much to do to counter current trends.

1. Introduction

The ASEAN region is blessed with incredibly rich biodiversity. While it occupies only 3% of the Earth's land, it covers four biodiversity hotspots and contains three of the world's 17 mega-diverse nations, which have exceptionally high levels of species endemism. The region's biodiversity and ecosystems are essential to the economic, social and environmental well-being of the ASEAN people, contributing to the continued growth of agricultural export economies, food security and livelihoods for millions of people, and the preservation of indigenous cultures. However, like in other parts of the world, biota and ecosystems in the region are under threat from a variety of pressures. This chapter explores the status and trends of biota and ecosystems in the ASEAN region, the reasons for these trends, and implications for the ASEAN Member States (AMS). The DPSIR framework below (see Figure 31) shows a summary of these drivers, pressures, states and trends, impacts, and responses covered in this chapter.

The focus of the chapter is on terrestrial and inland freshwater biota and ecosystems (coastal and marine ecosystems are covered in Chapter 2-5 of this report).

2. Drivers

Growth in population and consumption

Rapid economic growth in the region has lifted many out of poverty, increased purchasing power, and changed consumption habits (see Chapter 2.6: Production and Consumption for more details). But economic growth, along with the growing population of the ASEAN region, has increased the consumption and exploitation of natural resources. The concomitant rising demands for agricultural products, energy, water, minerals, and forest resources such as timber and wildlife products are affecting ecosystems and biodiversity in adverse ways. The strain on the region's natural resources and ecosystems is affecting people who depend on their local ecosystems for income and sustenance (Samdhana Institute 2016b).

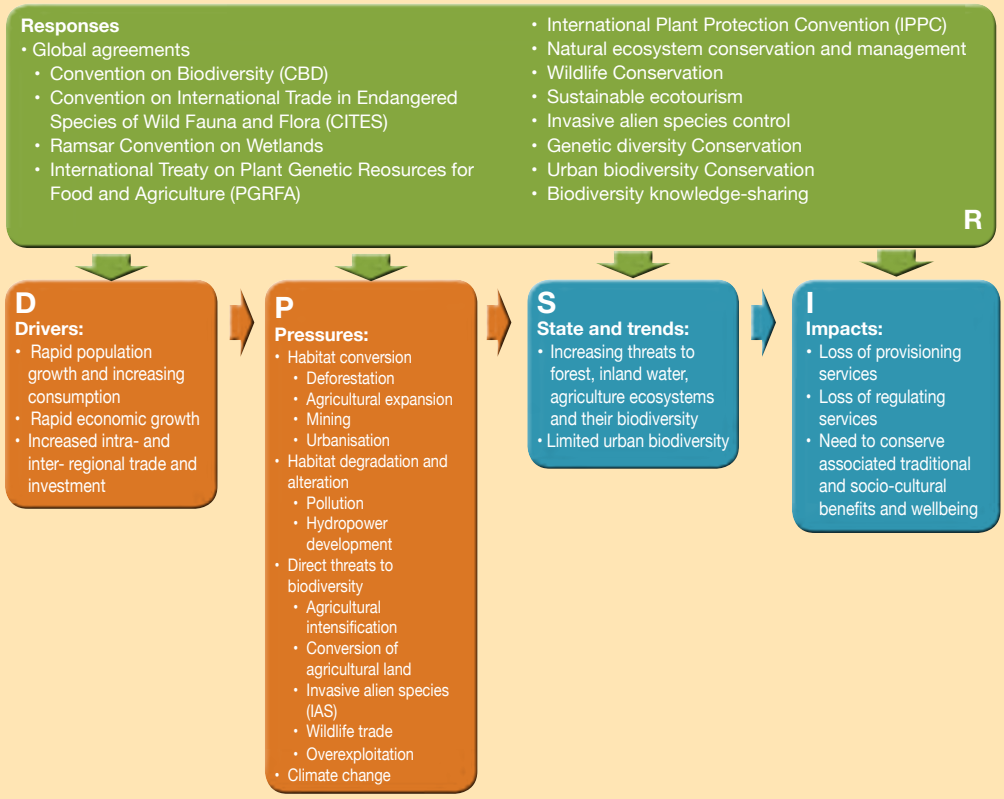


Figure 31. DPSIR Framework for biota and ecosystems in the ASEAN region

Rural-urban migration and urbanization are vastly expanding urban populations and settlement areas, which are major consumers of food, energy and building materials. Urbanization has therefore increased pressure on agricultural production, as more resources are needed to feed the region's growing urban centres; particularly megacities such as Bangkok, Jakarta and Manila. Industrial development is also a significant consumer of energy and resources (CEPF 2011).

Certain consumption habits are encouraging illegal natural resource extraction and trade. For example, wealthy consumers from nations both within and outside the ASEAN region, such as China, the United States and European nations, are purchasing a large proportion of wildlife trafficked in the region (ASEAN Centre for Biodiversity 2010).

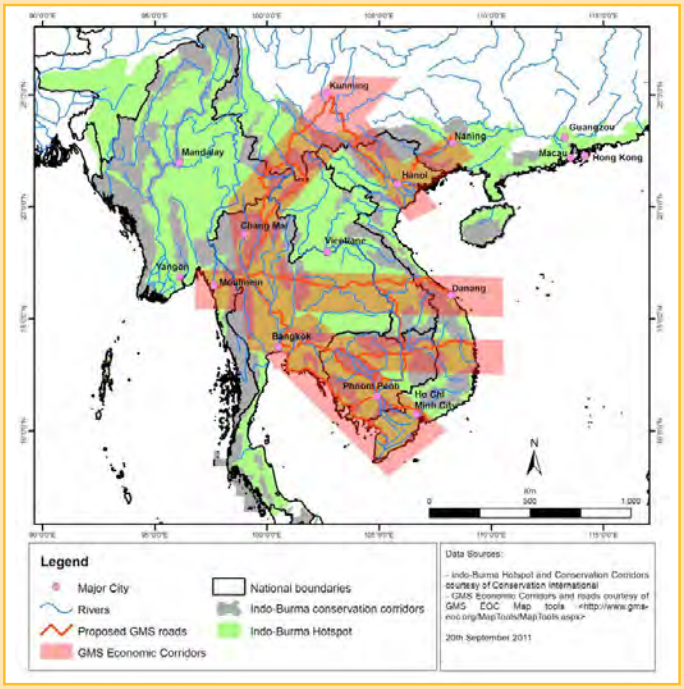
Rapid economic growth

The economic growth-driven development of the AMS is fuelling much of the increase in natural resource exploitation and ensuing biodiversity loss.

Agriculture remains a major economic activity for all the biodiversity hotspots among the AMS. Agro-industrial plantations of commercial crops such as palm oil, rubber and coffee have rapidly expanded in response to dramatic increases in global commodity prices, pushed by the rising demand for biofuels, rubber tires for vehicles, and other agro-industrial products (CEPF 2011).

Mining and quarrying operations are also key to many AMS economies. Coal, oil and gas production are increasing in an attempt to meet rising energy demands within the region,

despite the development of renewable energy sources (Samdhana Institute 2016a). The region also exports coal and gas, with Indonesia as the world's largest coal exporter (Samdhana Institute 2016b). In addition, the extraction of limestone, copper, gold, jade and other mineral resources is present throughout the region, both in the form of open pits and small-scale artisanal mining (Samdhana Institute 2016a; Samdhana Institute 2016b).



Source: ADB (2011b); unpublished data from CI. (CEPF 2011)

Figure 32. Overlap between GMS Economic Corridors and Conservation Corridors in the Indo-Burma Hotspot

Tourism is another important revenue, generating sector for many AMS attracting tens of millions of tourists every year, a proportion of whom do nature-based tourism, such as visits to protected areas, and thus also increase pressure on the environment (CEPF 2011).

Increased intra- and inter-regional trade and investment

Increased cross-border trade investment within ASEAN and between ASEAN and other region has been linked with land conversion and biodiversity loss in the region. In the Mekong Region, foreign investors, typically from larger economies (Thailand, Viet Nam and China), have been granted large land concessions in smaller economies (Cambodia, Lao PDR and Myanmar) for industrial agriculture, plantation and extractive activities to supply raw materials to the former nations (Samdhana Institute 2016a; CEPF 2011). Infrastructure investments have also expanded road networks to ease the transport of goods. The three main Mekong economic corridors, stretching across China, Myanmar, Thailand, Lao PDR, Cambodia and Viet Nam (Figure 32), have improved access to previously remote areas, increasing agricultural expansion and forest resource extraction (CEPF 2011).

Increased energy demand in China, Thailand and Viet Nam, as well as the demand for flood control and irrigation, has driven hydropower dam development in the Mekong Region. Thailand and Viet Nam are estimated to contribute to 96% of demand for hydroelectricity on the mainstream section of the lower Mekong River Basin. There is also economic incentive for hydropower development. Lao PDR earns significant income from its dams, and stands to gain the most in terms of revenue from future dam construction (CEPF 2011). At least 82 of the planned 149 dams on the Mekong River and its tributaries have been built, while hydropower is being planned on the Ayeyarwady and Salween Rivers (Samdhana Institute 2016a).

3. Pressures

Human activities threaten biodiversity in the ASEAN region by transforming habitats and degrading ecosystems that are key to species' wellbeing and survival. The drivers described above have induced large-scale land use changes, altered habitats, and introduced direct threats to biota, such as the over-exploitation of certain species. A summary of the numbers of species threatened by different pressures is shown in Table 25.

Table 25. Threats to plant and animal species in ASEAN Members States, and the number of species threatened (critically endangered, endangered, and vulnerable) (IUCN 2016)

IUCN Red List Threat	Description	Number of threatened species
Residential and commercial development	Housing and urban areas; commercial and industrial areas; tourism and recreation areas	883
Agriculture and aquaculture	Annual and parennial non-timber crops; wood and pulp plantations; livestock farming and ranching; marine and freshawater aquaculture	976
Energy production and mining	Oil and gas drilling; mining and quaryying; renewabel energy	313
Transportation and service corridors	Roads and raildoards; utility and service lanes; shipping lanes	349
Biological resource use	Hunting and trapping terrestrial animals; gathering terrestrial plants; logging and wood harvesting; fishing and harvesting aquatic resources	1703
Human intrusions and disturbance	Recreational activities; war; civil unrest and military exercises; work and other activities	445
Natural system modifications	Fire and fire suppression; dams and water management/use; other ecosystem modifications	395
Invasive and other problematic species, genes and desease	Invasive non-native/alien species/desease; problematic native species/desease	362
Pollution	Domestic and urban waste water; industrial and military effluents; agricultural and forestry effluents; garbage and solid waste; air-borne pullutants	570
Climate change and severe weather	Habitat shifting and alteration; droughts; extreme temperatures; storms and flooding	341

Source: IUCN 2016

Habitat conversion

Natural habitat conversion to other land uses is a key pressure on ecosystems and biodiversity in the ASEAN region.

Deforestation has been driven mainly by industrial agriculture expansion, especially the establishment of oil palm plantations in Indonesia and Malaysia, as well as the logging industry (UNEP 2016; ASEAN Centre for Biodiversity 2010). The growth of other commercial crop plantations in the region, such as coffee (Viet Nam), cashew and cassava (southern Viet Nam and Cambodia), rubber (southern Thailand, Lao PDR, Viet Nam) and sugarcane (Myanmar) has resulted in a large loss of forest cover (CEPF 2011).

The mining of limestone karst for cement production is an often-overlooked pressure on biodiversity in the region. Viet Nam and Malaysia are among the world's top five exporters of limestone, and the constantly increasing demand is destroying hotspots of endemic species of reptiles, amphibians, rodents, bats, plants, snails, and slugs (Hughes 2017).

Urbanization has also led to significant conversion of natural habitat. At the beginning of the century, biodiversity hotspots covered more than half of the region's urban areas (Güneralp and Seto 2013). It is projected that by 2030, more protected areas in the ASEAN region will be within 10 km of a city than in any other region globally (Mcdonald et al. 2008).

Habitat degradation and alteration

Habitat degradation is also placing major pressures on the integrity of ecosystems and biodiversity in the region.

The pollution of terrestrial and inland water ecosystems has resulted in severe ecological imbalances that threaten the health and survival of many species. The pollution of inland water ecosystems is caused by agricultural fertilizer and pesticide runoff, domestic and industrial waste disposal, mining, and other development activities. Eutrophication from nutrient loading is of particular concern. The over-application of fertilizers from agriculture intensification is the main source of nutrient pollution in aquatic systems. The excess quantities of nitrogen and phosphorus encourage rapid and dense growth of like algae and other aquatic flora, which depletes the oxygen needed to support most living organisms and reduces water quality (ASEAN Centre for Biodiversity 2010; UNEP 2016). The disposal of toxic mine tailings in rivers and the widespread use of cyanide and mercury in small-scale artisanal mining have severely polluted inland waters and wetlands (Samdhana Institute 2016b).

Other forms of habitat alteration have negative impacts on biodiversity. The development of dams and reservoirs are major threats to river ecosystems in the region because they disrupt their natural flooding cycles and sedimentation processes, and change water temperature and quality. Physically, dams block the passage of migratory fish. Dams have a huge impact on major river basins like the Mekong, where migratory species comprise up to 87% of all fish species that traverse across the basin, and between the main river and its tributaries, lakes, streams and seasonal wetlands. The dams block hundreds of fish species from accessing their spawning grounds and seasonal habitats (CEPF 2011; Samdhana Institute 2016a). In addition to altering river ecosystems, dam construction and operation also indirectly affects connected upstream and downstream ecosystems and their biodiversity. In 2016, the Mekong Region experienced severe drought attributed partially to upstream dam operations in China. The resulting low water levels in the Mekong Delta led to saltwater intrusion into the delta's low-lying areas, that affected 400,000 hectares of farmlands and caused serious environmental and livelihood damage (Hughes 2017). Dam construction also results in village resettlement, placing additional strain on biota and habitats (CEPF 2011; Samdhana Institute 2016a).

Direct threats to biodiversity

As agriculture is still the main land use, agro-ecosystems are an important source of biodiversity in the ASEAN region. However, agricultural intensification is placing great pressure on agrobiodiversity. The emphasis on productivity has led to monoculture, the selection of high-yielding crop and livestock varieties, and more intensive use of agrochemicals such as pesticides (ASEAN Centre for Biodiversity 2010; IPBES 2016). The conversion of agricultural land for other uses is also threatening agrobiodiversity (ASEAN Centre for Biodiversity 2010).

Invasive alien species (IAS) are a key threat to biodiversity in the region (Box 7). They are introduced both intentionally and unintentionally through movement of plants, animals and micro-organisms. Invasive alien species can outcompete native species for food, and the absence of predators in their new habitats can lead to their proliferation and domination of local ecosystems. Agrobiodiversity is also susceptible to damage from invasive alien species, as new varieties of pests and diseases can devastate crop and livestock populations (ASEAN Centre for Biodiversity 2010).

Box 7. Invasive alien species in the ASEAN region

Listed below are examples of key invasive alien species that have threatened native biodiversity in the ASEAN region.

Mimosa pigra, a woody shrub native to tropical America that has converted fertile agricultural land along the Mekong River into shrub lands unsuitable for cultivation, and affected fish and water bird populations.

Eichhorniacrassipes (Water Hyacinth), a fast-growing floating plant whose population can double in twelve days. It often crowds certain rivers and lakes, cutting off sunlight and oxygen from the water column, which affects the survival of other aquatic species.

Pomacea canaliculate (Golden Apple Snail), a freshwater snail from South America that feeds on rice seedlings and has destroyed rice fields across the region.

Source: ASEAN Centre for Biodiversity (2010)

Targeted consumption of certain wild plant and animal species for food, medicine and ornamentation has led to their over-exploitation (Hughes 2017). The ASEAN region is a supplier to both the legal and illegal wildlife trade of products that range from medicinal plants, rare orchids and high-value timber to birds, reptiles and mammals (ASEAN Centre for Biodiversity 2010; Sodhi et al. 2004). Malaysia, Viet Nam, and Indonesia are top exporters of wild animals in the region, with the European Union (EU) and Japan being the main importers. Wildlife trade is an important source of income for some of the poorest people in the region, but is also creates revenue for large business operators (Nijman 2010).

Overfishing is also a growing concern, as the harvesting of freshwater fish in the region has increased rapidly over the past two decades in response to increasing food demand, especially in AMS with important inland fisheries such as Cambodia, Indonesia, Myanmar and Thailand (Allan et al. 2005).

Climate change

Greenhouse gas (GHG) emissions from anthropogenic activity worldwide are changing the climate of the ASEAN region, with implications for its ecosystems and biodiversity.

The ASEAN region has been facing a rise in average temperatures and temperature extremes, increases in wet season rainfall and rainfall intensity, and greater frequency of extreme events.. Climate change projections for the ASEAN region include increases in mean temperatures by 2°C to 3°C above the late 20th century baseline by 2100, and increases in monsoon precipitation extremes (Hijioka et al. 2014). Droughts are also likely to increase water stress in the region (Zhang et al. 2016).

Climate change is exacerbating the negative effects of other anthropogenic pressures on ecosystems and biodiversity in the region (ASEAN Centre for Biodiversity 2010; CEPF 2011; Samdhana Institute 2016a; Samdhana Institute 2016b; UNEP 2016). Changes in temperature and precipitation will affect many species by changing feeding, breeding and migrating environments, introducing competition from invasive species, and increasing exposure to pest and disease outbreaks (CEPF 2011; Samdhana Institute 2016a). Species in montane forests, lowland forests, and inland freshwater wetlands are especially vulnerable to climate change.

Climate change will likely shift habitat and species distributions, with high risks of extinction for species that have small habitat ranges and need particular environmental conditions (ASEAN Centre for Biodiversity 2010). It is projected that climate change will shift vegetation and many species northward, and reduce the distributions of many species (Hijioka et al. 2014). Climate change is already reported to have moved the habitat ranges to higher elevations of at least 94 bird species in the ASEAN region (Peh 2007).

Climate change will also impact biodiversity indirectly. Shifts in human populations due to floods and water shortages, changes in agricultural land use, and increased engineering of waterways will increase the pressure on biodiversity in the region (CEPF 2011; Samdhana Institute 2016a).

4. State and trends

Biodiversity

The ASEAN region is home to an incredible array of biodiversity.[30] Occupying only 3% of global land area, the region has the highest proportion of endemic bird and mammal species (9% and 11%) and the second highest proportion of endemic vascular plant species (25%) compared to the tropical regions of Meso-America, South America, and sub-Saharan Africa (Sodhi et al. 2010). Indonesia, Malaysia, and the Philippines are three of the world's 17 mega-diverse nations, containing exceptionally high levels of endemism due to geographical isolation and a complex geological history (Sodhi et al. 2004; ASEAN Centre for Biodiversity 2010). For example, over half of Indonesia's plant species are endemic species (ASEAN Centre for Biodiversity 2010; Ministry of Environment and Forestry 2014). More than two thousand species have been discovered in the ASEAN region over the past two decades (Box 8).

30. Academic studies on biodiversity and ecosystems tend to use the geographical designation of Southeast Asia (and not the politically defined "ASEAN Member States") when defining their study area, following biogeographical conventions. Although technically incorrect, the authors of this report have taken the liberty of using the term "the ASEAN region" in place of "Southeast Asia" when referring to the results of these studies, as this report focuses on the AMS. The AMS comprise 10 of the 11 nations of Southeast Asia, excluding Timor-Leste.

Box 8. Recently discovered species in the ASEAN region

In 2015 alone, 163 new species were found in the Mekong Region nations of Cambodia, Lao PDR, Myanmar, Thailand, Viet Nam, and China's Yunnan province, including:

- Parafimbrios lao, a rainbow-headed snake, and the 111th snake species documented in Lao PDR
- *Acanthosaura phuketensis* (Phuket Horned Tree Agamid), a lowland forest lizard species with horns down its head and spine, from Phuket, Thailand
- *Murina kontumensis* (Wooly-Headed Bat), a medium-sized bat with thick fur on its head and forearms, from the central highlands Viet Nam
- *Tylototriton anguliceps*, a newt with a dorsal ridge and distinct red markings, and only the fourth species of newt documented in Thailand
- *Musa nanensis*, a rare banana species from northern Thailand with fluorescent red flowers and tiny flower structures that are distinct from the rest of the banana family
- *Leptolalax isos* (Orange-Eyed Litter Frog), a small frog that lives in the hilly forests of northeastern Cambodia and neighbouring Viet Nam
- *Gekko bonkowskii*, a pale blue spotted gecko from the remote karst massifs of Lao PDR
- *Impatiens kingdom-wardii* (Purple Mouse-Eared Flower), a small purple flower from Mt. Victoria in southwestern Myanmar

Other recently discovered species reported by the AMS in the Fifth National Report to the Convention on Biological Diversity include:

- the Camiguin hawk owl (*Ninoxleventisi*), Cordillera shrew mouse (*Archboldomys maximus*), Zambales forest mouse (*Apomys zambalensis*), Sierra Madre forest mouse (*Apomys sierra*), and Southern Leyte frog (*Platymantis guentheri* and *Platymantis hazelae*) in the Philippines
- one new land fish species and four new insect species in the karsts of Indonesia
- the Myanmar Snub-nosed monkey (*Rhinopithecus strykeri*), and two new species of ginger (*Globba sherwoodiana* and *Curcuma arracanensis*) in Myanmar
- the Yellow Meranti (*Shoreaa cuminatissima*) and *Diospyros fusiformis*, tree species endemic to Borneo
- three new species of reptiles in the Cardamom Mountains of Cambodia
- *Plectranthus phulangaensis*, *Bauhinia nakhonphanomensis*, and *Ixora phulangkaensis*, threatened plant species that are endemic to the Phu Wua – Phu Langka forests of Thailand

Sources: WWF (2016); DENR-BMB (2014); Ministry of Environment and Forestry (2014); Ministry of Environmental Conservation and Forestry (2014); Ministry of Natural Resources and Environment (2014); National Biodiversity Steering Committee (2014); Government of Thailand (2015)

Biodiversity in the ASEAN region is among the most threatened in the world (Table 26). The region lies almost completely within four biodiversity hotspots (areas with high levels of endemism that are also threatened): Indo-Burma, the Philippines, Sundaland, and Wallacea (Myers et al. 2000). Compared to the tropical regions of Meso-America, South America, and sub-Saharan Africa, the ASEAN region has the highest proportion of known plant, reptile, bird and mammal species that are threatened (critically endangered, endangered, and vulnerable) (Sodhi et al. 2010).

As of 2016, three plant species and five animal species are known to have gone extinct in the past 100 years or so in the ASEAN region[31] (Box 9) (IUCN 2016). While these numbers are not considered large, the imminent extinction of many species in the region is a grave concern, and in many cases inevitable, due to large-scale deforestation over the last two hundred years. Since many of these species are endemic, their regional extinction would also mean global extinction (Sodhi et al. 2004). In addition, many species might become extinct before they are identified, as many large taxa are still not

fully discovered; between 1997 and 2015, over 2,216 new species were found in the ASEAN region (Hughes 2017).

Table 26. Threatened species by IUCN Red List of Threatened Species categories (as of 2016)

Status	Mammaals	Birds	Reptiles	Amphibians	Freshwater fish	Freahwater molluscs	insect	Plants
Critically Endangered	40	52	24	10	47	8	7	352
Endangered	90	73	42	53	52	15	25	277
Vulnerable	147	171	54	97	123	28	58	775
Total	**277**	**296**	**120**	**160**	**222**	**51**	**90**	**1404**

Source: IUCN Red List of Threatened Species 2016 (IUCN 2016)

Box 9. Recently extinct species in the ASEAN region

A number of species in the ASEAN region have gone extinct in the past century or so due to human activity. Here are some examples:

- The **Woolly-stalked Begonia** (*Begonia eiromischa*) is known to have disappeared from Penang Island in Malaysia within the last 100 years, due to the clearing of dipterocarp forest for agriculture.
- **Ridley's Stick Insect** (*Pseudobactricia ridleyi*) went extinct in Singapore over 100 years ago, due to the clearing of almost all natural forest.
- **Schomburgk's Deer** (*Rucervuss chomburgki*) disappeared from the central plains of Thailand in 1938 due to the conversion and fragmentation of grassland and swamp areas for commercial rice production, and intensive hunting for its antlers, used in Chinese medicine. This species was common in the late nineteenth century, and underwent a rapid decline after the early twentieth century.
- ***Plectostoma sciaphilum***, a land snail, went extinct in 2007 due to the quarrying of limestone karst at Bukit Panching in peninsular Malaysia in the mid-2000s. This species had a very small area of occupancy and was found only on this limestone hill.
- The **Siamese flat-barbelled catfish** (*Platytropius siamensis*) was an abundant freshwater fish in the Chao Phraya and Bang Pakong rivers of Thailand in the 1920s, but has not been encountered since 1977. It disappeared due to the damming and canalization of the Chao Phraya river, extensive reclamation of wetlands around Bangkok, and river pollution.
- ***Macrobrachium leptodactylus***, a freshwater crustacean, has not been seen in the past 30 years in the Indonesian island of Java, and is considered extinct. The causes were urbanization and agricultural intensification.

Source: IUCN (2016)

Ecosystems

Forest ecosystems

The forest ecosystems of the ASEAN region are some of the world's most diverse. The lowlands of the Ayeyarwady and the Salween River Basin in Myanmar, and of the Mekong River Basin in Thailand, Lao PDR and Cambodia, were formerly covered by dry or deciduous forests. Agriculture and logging are threats to the small portions that remain. Evergreen and semi-evergreen sub-tropical forests still cover the northern

31. The extinction status of one animal species on the IUCN Red List is debated due to taxonomic uncertainty. Another animal species has only been identified through subfossils, indicating it did not go extinct as recently as the other species on the list. These two species were not included in the five extinct animal species in this report.

highlands of Myanmar, Lao PDR and Viet Nam, while evergreen and semi-evergreen rainforests occur on the Thai-Myanmar and Viet Nam-Lao PDR-Cambodia borders, as well as in southern Cambodia and eastern Thailand (ASEAN Centre for Biodiversity 2010; Samdhana Institute 2016a). The natural vegetation of the archipelagic portion of ASEAN comprises evergreen and semi-evergreen tropical rainforest (Samdhana Institute 2016b; Ministry of Industry and Primary Resources 2014). Mangrove forests are found along the coasts (more information on coastal ecosystems and their biodiversity can be found in chapter 2.5). With the exception of the Philippines and Viet Nam, all of the AMS have experienced continuous decline in forest cover over the past few decades.[32] The ASEAN region has lost 13% of its forest area since 1992 (UNEP 2016). By the end of the century, three quarters of the region's original forests could disappear (Sodhi et al. 2004). At the same time, there is an increase in the proportion of production forests (also see chapter 2.2 Land). Deforestation has led to significant habitat loss and declines in species populations, as well as species extinction (UNEP 2016; ASEAN Centre for Biodiversity 2010). The forests of AMS are a major contributor to the region's rich biodiversity, and their destruction has led to warnings of an 'impending biodiversity disaster', where up to 42% of all species could be lost by 2100 (Sodhi et al. 2004). The loss of primary and secondary forests, especially in mega-diverse nations such as Indonesia, threatens many forest-dependent species such as the orang-utan (Koh 2007). One-fifth of all amphibians in the region are threatened primarily by deforestation (Rowley et al. 2010). Large-ranging species are affected by forest fragmentation from activities such as road construction for logging (Hughes 2017). Habitat loss and disruption of ecosystem stability by land-use change and fragmentation is not easily restored.

Much of the wildlife trade, both legal and illegal, originates in the forests of mainland ASEAN (Sodhi et al. 2004). The biodiversity in Indonesia, Malaysia and Myanmar are especially vulnerable to the illegal wildlife trade that have resulted in steep population declines and the local extinction of species such as the tiger, Asian elephant, pangolins, and freshwater turtles (ASEAN Centre for Biodiversity 2010). Certain amphibians, such as salamandrids and large frogs, have been overharvested as traditional medicine, pets, and food, to the extent that they are nearing extinction (Rowley et al. 2010).

The insular AMS also have important freshwater ecosystems, such as the 13 large lakes in Indonesia's Sulawesi island, including Lake Matano, the ASEAN region's deepest lake (Samdhana Institute 2016b). Around half of the world's peatlands are found in the insular AMS. Most of these peatlands are in Indonesia, which has the fourth largest area of peatland in the world (Samdhana Institute 2016b; Ministry of Environment and Forestry 2014).

Eight AMS are parties to the Ramsar Convention on Wetlands. Together, they have designated 55 wetlands, covering a total area of over 2.5 million hectares, to the Ramsar List of Wetlands of International Importance. 35 of those are inland wetlands (Table 27).

The biodiversity of freshwater ecosystems in the ASEAN region is notable. The Indo-Burma hotspot contains over 2,515 freshwater species, over 1,780 of which are freshwater fish species (IUCN 2012; Allen et al. 2012). With a documented 877 fish species, the Mekong River is only second to the Amazon River in level of biodiversity world-wide (Ziv et al. 2012). There is a great diversity of waterbirds, as the wetlands of the ASEAN region are key stop-over points for migratory birds of the East Asian-Australasian Flyway (Wetlands International 2017; Kirby et al. 2008).

32. See Chapter 2.2 Land for more information on the status and trends in forest cover in the AMS.

Freshwater ecosystems are the most threatened ecosystems in the world. Losses in fish biodiversity are expected due to climate change, pollution, and invasive alien species (ASEAN Centre for Biodiversity 2010). Eutrophication is threatening the lakes of central Sulawesi, Indonesia, which are important habitats for endangered species (Samdhana Institute 2016b).

Table 27. Ramsar Sites in the ASEAN region

ASEAN Member States	Number of inland wetlands that are Ramsar Sites	Surface area of inland wetland Ramsar Sites (hectares)	Total Number of Ramsar Sites	Surfaces area of Ramsar ites (hectares)
Cambodia	3	63,942	4	75,942
Indonesia	7	1,372,976	7	1,372,976
Lao PDR	2	14,760	2	14,760
Malaysia	2	117,249	7	134,182
Myanmar	3	100,743	4	150,743
Philippines	3	51,606	7	244,017
Thailand	7	51,982	14	399,714
Viet Nam	8	117,813	8	117,813
Total	35	1,891,071	55	2,510,147

Source: Ramsar Conventionon Wetlands, 2014

The damming of rivers, especially in the Mekong Region, is one of the biggest threats to freshwater biodiversity. If current plans proceed for dam construction on the Mekong River and its tributaries, almost one-third of fish species, including up to 103 migrating fish species, and 40% of mollusc species will be threatened over the next decade (Ziv et al. 2012; Allen et al. 2012). Karsts, which are endemism hotspots, are frequently flooded for dam construction, with ensuing loss in terrestrial biodiversity (Hughes 2017).

Many freshwater fish species in the region are threatened by overfishing. Some species have faced population declines of over 80% over the past two decades. These include critically endangered migratory megafish such as the endemic Mekong Giant Catfish (*Pangasianodon gigas*, the world's largest freshwater fish), the Giant Barb (*Catlocarpio siamensis*), and the Dog-eating Catfish (*Pangasius sanitwongsei*) (Allen et al. 2012; CEPF 2011; Hogan et al. 2004).

Agroecosystems

In biodiversity conservation, agriculture is often seen mainly as a driver of natural biodiverisity loss. However, agroecosystems are key to sustaining biodiversity, both in terms of natural species diversity and the genetic diversity of crops and livestock. Overall, there is still limited information on crop and livestock genetic diversity in the region.

Box 10. Cambodia's Great Lake

The Tonlé Sap, also known as the Great Lake, is the ASEAN region's largest permanent freshwater lake. Located in central Cambodia, it is connected to the Mekong River through the Tonlé Sap River. During the dry season it covers over 2,000 square kilometres, and when fully flooded expands to over 13,000 square kilometres (Welcomme et al. 2015). The seasonally flooded plains surrounding the Tonlé Sap are home to swamp forests, dipterocarp forests, wetlands and grasslands (CEPF 2011).

The lake is one of the world's most productive fisheries. Communities living by the lake and its waterways rely on fishing for subsistence and as their source of livelihood. The average per capita consumption of fish can reach 71 kilogrammes per year (compared to a global average of 16 kilogrammes). Increased fishing activity has substantially reduced the stocks of high-value fish species. For example, catches of river catfish were reported to have dropped by 90% within two decades (Allan et al. 2005). The 'dai' (stationary trawl) fishery affects migrating fish in particular; up to 80% of the 1.6 million fish that migrate from the Tonlé Sap everyday between October and March are caught by 'dai' gillnets (Welcomme et al. 2015).

Communities surrounding the Tonlé Sap floodplain cultivate rice as a major economic activity. The sediments from the Mekong River contribute to the floodplain's fertile soils. Deepwater rice is traditionally cultivated in inundated zones, but the expansion of dry-season rice farming has displaced large areas of a grassland ecosystem that is important to threatened species such as the Bengal florican (*Houbaropsis bengalensis*) (CEPF 2011). Changes in the hydrological regime of the Mekong River and the Tonlé Sap due to hydropower development could impact the production of both rice and fish, the two staples of Cambodia (National Biodiversity Steering Committee 2014)

The Tonlé Sap was designated as a UNESCO Biosphere Reserve in 1997. It protects seasonally flooded swamp forest and grasslands rich in endemic and diverse species. Waterbird populations in the Prek Toal core area, recognized as one of the premier habits in Asia for large waterbirds, are on the rise (Allen et al. 2012; National Biodiversity Steering Committee 2014).

The Cambodia government has taken action to protect the Tonlé Sap ecosystems and economic activities. All private fishing lots were abolished in 2012 to encourage community-based fishery management, and several fish conservation areas have been established. The Tonlé Sap Environmental Management Project supports the integrated management of the Tonlé Sap through environmental education, land use planning and zoning, community development, and small-scale industrial development (National Biodiversity Steering Committee 2014).

Sources: Allen et al. (2012); Welcomme et al. (2015); Samdhana Institute (2016a); CEPF (2011); National Biodiversity Steering Committee (2014)

The ASEAN region has significant genetic diversity for rice (*Oryza spp*.); banana (*Musa spp*.); fruit trees such as lime, pomelo, mangosteen, rambutan, and durian; vegetables such as eggplant and pepper (*Piper spp*.); roots and tubers such as taro (*Colocasia esculenta*) and yam (*Diascorea spp*.), and other crops such as sugarcane (*Saccharum officinarum*) and coconut (*Cocos nucifera*) (Commission on Genetic Resources for Food and Agriculture 2010; Li 1970; Zeven and Wet 1982). For example, the Philippines has over 5,500 native rice varieties and wild relatives, and Thailand is expected to have over 10,000 varieties (DENR-BMB 2014; Ministry of Natural Resources and Environment 2015). The ASEAN region has almost 560 livestock breeds, including one-fifth of

the world's buffalo breeds and 14% of the world's duck breeds (ASEAN Centre for Biodiversity 2010).

The region's crop genetic diversity has been in decline due to several factors. Genetic erosion, mainly due to farmer preference for new high-yielding varieties, is causing the extinction of less productive varieties, especially indigenous ones (ASEAN Centre for Biodiversity 2010). In Shan state, Myanmar, modern hybrid cereal varieties have replaced most local crop landraces (Ministry of Environmental Conservation and Forestry 2014). Many native vegetables and fruit varieties are reported to be at risk of extinction in Thailand because they are no longer commonly grown and consumed (Government of Thailand 2015). Natural disasters and land-use change also affects native varieties and their wild relatives. In Myanmar, the destruction of wild crop habitats along forest margins for infrastructure development has affected rice varieties such as *Oryza ridleyi, O. granulata, O. officinalis, O. nivara*, and *O. rufipogon* (Ministry of Environmental Conservation and Forestry 2014). Severe flooding in 2011 in Thailand damaged plantations of many native and iconic durian cultivars in Nonthaburi Province (Government of Thailand 2015).

There is a similar decline in livestock genetic diversity in the region. The import of high-yielding non-native livestock breeds has displaced traditional breeds in Indonesia, Malaysia, the Philippines, Thailand and Viet Nam (Scherf et al. 2015). 23 native livestock breeds in the region are at risk of extinction (ASEAN Centre for Biodiversity 2010). In Viet Nam, endemic breeds such as the Ba Xuyen pig and the Ho chicken remain in very small population numbers (Government of Viet Nam 2014).

However, there has also been increasing interest in the preservation and use of traditional varieties. Plant breeders are turning to native varieties to develop cultivars with traits such as disease and pest resistance, drought tolerance, and flood tolerance; in Thailand, around 100–300 native varieties are used each year for this purpose (Government of Thailand 2015).

Agrobiodiversity also refers to other biota that interacts with crops and livestock and play crucial agroecosystem functions. Soil biota includes animals such as earthworms, insects and nematodes, and microorganisms such as fungi, bacteria and archaea. These organisms maintain soil fertility by decomposing organic matter and recycling nutrients, control pathogens, and maintain soil structure and water distribution. Soil is one of the most biodiverse habitats; even highly disturbed soils such as rice paddy soils are known to have high levels of bacterial diversity. Soil biota in agroecosystems are affected by pesticide and fertilizer application, soil tillage, and monoculture cropping. Despite their importance, soil biodiversity in general is still very poorly understood (Orgiazzi et al. 2016).

Pollinators are another key group of biota in agroecosystems. The ASEAN region depends on pollinators such as honey bees and bats in the production of many economically important crops, especially fruit trees. Over 40% of pollinators are threatened by extinction worldwide from pesticide use and the destruction of natural habitats. Many local honey bee species in the ASEAN region are in decline. *Apis cerana*, which is common throughout Asia, is threatened. The red honey bee (*Apis koschevnikovi*) is now rarely seen in the south of Thailand and peninsular Malaysia. A*pis andreniformis* and *Apis dorsata*, both forest inhabitants, are also in decline in mainland and archipelagic AMS due to forest conversion (IPBES 2016; Oldroyd and Nanork 2009). More studies are needed to determine whether these pollinator declines are reversible (IPBES 2016).

Urban ecosystems

It is increasingly recognized that biodiversity can co-exist with urban spaces. Cities can even have high species diversity; Singapore is a key example of a highly-urbanised city-state with rich biodiversity (Box 11).

Box 11. Urban biodiversity conservation in Singapore

Singapore is a city-state with a land area of about 719 km2 located within the Sundaland biodiversity hotspot. It is one of the most densely populated nations in the world. Despite being highly urbanised, Singapore has a rich array of native biodiversity in a diverse range of ecosystems. Singapore has recorded 2,145 species of native vascular plants, 392 species of birds, 324 species of butterflies, 109 species of reptiles, 85 species of freshwater fish, 65 species of mammals, 29 species of amphibians, 12 seagrass species, and 255 hard coral species which can be found in natural habitats such as primary dryland forest, tall secondary forest, freshwater swamps, rocky shores, mangroves, seagrass beds and coral reefs.

The National Parks Board (NParks) works in partnership with other government agencies and stakeholders to maintain and enhance urban greenery and biodiversity in Singapore and to increasingly seek innovative ways to address the challenges of land scarcity. NParks developed the National Biodiversity Strategy and Action Plan (NBSAP) in 2009 for better planning and co-ordination in the sustainable use, management and conservation of Singapore's biodiversity. To operationalise the NBSAP, NParks launched the Nature Conservation Master Plan (NCMP) in 2015 which aims to conserve key habitats; enhance, restore and recover species; conduct conservation biology and planning research; and increase community stewardship and outreach.

One example of habitat conservation is the transformation of Bishan-Ang Mo Kio Park (BAMK), where a concrete canal was converted into a naturalised stream which eventually attracted a lot of biodiversity. BAMK is complemented with green corridors in the form of Nature Ways and the Park Connector Network. Nature Ways mimic the canopy structure of a forest and connect areas of high biodiversity to encourage the movement of animals and gene flow.

NParks has identified 68 species of flora and fauna for recovery efforts, and works alongside partners in implementing a breeding and translocation programme for the Harlequin butterfly (Taxilahaquinushaquinus). NParks also engages the community through citizen science programmes such as the Garden Bird Watch and Butterfly Watch, and enhances education and public awareness, with events such as the Festival of Biodiversity under NParks' Community in Nature initiative.

To monitor the progress of these conservation efforts, Singapore applies the Singapore Index on Cities' Biodiversity (SI), a self-assessment tool consisting of 23 indicators designed to help cities to track progress in their biodiversity conservation efforts. The SI measures efforts in three components: Native Biodiversity in the City; Ecosystem Services provided by Biodiversity; and Governance and Management of Biodiversity.

Source: National Parks Board, Singapore (2017)

A range of landscapes in and around cities can host biodiversity, including city parks and nature reserves, residential areas and city centres, and peri-urban agricultural land, although to differing degrees (Secretariat of the Convention on Biological Diversity 2012). Green spaces within cities tend to have more biodiversity. In Singapore, 90% of all butterfly species in the city were documented in forest reserves and urban parks (Koh and Sodhi 2004). A study of 111 cities in the ASEAN region found that green coverage

in urban areas ranges from 17% to 79% (Richards et al. 2017). A comparison of ASEAN capital cities found that in 2010, Singapore had the highest urban green space area per capita (19 square metres), and Kuala Lumpur, the second highest (12 square metres). Manila and Bangkok had around 4.5 and 3.5 square metres per capita, while Jakarta and Ho Chi Minh had around 1.6 and 0.7 square metres per capita, respectively (Tan 2012). Among all similarly sized urban regions in the world, the mega-urban regions of Bangkok, Manila, Ho Chi Minh and Jakarta rank among the lowest in terms of amount of green and public spaces (Douglass et al. 2008).

5. Impacts

Ecosystems and their biodiversity provide a range of ecosystem services that are crucial to the economies, livelihoods, food security, and well-being of the ASEAN region's people and communities. These benefits, and the negative outcomes from the loss of these ecosystem services, are described below.

Provision of services

Agricultural ecosystems and biodiversity ensure the sustainability of agricultural production in the region. Globally, pollination services contribute US$ 235 - 577 billion in crop value (IPBES 2016). AMS such as Indonesia, Malaysia, Thailand and Viet Nam are important producers and exporters of pollination-dependent crops such as mango, guava, mangosteen, durian, coconut, and coffee (FAO 2017).The decline in pollinators poses threats to the production of these crops, and therefore economies and livelihoods. In Indonesia, the loss of mangroves has affected bat species and reduced yields of fruit trees pollinated by bats (Ministry of Environment and Forestry 2014). Invasive alien species also cause extensive damage to agricultural production in the region, equivalent to between US$ 23 and 34 billion in losses each year (Nghiem et al. 2013).

Natural ecosystems are also important for food security and local livelihoods in the region. Around 25 million people in Viet Nam live in or near forests, and up to half of their income is derived from non-timber forest products (Government of Viet Nam 2014).

Fish is a crucial source of protein for people, especially in the Mekong Basin which is home to the largest inland fishery in the world. In 2000, 56 million people in the Lower Mekong Basin consumed over 2 million tons of inland fish (Hortle 2009). Communities in the Lower Mekong Basin are particularly dependent on fisheries for protein and food security, consuming an annual average of 29–39 kg of fish and other aquatic animals per person; this comprises 47 - 80% of their total protein intake (Hortle 2007). Hydropower development in the basin is estimated to reduce fish biomass by 0.7–1.6 million tonnes per year, which is worth US$ 2.4–3.0 billion at first-sale value (Barlow et al. 2008). Dams in the Mekong River and its tributaries therefore pose a major threat to food security and the livelihoods of low-income communities in the basin.

Regulating services

Ecosystems play an important role in providing regulating services related to climate, water, erosion, disease, and disasters, which in turn affect human well-being.

In the Philippines, an executive order declared a moratorium on timber harvests in response to severe floods, soil erosion and landslides caused by deforestation that claimed many lives, displaced communities, and damaged property (DENR-BMB 2014).

Like in natural ecosystems, biodiversity is key to regulating agroecosystem functions. Losing certain species or varieties means losing certain traits and interactions within the

ecosystem, such as those that regulate crucial functions: nutrient cycling, soil moisture retention, and the regulation of pests and diseases (Jarvis et al. 2013). Many threatened local crop varieties in the ASEAN region have valuable genetic traits such as pest and disease resistance, and some local breeds of livestock are known to have resistance or tolerance to ticks, internal parasites, and certain diseases (Scherf et al. 2015; ASEAN Centre for Biodiversity 2010). The conservation of agricultural genetic resources improves the capacity of crop and livestock systems to adapt to climate change impacts. For example, studies have found that most traditional rice varieties are less susceptible to flood damage than new, high-yielding varieties (Talberth and Reytar 2014).

Invasive alien species can disrupt ecosystem services that regulate the spread of human diseases. Dengue, which was introduced to the ASEAN region by *Aedes aegypti*, the African yellow fever mosquito, caused around 6,000 deaths in 2008 and cost the region around US$ 0.95 billion annually. Malaria in the ASEAN region is caused by invasive pathogens (*Plasmodium falciparum* and *Plasmodium vivax*); the annual cost of controlling malaria in the AMS, excluding Singapore and Brunei, is on average US$ 93 million (Nghiem et al. 2013).

In cities, green spaces are important for reducing urban heat island effects. A study in Bangkok, Jakarta and Manila found that green spaces were strongly correlated with reduced land surface temperatures. Green spaces were on average 3°C cooler than built-up land (Estoque et al. 2017). Urban green spaces contribute to the physical, psychological, and social wellbeing of people in cities. However, most of the ASEAN region's largest cities have much less than the WHO-recommended minimum of nine square meters per capita (Tan 2012).

Traditional and socio-cultural benefits and wellbeing

The forests of the ASEAN region are important sources of plants with medicinal properties that are central to indigenous cultures and traditional medicines in the region. In peninsular Malaysia, over 800 medicinal and aromatic plant species have been documented in consultation with indigenous peoples. 760 plants have been identified as used by the indigenous peoples of Sarawak (Ministry of Natural Resources and Environment 2014). The legal system in the Philippines recognizes the value of the indigenous peoples' traditional knowledge and provides safeguards to protect this knowledge; for example, indigenous peoples have ownership rights over their knowledge of traditional medicine, and can obtain redress against products that have not complied with regulations for the utilization of biological and genetic resources (DENR-BMB 2014). In Thailand, over 1,400 species of medicinal plants are used in traditional Thai medicine (Government of Thailand 2015).

In recognition of the importance of indigenous plants to the health and cultures of the ASEAN people, ASEAN has published *ASEAN Herbal and Medicinal Plants*, a compilation of 90 popular herbal and medicinal plants from the ASEAN region as a reference for researchers and practitioners, and *Herbal Medicines Used in Primary Health Care in ASEAN*, a guide for the effective and safe use of herbal medicines in primary health care, particularly for people in rural communities (Sittichai et al. 2014; ASEAN 2010).

6. Responses

AMS recognize the importance of protecting and supporting ecosystems and biodiversity in the region, and are taking actions at different levels, nationally, regionally as well as globally in accordance with various domestic legislations and priority activities, ASEAN-

wide policies and action plans as well as international agreements including the United Nations Sustainable Development Goals (SDGs), particularly SDG 15: Life on Land. This section describes efforts in a variety of areas.

National responses

Natural ecosystem conservation and management

AMS are undertaking national-level actions such as increasing protected areas, afforestation, and supporting community-based forest management. Malaysia, Myanmar and the Philippines have developed national wetland policies and action plans (Ministry of Natural Resources and Environment 2014; DENR-BMB 2014; Ministry of Environmental Conservation and Forestry 2014). Cambodia's Tonlé Sap Biosphere Reserve and the Tonlé Sap Environmental Management Project aim to conserve unique natural freshwater habitats and encourage an integrated and sustainable management approach for the Tonlé Sap lake (National Biodiversity Steering Committee 2014).

Wildlife conservation

All ten AMS have developed national wildlife laws and/or policies (Fifth National Reports to the Convention on Biological Diversity). For example, the government of Lao PDR recently created recovery plans for specific species such as the National Tiger Action Plan (2010-2020) and the National Action Plan for Conservation of Gibbons (2011-2020) (Government of Laos 2016).

Invasive species

The Philippines has prepared National Invasive Species Strategic Action Plans to respond to threats posted by invasive alien species (DENR-BMB 2014). Malaysia adopted the National Action Plan for Prevention, Eradication, Containment and Control of Invasive Alien Species (Ministry of Natural Resources and Environment 2014).

Genetic diversity conservation

Both in situ and ex situ conservation have been used to conserve crop varieties and livestock breeds in the region. Malaysia, the Philippines, Viet Nam and Thailand have established gene banks for crops (Sajise 2015). Over 290,000 plant accessions are stored in national gene banks in the ASEAN region (Commission on Genetic Resources for Food and Agriculture 2010). In situ conservation of wild tropical fruit species (e.g. citrus, jackfruit, litchi, mango, mangosteen and rambutan) has been implemented in Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam (Commission on Genetic Resources for Food and Agriculture 2010). Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam have in situ and ex situ conservation programs for animal genetic resources (Scherf et al. 2015). A few AMS have started to document indigenous knowledge on genetic diversity conservation (Sajise 2015).

Urban biodiversity conservation

Parties to the Convention on Biological Diversity at their Tenth Meeting in 2010 endorsed the Plan of Action on Sub-national Governments, Cities and Other Local Authorities. The Plan of Action encourages parties to actively engage cities and local authorities in implementing the CBD.

The Plan of Action also highlights the City Biodiversity Index, also known as the Singapore Index on Cities' Biodiversity (Singapore Index), as a monitoring tool to assist local authorities to evaluate their progress in urban biodiversity conservation. Singapore,

as one of the key partners in developing the Singapore Index, has been encouraging AMS to apply the Singapore Index and conducted workshops to promote its application and to share experience and good practices on urban biodiversity conservation.

Several AMS have adopted measures to conserve urban biodiversity. The Philippines and Lao PDR have included urban biodiversity conservation in their updated national biodiversity strategies and action plans. Conservation efforts are also being carried out in some highly-urbanized cities in Metro Manila, Philippines (DENR-BMB 2014). Lao PDR has included urban biodiversity conservation in its action plan with targets for XiengKhouang province (Government of Laos 2016). Urban biodiversity conservation is a nascent area of cooperation in ASEAN which will be built on moving forward.

Environmental education and public awareness

Brunei Darussalam and Thailand have developed communication, education and public awareness materials on biodiversity (Ministry of Industry and Primary Resources 2014; Government of Thailand 2015). In Thailand, over 100 projects were carried out between 2008 and 2012 to educate the public on biological diversity, such as exhibitions on the International Day of Biodiversity and Wetlands Day, youth camps, and trainings (Government of Thailand 2015). The NParks agency in Singapore implements the Community in Nature initiative, and holds events such as the Festival of Biodiversity (Government of Singapore 2014). Indonesia, the Philippines, and Viet Nam have government programs to raise awareness and mainstream biodiversity into national development plans (Ministry of Environment and Forestry 2014; DENR-BMB 2014; Government of Viet Nam 2014).

Regional responses

ASEAN Centre for Biodiversity

The ASEAN Centre for Biodiversity (ACB) was established in 2005 and is located in Los Baños, the Philippines. ACB facilitates cooperation and coordination among AMS, and with relevant national government, regional and international organizations, on the conservation and sustainable use of biological diversity and the fair and equitable sharing of benefits arising from the use of such biodiversity in the ASEAN region. The ACB has the following roles:

- Programme development and policy coordination
- Human and institutional capacity development
- Biodiversity information management
- Communication and public affairs
- Organizational management and resource mobilization.

The ACB serves as the Secretariat of the ASEAN Heritage Parks Programme, an ASEAN flagship programme promoting a regional network of national protected areas of high conservation importance to generate greater awareness, pride, appreciation, enjoyment, and conservation of ASEAN's rich natural heritage. As of 2016, there were 38 ASEAN Heritage Parks established. Other major ACB initiatives include the Biodiversity and Climate Change Project (BCCP), the Protection of Biological Diversity in the AMS (Care4Bio), the Biodiversity Conservation and Management of Protected Areas in ASEAN (BCAMP), ASEAN Biodiversity Outlook, and the ASEAN Conference on Biodiversity. The BCCP, with technical assistance from GIZ, supported the implementation of the ASEAN Heritage Parks Programme through capacity building,

regional knowledge exchange, pilot projects, and regional studies. As a follow-up to the BCCP, the CARE4BioDiv programme provides small grants and technical assistance to strengthen the ACB institutionally and improve local livelihoods through biodiversity protection and sustainable ecosystem management. The BCAMP is an EU funded project that supports sub-national level activities to enhance biodiversity conservation and protected area management.

Natural ecosystem conservation and management

The Greater Mekong Sub-Region Biodiversity Corridors Initiative (BCI) and the Heart of Borneo (HoB) are examples of transboundary initiatives within the ASEAN region to protect forest ecosystems. The BCI aims to maintain forest cover and biodiversity by conserving landscapes that intersect with the Mekong region economic corridors to prevent ecosystem fragmentation. The Heart of Borneo initiative involves cooperation between Brunei Darussalam, Indonesia and Malaysia to protect the remaining forests on Borneo island. It covers an area of 22 million hectares (ASEAN Centre for Biodiversity 2010). Other initiatives in the region include the ASEAN Heritage Parks Programme and the ASEAN Peatland Management Strategy.

Wildlife conservation

The ASEAN Wildlife Enforcement Network (ASEAN-WEN) is the region's main mechanism for countering illegal wildlife trade, using a network of law enforcement agencies, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) authorities, police, customs, and other organizations both within and beyond the ASEAN region (ASEAN Centre for Biodiversity 2010).

Sustainable ecotourism

In 2016, ASEAN Tourism Ministers announced a declaration on the strategic development of ecotourism clusters and tourism corridors in the region (ASEAN 2016). Actions include the establishment of an inventory of protected areas, national parks and wildlife reserves; the establishment of a network of ecotourism sites across the AMS; and the encouragement of concerted action between stakeholders for the sustainable development of ecotourism, in connection with programs such as the International Union for Conservation of Nature (IUCN), the Global Sustainable Tourism Council, and the World Wildlife Fund (WWF).

Biodiversity knowledge sharing

The ASEAN Clearing-House Mechanism (ASEAN CHM) is ACB's contribution to science-based decision making for biodiversity conservation in the ASEAN region. It is designed to support the AMS in meeting their reporting requirements to multilateral environmental agreements, particularly the Convention on Biological Diversity, with special emphasis on meeting the Aichi Biodiversity Targets. The ASEAN CHM serves as gateway to available biodiversity information in the ASEAN region and is designed to provide a cohesive and integrated perspective of the region's biological resources. The website hosts a species database with almost 34,000 records of invasive and potentially invasive species that acts as an early warning facility for AMS, a mapping tool that advises protected area management, and a Friends of Biodiversity database that helps visitors locate biodiversity experts in the region.

Environmental education and public awareness

AMS recognize the need to raise public awareness on the importance of protecting ecosystems and biodiversity. Ten ASEAN Biodiversity heroes are being recognized on the 50th anniversary of ASEAN in 2017 for significant contribution to biodiversity conservation and advocacy efforts in AMS and the ASEAN region.

Assessment and valuation of biodiversity

AMS are increasingly acknowledging the need to account for the value of the region's natural resources. The ASEAN Economics of Ecosystems and Biodiversity (TEEB) initiative was established to provide information on ecosystem service and biodiversity valuation to decision makers. The TEEB Scoping Study implemented in 2012 highlighted both tangible goods and services derived from ecosystems and intangible values that are often excluded from economic analyses (Mamiit 2015).

Achieving internationally agreed environmental goals

AMS are parties to international environmental conventions related to ecosystem and biodiversity protection such as the Convention on Biodiversity (CBD), CITES, and the Ramsar Convention on Wetlands. As part of the CBD, the AMS adopted the Strategic Plan for Biodiversity 2011-2020, which include the Aichi Biodiversity Targets. The plan provides a framework for policy development to reach the following strategic goals:

- Address the underlying causes of biodiversity loss by mainstreaming biodiversity conservation across government and society
- Reduce the direct pressures on biodiversity and promote sustainable use
- Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity
- Enhance the benefits to all from biodiversity and ecosystem services
- Enhance implementation through participatory planning, knowledge management and capacity building.

All ten AMS have produced the Fifth National Report to the Convention on Biodiversity to report progress on the implementation of national biodiversity strategies and action plans, and progress towards achieving the Aichi Biodiversity Targets (CBD 2017). Efforts toward reaching these Targets contribute to all 17 SDGs both directly and indirectly, with particular relevance toward SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss (Secretariat of the Convention on Biological Diversity 2016). At the Eleventh Meeting of the COP to the CBD in 2012, parties were encouraged to use the Singapore Index on Cities Biodiversity to monitor progress toward achieving the Aichi Biodiversity Targets in urban areas (National Parks Board, Singapore 2014).

Six AMS are contracting parties and one is a signatory to the International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA), and nine are contracting parties to the International Plant Protection Convention (IPPC) (IPPC 2017; PGRFA 2017).

7. References

Allan, J. D., Abell, R., Hogan, Z., Revenga, C., Taylor, B. W., Welcomme, R. L. and Winemiller, K. (2005). *Overfishing of Inland Waters*. BioScience, 55(12). 1041–51. DOI:10.1641/0006-3568(2005)055[1041:OOIW]2.0.CO;2.

Allen, D. J., Smith, K. G. and Darwall, W. R. T. (2012). *The Status and Distribution of Freshwater Biodiversity in Indo-Burma*. IUCN, Cambridge, UK and Gland, Switzerland.

ASEAN, ed. (2010). *ASEAN Herbal and Medicinal Plants. ASEAN Secretariat*, Jakarta, Indonesia.

ASEAN (2016). *Pakse Declaration on ASEAN Roadmap for Strategic Development of Ecotourism Clusters and Tourism Corridors*. http://asean.org/storage/2016/08/Pakse-Declaration-on-Ecotourism.pdf.

ASEAN Centre for Biodiversity (2010). *ASEAN Biodiversity Outlook*. ASEAN Centre for Biodiversity, Los Baños, Laguna, Philippines.

Barlow, C., Baran, E., Halls, A. S. and Kshatriya, M. (2008). *How much of the Mekong fish catch is at risk from mainstream dam development? Catch and Culture*, 14(3). 16–21.

CBD (2017). Key *Elements of the Strategic Plan 2011-2020, including Aichi Biodiversity Targets*. https://www.cbd.int/sp/elements/default.shtml.

CEPF (2011). *Indo-Burma Biodiversity Hotspot Ecosystem Profile. Critical Ecosystem Partnership Fund*. http://www.cepf.net/SiteCollectionDocuments/indo_burma/IndoBurma_ecosystemprofile_2011_update.pdf.

Commission on Genetic Resources for Food and Agriculture, ed. (2010). *The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture*. Commission on Genetic Resources for Food and Agriculture, Food and Agriculture Organization of the United Nations, Rome.

DENR-BMB (2014). The Fifth National Report to the Convention on Biological Diversity - Philippines 2014. Biodiversity Management Bureau, Department of Environment and Natural Resources. https://www.cbd.int/doc/world/ph/ph-nr-05-en.pdf.

Douglass, M., Le, T., Lowry, C., Nguyen, H., Pham, A., Thai, H. and Yulinawati, H. (2008). *The livability of mega-urban regions in Southeast Asia: Bangkok, Ho Chi Minh City, Jakarta and Manila compared*. In Mega-urban Regions in Pacific Asia: Urban Dynamics in a Global Era. G. W. Jones and M. Douglass (eds.). NUS Press. 284.

Estoque, R. C., Murayama, Y. and Myint, S. W. (2017). *Effects of landscape composition and pattern on land surface temperature: An urban heat island study in the megacities of Southeast Asia*. Sci Total Environ, 577. 349–59.

FAO (2017). *FAOSTAT Statistics Database*. http://www.fao.org/faostat/.

Government of Laos (2016). *The Fifth National Report to the Convention on Biological Diversity - Lao PDR (2015). MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT*. https://www.cbd.int/doc/world/la/la-nr-05-en.pdf.

Government of Singapore (2014). *The Fifth National Report to the Convention on Biological Diversity - Singapore (2010-2014).* National Parks Board.

Government of Thailand (2015). *The Fifth National Report to the Convention on Biological Diversity - Thailand.* Ministry of Natural Resources and Environment.

Government of Viet Nam (2014). *The Fifth National Report to the Convention on Biological Diversity - Viet Nam*. MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT, Hanoi. https://www.cbd.int/doc/world/vn/vn-nr-05-en.pdf.

Güneralp, B. and Seto, K. C. (2013). *Futures of global urban expansion: uncertainties and implications for biodiversity conservation*. Environmental Research Letters, 8(1). 014025. DOI:10.1088/1748-9326/8/1/014025.

Hijioka, Y., Lin, E., Pereira, J., Corlett, R., Cui, X., Insarov, G., Lasco, R., Lindgren, E. and Surjan, A. (2014). Asia. *In Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects*. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. V. Barros, C. Field, D. Dokken, M. Mastrandrea, K. Mach, et al. (eds.). Cambridge University Press, Cambridge, UK. 1327–70.

Hogan, Z. S., Moyle, P. B., May, B., Zanden, M. J. V. and Baird, I. G. (2004). *The imperiled giants of the Mekong*. American Scientist, 92(3). 228–237.

Hortle, K. (2007). *Consumption and the Yield of Fish and Other Aquatic Animals from the Lower Mekong Basin*. Mekong River Commission, Vientiane, Lao PDR. http://www.mrcmekong.org/assets/Publications/technical/tech-No16-consumption-n-yield-of-fish.pdf. MRC Technical Paper No. 16.

Hortle, K. G. (2009). *Fisheries of the Mekong river basin*. In The Mekong. Biophysical environment of a transboundary river. I. Campbell (ed.). Elsevier, New York, USA. 199–253.

Hughes, A. C. (2017). *Understanding the drivers of Southeast Asian biodiversity loss*. Ecosphere, 8(1). 1–33. DOI:10.1002/ecs2.1624.

IPBES (2016). *The Assessment Report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on Pollinators, Pollination and Food Production*. Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. http://nora.nerc.ac.uk/514356/.

IPPC (2017). *Countries List: Countries - International Plant Protection Convention*. https://www.ippc.int/en/countries/asia/list-countries/.

IUCN (2012). *Freshwater species in Indo-Burma region under threat*. http://www.iucnredlist.org/news/freshwater-species-in-indoburma-region-under-threat.

IUCN (2016). *The IUCN Red List of Threatened Species 2016-3*. http://www.iucnredlist.org/.

Jarvis, D. I., Khaka, E., Pert, P. L., Thiombiano, L. and Boelee, E. (2013). *Managing agroecosystem services. Managing water and agroecosystems for food security-Comprehensive assessment of water management in agriculture series*, 10. 124–41.

Kirby, J. S., Stattersfield, A. J., Butchart, S. H. M., Evans, M. I., Grimmett, R. F. A., Jones, V. R., O'Sullivan, J., Tucker, G. M. and Newton, I. (2008). *Key conservation issues for migratory land- and waterbird species on the world's major flyways*. Bird Conservation International, 18(S1). DOI:10.1017/S0959270908000439.

Koh, L. P. (2007). *Impending disaster or sliver of hope for Southeast Asian forests? The devil may lie in the details*. Biodiversity and Conservation, 16(13). 3935–38. DOI:10.1007/s10531-007-9177-3.

Koh, L. P. and Sodhi, N. S. (2004). *Importance of Reserves, Fragments, and Parks for Butterfly Conservation in a Tropical Urban Landscape*. Ecological Applications, 14(6). 1695–1708. DOI:10.1890/03-5269.

Li, H.-L. (1970). *The Origin of Cultivated Plants in Southeast Asia*. Economic Botany, 24(1). 3–19.

Mamiit, J. (2015). *The Economics of Ecosystems and Biodiversity for Southeast Asia (ASEAN TEEB) Scoping Study*. ASEAN Centre for Biodiversity. http://img.teebweb.org/wp-content/uploads/2013/07/EXECUTIVE-SUMMARY_ASEAN-TEEB_web.pdf.

Mcdonald, R. I., Kareiva, P. and Forman, R. T. T. (2008). *The implications of current and future urbanization for global protected areas and biodiversity conservation*. Biological Conservation, 141(6). 1695–1703. DOI:10.1016/j.biocon.2008.04.025.

Ministry of Environment and Forestry (2014). *The Fifth National Report to the Convention on Biological Diversity - Indonesia*. Ministry of Environment and Forestry, Indonesia. https://www.cbd.int/doc/world/id/id-nr-05-en.pdf.

Ministry of Environmental Conservation and Forestry (2014). *The Fifth National Report to the Convention on Biological Diversity - Myanmar 2014*. Ministry of Environmental Conservation and Forestry, Myanmar.

Ministry of Industry and Primary Resources (2014). *The Fifth National Report to the Convention on Biological Diversity - Brunei Darussalam*. Forestry Department, Ministry of Industry and Primary Resources, Brunei Darussalam. https://www.cbd.int/doc/world/bn/bn-nr-05-en.pdf.

Ministry of Natural Resources and Environment (2014). *The Fifth National Report to the Convention on Biological Diversity - Malaysia.* Biodiversity and Forestry Management Division, Ministry of Natural Resources and Environment, Malaysia.

Ministry of Natural Resources and Environment (2015). *Master Plan for Integrated Biodiversity Management for Thailand 2015-2021*. Office of Natural Resources and Environmental Policy and Planning, Ministry of Natural Resources and Environment, Thailand. https://www.cbd.int/doc/world/th/th-nbsap-v4-en.pdf.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A. and Kent, J. (2000). *Biodiversity hotspots for conservation priorities*. Nature, 403(6772). 853–858.

National Biodiversity Steering Committee (2014). *The Fifth National Report to the Convention on Biological Diversity - Cambodia 2014*. National Biodiversity Steering Committee.

National Parks Board, Singapore (2014). *User's manual on the Singapore Index on Cities Biodiversity*. https://www.cbd.int/doc/meetings/city/subws-2014-01/other/subws-2014-01-singapore-index-manual-en.pdf.

Nghiem, L. T. P., Soliman, T., Yeo, D. C. J., Tan, H. T. W., Evans, T. A., et al. (2013). *Economic and Environmental Impacts of Harmful Non-Indigenous Species in Southeast Asia*. PLoS ONE, 8(8). 1–9. DOI:10.1371/journal.pone.0071255.

Nijman, V. (2010). *An overview of international wildlife trade from Southeast Asia*. Biodiversity and Conservation, 19(4). 1101–14. DOI:10.1007/s10531-009-9758-4.

Oldroyd, B. P. and Nanork, P. (2009). *Conservation of Asian honey bees*. Apidologie, 40(3). 296–312. DOI:10.1051/apido/2009021.

Orgiazzi, A., Bardgett, R. D., Barrios, E., Behan-Pelletier, V., Briones, M. J. I., et al., eds. (2016). *Global Soil Biodiversity Atlas*. European Commission, Publications Office of the European Union, Luxembourg.

Peh, K. S.-H. (2007). *Potential Effects of Climate Change on Elevational Distributions of Tropical Birds in Southeast Asia*. The Condor, 109(2). 437–41.

PGRFA (2017). Membership | FAO | *Food and Agriculture Organization of the United Nations*. http://www.fao.org/plant-treaty/.

Ramsar Convention on Wetlands (2014). *The Ramsar Sites Information Service*. http://www.ramsar.org/sites-countries/the-ramsar-sites.

Richards, D. R., Passy, P. and Oh, R. R. Y. (2017). *Impacts of population density and wealth on the quantity and structure of urban green space in tropical Southeast Asia*. Landscape and Urban Planning, 157. 553–60. DOI:10.1016/j.landurbplan.2016.09.005.

Rowley, J., Brown, R., Bain, R., Kusrini, M., Inger, R., et al. (2010). *Impending conservation crisis for Southeast Asian amphibians*. Biology Letters, 6(3). 336–38. DOI:10.1098/rsbl.2009.0793.

Sajise, P. E. (2015). *Empowering Communities and Countries to Conserve Biodiversity at the National and ASEAN Levels: Status, Challenges, and Ways Forward*. ERIA Discussion Paper Series, ERIA-DP-2015-81. Bioversity International, Southeast Asia Regional Center for Graduate Study and Research in Agriculture (SEARCA). http://www.eria.org/ERIA-DP-2015-81.pdf.

Samdhana Institute (2016a). *Preparation of a Biodiversity Conservation Strategic Approach for Asia- GREATER MEKONG REGION*. Samdhana Institute, Indonesia.

Samdhana Institute (2016b). *Preparation of a Biodiversity Conservation Strategic Approach for Asia- Island Southeast Asia and New Guinea*. Samdhana Institute, Indonesia.

Scherf, B. D., Pilling, D. and Commission on Genetic Resources for Food and Agriculture (2015). *The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture*.

Secretariat of the Convention on Biological Diversity (2012). *Cities and Biodiversity Outlook*. Montreal.

Secretariat of the Convention on Biological Diversity (2016). *Biodiversity and the 2030 Agenda for Sustainable Development: Technical Note. Convention on Biological Diversity*. https://www.cbd.int/development/doc/biodiversity-2030-agenda-technical-note-en.pdf.

Sittichai, N., Picheansoonthon, C. and Sāthāranasuk, K. (2014). *Herbal Medicines Used in Primary Health Care in ASEAN*. Department for Development of Thai Traditional and Alternative Medicine Ministry of Public Health, Nonthaburi.

Sodhi, N. S., Koh, L. P., Brook, B. W. and Ng, P. K. L. (2004). *Southeast Asian biodiversity: an impending disaster*. Trends in Ecology & Evolution, 19(12). 654–60. DOI:10.1016/j.tree.2004.09.006.

Sodhi, N. S., Posa, M. R. C., Lee, T. M., Bickford, D., Koh, L. P. and Brook, B. W. (2010). *The state and conservation of Southeast Asian biodiversity*. Biodiversity and Conservation, 19(2). 317–28. DOI:10.1007/s10531-009-9607-5.

Talberth, J. and Reytar, K. (2014). *Climate Change in the Lower Mekong Basin: An Analysis of Economic Values at Risk*. Prepared for the United States Agency for International Development by WRI - the World Resources Institute. http://mekongarcc.net/sites/default/files/usaid_marcc_values_at_risk_report_with_exesum-revised.pdf.

Tan, P. T. (2012). *Urban Green Spaces and Liveability in Southeast Asia*. In Urbanization in Southeast Asia: Issues & Impacts. ISEAS-Yusof Ishak Institute. 262–76.

UNEP (2016). *The State of Biodiversity in Asia and the Pacific - A Mid-Term Review of Progress Towards the Aichi Biodiversity Targets*. UNEP-WCMC. https://www.cbd.int/gbo/gbo4/outlook-asiapacific-en.pdf.

Welcomme, R. L., Baird, I. G., Dudgeon, D., Halls, A., Lamberts, D. and Mustafa, M. G. (2015). *Fisheries of the rivers of Southeast Asia. In Freshwater Fisheries Ecology*. J. F. Craig (ed.). John Wiley & Sons, Ltd, Chichester, UK. 363–76. DOI:10.1002/9781118394380.ch29.

Wetlands International (2017). *Asian Waterbird Census 2008-2015*. https://www.wetlands.org/publications/awc2008_2015/.

Zeven, A. C. and Wet, J. M. J. de (1982). *Dictionary of Cultivated Plants and Their Regions of Diversity: Excluding Most Ornamentals, Forest Trees and Lower Plants*. 2. ed., rev. Centre for Agricultural Publishing and Documentation, Wageningen.

Zhang, Y., Zhu, Z., Liu, Z., Zeng, Z., Ciais, P., Huang, M., Liu, Y. and Piao, S. (2016). *Seasonal and interannual changes in vegetation activity of tropical forests in Southeast Asia*. Agricultural and Forest Meteorology, 224. 1–10. DOI:10.1016/j.agrformet.2016.04.009.

Ziv, G., Baran, E., Nam, S., Rodríguez-Iturbe, I. and Levin, S. A. (2012). *Trading-off fish biodiversity, food security, and hydropower in the Mekong River Basin*. Proceedings of the National Academy of Sciences, 109(15). 5609–14. DOI:10.1073/pnas.1201423109.

2.4. Freshwater

Water demand in the ASEAN region is expected to increase by about one-thirds in 2025 and double during the latter half of the 21st century to serve urbanization and economic development. This chapter looks at the water situation in the ASEAN countries that are facing a number of challenges related to water quality and sanitation as well as water-related disasters and weak governance.

2.4. Freshwater

Key Messages

- Water demand is expected to increase by about one-third by 2025 and double during the latter half of the 21st century, resulting in increased water stress and water insecurity across the ASEAN region.
- Most ASEAN Member States (AMS) have made significant progress in improving access to safe drinking water and sanitation facilities, except Cambodia and Indonesia where about half of the population still lack access.
- Low wastewater treatment levels for a growing population, as well as the dumping of personal and industrial wastes, are contaminating various water sources and considerably reducing the quality of freshwater, which is leading to increased exposure to human health and environmental risks.
- The main threat to water availability and water quality in most AMS is poor management, coordination and awareness. Rapid urban development and poor spatial planning leads to encroachment of the built environment into flood-prone areas and serious degradation of catchments.
- Climate change adds a level of uncertainty to water availability and leads to increasing frequency and intensity of extreme flood and drought events in the region. It also causes alteration of river flow regimes, loss of wetlands and floodplains, and salinity intrusion in river deltas due to sea level rise.

1. Introduction

Water is an essential resource to sustain life, ecosystems and development in the ASEAN region. In 2014, the total renewable internal freshwater resource[38] in the ASEAN region was estimated at 4,985 billion m3 (FAO 2017) but has been declining during the last two decades. Water demand is, however, expected to increase by about one-third in 2025 and double that during the latter half of the 21st century (ASEAN 2005). Agriculture is a major user of ground and surface water, accounting for at least 80% of the total withdrawals in several ASEAN Member States (AMS) (FAO 2012).

The demand for freshwater resources for hydropower, industry and urbanization is increasing significantly in several AMS, particularly Cambodia, Lao PDR, and Viet Nam. Many rivers in the ASEAN region are highly polluted with domestic, urban, industrial and agriculture waste causing considerable water quality degradation. Inadequate provision of sanitation facilities, sewerage and wastewater treatment results in significant quantities of this wastewater reaching both surface and ground water bodies. Climate change, particularly extreme flood and drought events, increases vulnerability of freshwater resources across the ASEAN region. Sea level rise (SLR) due to climate change will affect salinity intrusion in many cities in delta area (see Chapter 5 for more discussion). Weak governance exacerbates these freshwater-related issues, which are summarized per AMS in Table 29 (UNEP 2016).

To secure water for different needs, freshwater resources in the region need to be monitored, preserved and managed to meet the increasing and competing demands

38. Internal renewable fresh water resources are computed based on long-term average annual flow of rivers and recharge of groundwater (aquifers) generated from endogenous (internal) precipitation.

as well as to preserve biodiversity and ecosystems. In 2005, the ASEAN Strategic Plan of Action on Water Resources Management was developed (ASEAN 2005). The plan complements and supports actions at the national level to address key challenges in water resources in the ASEAN region including improving access to safe drinking water and sanitation; managing water resources efficiently and effectively; moving towards integrated river basin management (IRBM); translating awareness to political will and capacities; and moving towards adequate and affordable water services.

Table 28. Water-related issues faced by the ASEAN Member States

ASEAN Member State	Increasing water scarcity threat	Deteriorating water quality	Poor water quality and low water endowment	flood prone countries	Cyclone prone countires	Drought prone countires	Elevated ecosystem/ climate change risk	Poor access to drinking water	Poor access to sanitation
Cambodia				X	X	X	X	X	X
Indonesia		X		X	X	X	X		X
Lao PDR				X	X	X	X	X	X
Malaysia		X		X	X	X	X		
Myanmar			X	X	X	X	X		
Philippines	X	X		X	X	X	X		
Thailand		X		X	X	X	X		
Viet Nam				X	X	X	X		

Note: Information in Brunei Darussalam and Singapore is not available
Source: UNEP, 2016

The ASEAN Statistical Yearbook 2014 (ASEAN 2015) shows that most AMS have improved access to safe drinking water and sanitation during the last decade. In 2012, about 89% of the population in the ASEAN region had access to safe drinking water and about 71% had access to safe sanitation. AMS are investing in increasing and improving water quality and quality monitoring systems to increase efficiency in water resources management and disaster risk management.

In the ASCC Blueprint 2025, ASEAN has been promoting sustainable development of freshwater resources for equitable access and to provide sufficient water of acceptable quality to meet the needs of the peoples at all times. ASEAN has also strived to strengthen the resilience of the ASEAN community by enhancing capacity and capability to adapt and respond to social and economic vulnerabilities, disasters, climate change and emerging threats (ASEAN 2016).

These issues related with freshwater resources and relevant responses at the regional and national levels has been considered in developing linkages between key drivers, pressures, state, impacts and responses within freshwater resources in the ASEAN region through application of the DPSIR framework. The framework in presented in Figure 33.

2. Drivers

The key drivers of change in the freshwater resources in the ASEAN region are population growth and urbanization, increased demand for food and energy, rapid industrial growth, and the impacts of climate change. These are discussed in detail in Section 1 of this report.

The growing population and rapid urbanization in the ASEAN region are key challenges as described in Section 1. In 2014, 15 of the 22 global megacities (cities with populations greater than 10 million) are located in Asia-Pacific region (UN-Habitat and UNESCAP 2015).

The agriculture area in the ASEAN region is expanding and cultivation is intensifying to produce more food to serve global and regional demand. About 30% of the total land in the ASEAN region is agriculture land and the main crop is paddy (Chapter 2.2). Most AMS have increased their cultivation areas in the last 50 years, particularly in Cambodia, Indonesia, the Philippines, Thailand and Viet Nam. Only in Brunei Darussalam and Singapore, cultivation areas have decreased (ASEAN 2015). The intensification and expansion of cultivation is already increasing demand and competition for water.

Figure 33. DPSIR Framework for freshwater resources in the ASEAN region

The development of large-storage hydropower projects will increase flows during the dry season, decrease flows in the wet season and reduce the amplitude of flood peaks downstream (Lauri et al. 2012, Piman et al 2013). These changes will consequently impact on sediment transportation and freshwater ecosystem services (Mau et al. 2014)

Industrialization in the ASEAN region has been progressing rapidly since the 1990s. Industrial water demand as a proportion of total demand varies between AMS. Brunei Darussalam, Malaysia and Singapore require more than 40% of the total water demand for industries while the other seven AMS require less than 10% (FAO 2017). ASEAN began looking for a new form of industrial cooperation in 1996 to replace the ASEAN Industrial Joint Venture (AIJV) and the Brand-to-Brand Complementation (BBC) Schemes that will offer more in terms of tariff and non-tariff incentives (ASEAN 2017a). The ASEAN industrial cooperation scheme intends to increase ASEAN industrial production and trade in the region. This is expected to further drive up the industrial demand for water in the future.

Climate change has already caused major impacts on water availability throughout the ASEAN region, particularly for the least developed AMS which are the most vulnerable from climate change impacts. In recent years, several AMS have faced extreme

environmental disasters such as floods, droughts and typhoons. Thailand suffered severe flooding in 2011, the Philippines and Viet Nam suffered from Typhoon Haiyan in 2013 and a severe drought occurred across the Mekong region during 2014-2016 (MOF and WB 2012, UNICEF 2014, UNESCAP 2015). ADB (2009) projects a 4.8 degree rise in mean annual temperature and a 70 cm mean SLR by 2100 in Indonesia, the Philippines, Thailand and Viet Nam. Such a rise in sea level would exacerbate flood risk, salinity intrusion, and water quality issues for many of ASEAN's largest coastal cities, such as Jakarta, Bangkok and Manila. A number of recent studies also indicate that climate change is expected to increase the frequency and severity of droughts and floods as well as uncertainty in water availability across the region (ADB 2009, IPCC AR5 WGI 2014 and Almassy 2014).

3. Pressures

The main pressures on freshwater resources resulting from human activities in the ASEAN region are excessive use of water resources, increased wastewater pollution, and land-use change.

The demand for water across ASEAN will increase dramatically in all major use sectors and it is expected to double in the latter half of the 21st century (ASEAN 2005). The increased water demand will lead to massive abstractions of freshwater from rivers, groundwater aquifers, lakes and reservoirs. The result will be increased competition between users and usages, and increased water scarcity. The level of uncertainty in freshwater availability is expected to increase due to climate change through changes in rainfall patterns and distribution, evaporation, snow melt, river and groundwater flows over space and time across the region (ADB 2009). Furthermore, the development of large hydropower projects to support energy production are already causing significant alteration of river flow patterns (Piman 2013).

Water pollution and degradation in water quality is expected to exacerbate as urbanization and industrialization as well as agriculture expansion and intensification increase. The following are the key causes of water pollution in many AMS (WHO 2010, Alexandra 2012 and WEPA 2012).

- Untreated sewage from domestic and industrial processes such as poor sanitation and treatment facilities;
- Agriculture waste that contains pesticides and chemical fertilizers flowing into rivers, lake and reservoirs; Leaching from waste landfills and dumping wastes (i.e. plastic bags, bottles, garbage, etc.) into rivers or alongside river banks.
- Withdrawal of water faster than aquifers are replenished, resulting in seawater seepage into, or the collapse of, underground aquifers.

There is evidence that pollution of surface and groundwater is growing. For example, in Indonesia, heavily polluted water quality increased from 62% in 2009 to 80% in 2013. This increase in water pollution is being caused by domestic and non-domestic activities (MOE 2014). The number of rivers in Thailand classified as deteriorated increased from 15% in 2011 to 23% in 2013 (PCD, 2014). The salinization of fresh water sources in coastal areas due to the intrusion of seawater will be aggravated by SLR due to climate change (ADB 2009 and IPCC AR5 WGI 2014). See also Chapter 2.5. for further discussions.

As described in Chapter 2.2, forest cover has declined in most AMS. Converting forests into areas used for agriculture, urbanization and industrial purposes has caused significant

alterations of the catchment water and sediment balance and may influence surface and groundwater quality (IWMI 2010). The removal of trees results in the reduction of evaporation and water absorption. Agriculture land and urban areas will turn rainfall to surface runoff faster than forest areas. Many floodplain areas, particularly in the delta such as the Mekong River Delta in Cambodia and Viet Nam and the Chao Phraya River Delta in Thailand are threatened by the construction of roads and urbanization. Roads influence the duration and extent of the inundations and the dynamics of the Cambodia and Viet Nam floodplains in the Mekong delta. They fragment the floodplains and impede the natural flow of water, sediments, nutrients and aquatic life (MRC 2011a).

4. State and Trends

Water availability

Table 29. Total internal renewable freshwater resources (billion m³)

ASEAN Member State	2007	2014
Brunei Darussalam	9	9
Cambodia	121	121
Indonesia	2,019	2,019
Lao PDR	190	190
Malaysia	580	580
Myanmar	1,003	1,003
Philippines	479	479
Singapore	1	1
Thailand	225	225
Viet Nam	359	359
Total:	**4,986**	**4,986**

Source: WHO (2017).

Table 30. Total internal renewable freshwater resources per capita (m3/capita/year)

ASEAN Member State	2007	2014
Brunei Darussalam	22,675	20,646
Cambodia	8,818	7,897
Indonesia	8,666	7,914
Lao PDR	32,001	28,952
Malaysia	21,783	19,187
Myanmar	20,398	19,317
Philippines	5,364	4,785
Singapore	131	110
Thailand	3,391	3,281
Viet Nam	4,267	3,961

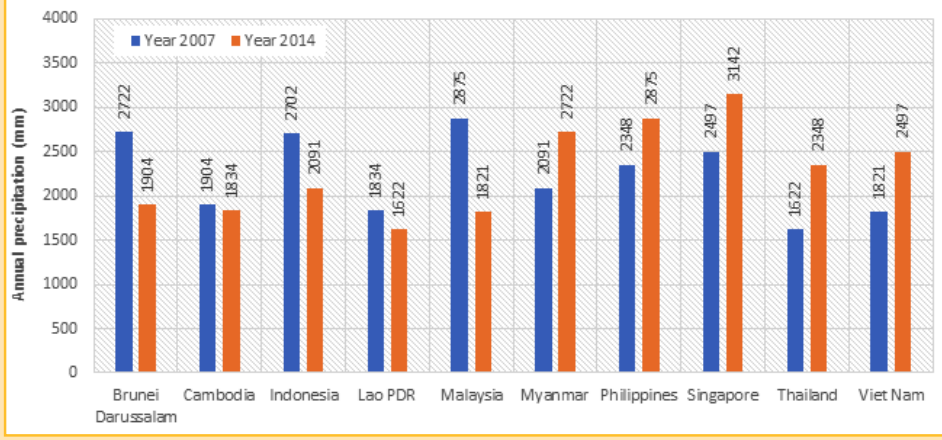
Source: FAO-AquaStat (2017).

The ASEAN region has a tropical climate that is characterized by relatively uniform warm and humid weather all year round. The rainfall patterns, however, vary greatly across different parts of the region due to geographical location and land size (Figure 34). The climate is influenced by maritime wind systems which originate in the South China Sea and the Indian Ocean. (See Section 1 on regional climate).

The amount of precipitation determines the availability of freshwater resources in the region. The total internal renewable freshwater resource is a common indicator for presenting the status of water availability and supply per capita. Renewable freshwater (surface and groundwater) resources are replenished by precipitation that ends up as runoff to rivers and recharge to aquifers (internal flow).

The status of the total internal renewable freshwater resources and per capita water resources availability in 2007 (ASEAN 2009) and 2014 is presented in Tables 30 and 31. About 78% of the total internal renewable freshwater resources is surface water and the remaining 22% is groundwater.

In 2014 Indonesia had the highest internal renewable freshwater resources, followed by Myanmar. Lao PDR had the highest per capita water resources availability in 2014, followed by Malaysia. Table 29 shows that total internal renewable freshwater resources in 2014 was 4,986 billion m³ which was 12% lower than in 2007. The water resources availability in the ASEAN region had also declined by 10% (per capita, per year), from 22,254 m3 in 2007 to 20,085 m³ in 2014.



Source: FAO-Aquastat (2017)

Figure 34. Annual precipitation in ASEAN Member States in 2007 and 2014

Table 31. Annual freshwater withdrawals in ASEAN Member States

ASEAN Member State	Total annual freshwater withdrawals (billion m^3)	Agriculture (% of total annual freshwater withdrawal)	Domestic (% of total annual freshwater withdrawal)	Industry (% of total annual freshwater withdrawal)
Brunei Darussalam	0.19	5.8	45.0	49.2
Cambodia	33.23	94.0	4.5	1.5
Indonesia	3.49	81.9	11.6	6.5
Lao PDR	0.09	91.4	3.7	4.9
Malaysia	57.31	22.4	34.9	42.8
Myanmar	11.20	89.0	10.0	1.0
Philippines	82.03	82.2	7.7	10.1
Singapore	81.56	4.0	45.0	51.0
Thailand	113.30	90.4	4.8	4.8
Viet Nam	2.18	94.8	1.5	3.7

Source: FAO-AquaStat (2017)

Water demands and withdrawals

There is a declining trend for the availability of water resources per capita per year as shown in Table 30. The estimated annual freshwater withdrawals by AMS and sector in 2014 for the three main water-consuming sectors (agriculture, domestic and industry) is presented in Table 31. Total annual water withdrawal for the ASEAN region is almost 385 billion m^3 which is around 20% of water withdrawals in Asia. Cambodia, Indonesia, Lao PDR, Myanmar, the Philippines, Thailand and Viet Nam use water for agriculture more than 80% of the total annual water withdrawal. Brunei Darussalam, Malaysia and Singapore mainly withdraw water for domestic and industrial uses.

Access to safe drinking water and improved sanitation

Universal access to safe drinking water is a fundamental human right. All AMS have continued to improve safe drinking and improve sanitation facilities to meet the Millennium Development Goals (MDGs) (ASEAN 2015a). The proportion of the population with access

to safe drinking water and improved sanitation in AMS is presented in Figure 35. In 2012, more than 90% of the population of Brunei Darussalam, Singapore, Thailand, Malaysia and Viet Nam had access to safe drinking water. However, only 41% of the population of Indonesia had access to safe drinking water, which is the smallest proportion among AMS. About half of the population of Cambodia and 42% of the population of Indonesia still lack access to improved sanitation facilities. Viet Nam has made significant progress in improving sanitation with an 18% increase in coverage in 2012 compared to 2006 (from 59% to 77%).

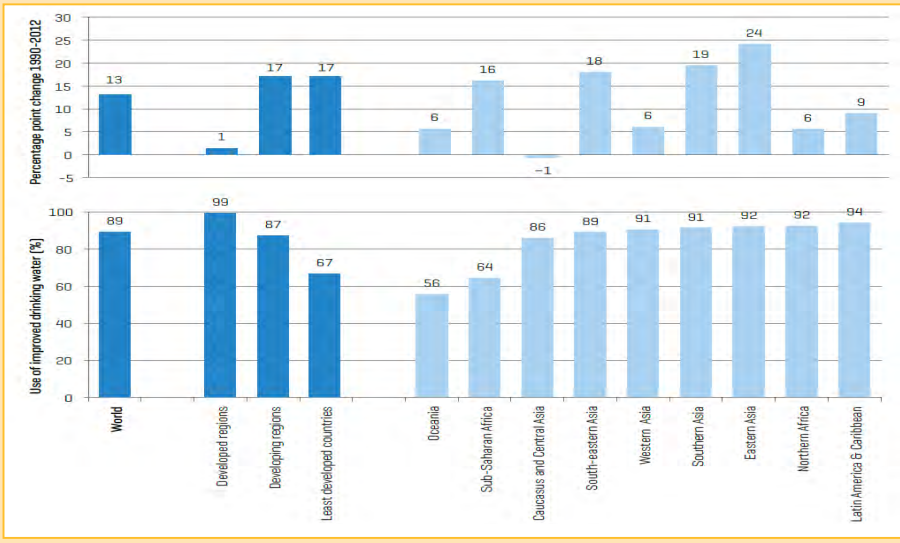
Table 32. Proportion of population with access to safe drinking water and access to improved sanitation, 2006-2013 (ASEAN 2015b)

(in percent)

Country	2006	2007	2008	2009	2010	2011	2012	2013
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Access to Safe Drinking Water								
Brunei Darussalam	99	100	100	100	100	100	100	100
Cambodia	-	55	55	49	48	51	51	54
Indonesia	48	48	46	48	44	43	43	41
Lao PDR	-	-	-	-	82	70	70	-
Malaysia	95	91	91	93	94	94	94	-
Myanmar	78	80	82	83	83	-	-	-
Philippines	81	82	81	-	83	83	83	-
Singapore	100	100	100	100	100	100	100	100
Thailand	99	99	-	99	99	100	100	97
Viet Nam	89	-	91	-	89	96	91	-
Access to Improved Sanitation								
Brunei Darussalam	80	80	80	80	80	80	80	-
Cambodia		31	33	35	40	44	44	52
Indonesia	35	44	49	51	51	56	56	58
Lao PDR	-	-	-	-	49	57	62	-
Malaysia	98	98	98	98	98	98	99	-
Myanmar		80	82	83	84	81	81	80
Philippines	84	88	89	-	92	92	92	-
Singapore	100	100	100	100	100	100	100	100
Thailand	99	99	99	99	99	100	100	97
Viet Nam	59	-	65	-	76	75	77	-

Source: AMSs' data submission for ASEAN Stastitical Yerabook and or CPMS Report;
Cambodia - Socio Economic Surey Cambodia, and Cambodia Demographic and Health Survey;
Malaysia - Water Works Department and Rural Environment Sanitation Program (RESP) and Population and Housing Census.
Philippines - National Demographic and Health Survey;
Singapore - Public Utilities Board and administrative records;
Thailand - Population and Housing Cencus;
Viet Nam - Living Standard Survey;
MICS and Multi-purpose Household Survey;
ADB Key Indicators 2006-2014;
UNSD - Demographic and social database, UNESCAP Yearbook 2009

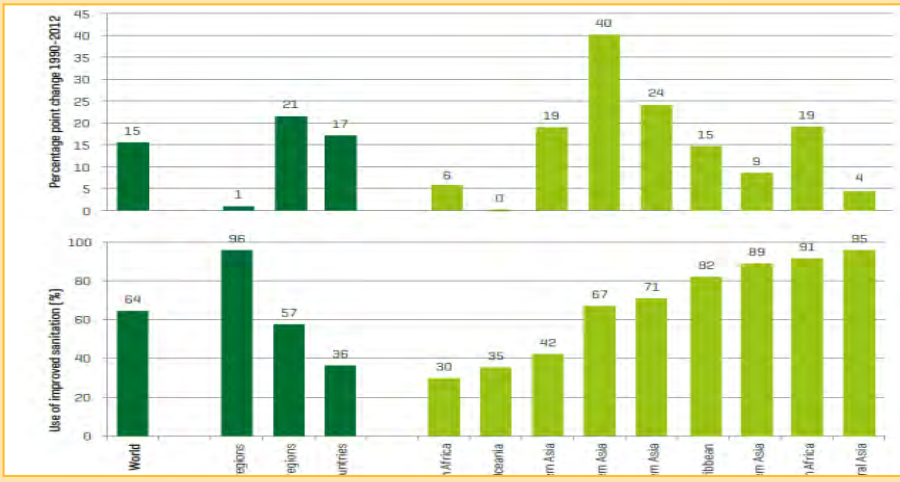
Notes: '-' - not available at the time of publication



Source: FAO-Aquastat (2017)

Figure 35 Use of improved drinking water (%) and percentage point change from 1990 to 2012 (WHO and UNICEF 2014)

89% of the ASEAN population used improved sources of drinking water which is exactly the same as the worldwide estimates (Figure 35) (WHO and UNICEF 2014). More people now enjoy a higher level of water access such as a piped water connection to their homes. The coverage of piped water supply in the region increased from 17% in 1990 to 30% in 2012 (WHO and UNICEF 2014). 71% of the ASEAN population has access to improved sanitation facilities, which is higher than the global coverage (Figure 36) (WHO and UNICEF 2014). The provision of improved sanitation in the ASEAN region has increased by 24% from 1990 to 2012. However, 29% of the population still does not have access to improved sanitation facilities, and of these, 13% still practice open defecation (WHO and UNICEF 2014).



Source: WHO-UNICEF (2014)

Figure 36. Use of improved sanitation (%) and percentage point change from 1990 to 2012 (WHO and UNICEF 2014)

Water quality

Freshwater quality in AMS is important not only to protect public health but also to maintain the integrity of ecosystems and fisheries. Freshwater is used by different sectors such as agriculture, industry and tourism. Increasing pollution of water bodies due lack or failed waste management and agriculture expansion and intensification is threatening water quality in the ASEAN region, even though many AMS have placed emphasis on the management of water quality. Data from AMS that have long-term water quality monitoring programs such as Thailand, Malaysia, Indonesia, Philippines, Singapore and Viet Nam shows that the number of rivers and lakes that are classified as having good water quality is decreasing while the number of those classified as having fair and degraded water quality is increasing. Thailand and Malaysia use the Water Quality Index (WQI) to indicate the level of pollution and the corresponding suitability in terms of water uses. However, all AMS have systematized their water source classification and standard.

Surface water quality from 52 water sources in Thailand was monitored in 2015 by the Pollution Control Department (PCD) through the collection of water samples from 366 monitoring stations. The results showed that 34% of the water resources were good quality, 41% were fair, 25% were poor, while none of the water resources was in excellent quality (PCD 2016). Eight water resources, mostly located in the northeast and the south of Thailand, which used to be in good quality dropped to fair level. There is an increase in the number of deteriorated water resources, most of which are located in the central region (Figure 37). Overall, the groundwater quality in Thailand in 2015 was satisfactory for consumption. However, saltwater intrusion into the groundwater layers at depths of 100m, 150m and 200m along the Chao Phraya River and the coastal zone along Gulf of Thailand. There are also some areas in the northeastern region of Thailand that have brackish and salty water due to the seepage of rock salt from underground layers (PCD 2016).

In 2015, river water quality in Malaysia was assessed by the Department of Environment (DOE) using 5,469 samples taken from 891 manual monitoring stations covering 477 rivers. Out of the 477 rivers monitored, 276 (58%) were found to have clean water quality, 168 (35%) were slightly polluted, and 33 (7%) were polluted (DOE 2015). The number of rivers that have clean water quality is decreasing. In Johor State, many of the rivers including the Danga, Semenchu, Perembi, Buluh, and Tukang Batu were polluted.

The water quality monitoring conducted in Indonesia by the Ministry of Environment (MOE) in 2009-2013 shows that 80% of monitoring points were heavily polluted in 2013 from 62% in 2009. Fewer than 8% of the water user communities use surface water (MOE 2013). The main pollutants were organic substances from domestic activities. This is indicated by the biochemical oxygen demand (BOD) and the presence of coliform bacteria.

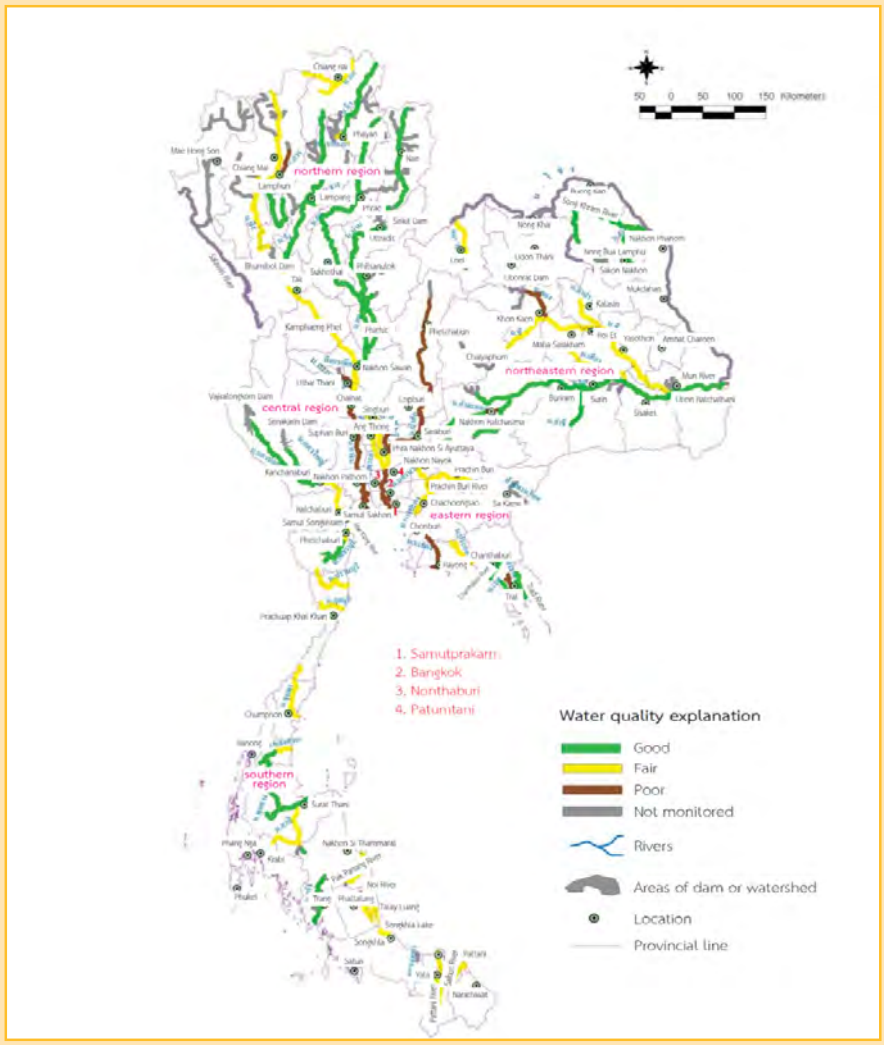


Figure 37. Quality of surface water in Thailand in 2015 (PCD 2015)

BOD monitoring in the Philippines between 2006 and 2013 under the Sagip Ilog Program of the Environmental Management Bureau (EMB) in 19 selected priority rivers showed that the majority of the samples exhibited high BOD levels. These rivers, most of which are located in highly urbanized and industrialized areas, had high levels of pollution that require concerted efforts to prevent further deterioration of water quality (EMB 2015). The monitoring of dissolved oxygen (DO) levels found that rivers in Metro Manila and surrounding regions and the cities of Calapan and Iloilo were unsuitable for aquatic life as their DO levels were less than 5 milligrams per liter.

Viet Nam is also facing water quality degradation in many geographical areas, particularly in major rivers such as the Cau, Nhue-Day and Dong Nai river basins as well as in big cities such as Hanoi and Ho Chi Minh which experience rapid urbanization and industrial development. Monitoring by Ministry of Natural Resources and Environment (2010) shows that the level of pollutants in major rivers in Viet Nam exceeded the permitted

levels by 1.5 to 3 times. Episodes of severe water pollution tend to occur during the dry season. The pollution is mainly caused by the discharge of industrial and domestic waste.

5. Impacts

Increasing uncertainty in freshwater availability and demands alongside the degradation in water quality in the ASEAN region pose a number of challenges. Further based on a study, Box 12 describes the six major water management issues in the ASEAN region (ASEAN 2017b).

Impact on water resources management

The changing status of freshwater resources in terms of their quantity, quality and timing negatively affects the current operation of existing water infrastructure and water management practices across the ASEAN region. Increasing temperatures, variability in precipitation, extreme floods and droughts, and sea-level rise due to climate change place additional pressure on water resources management and water allocation to meet the needs of the people and to sustain ecosystems and ecosystem services. Competition for freshwater resources is increasing and this could lead to conflicts between sectoral uses in some AMS and between riparian states sharing transboundary waters such as the Mekong River Basin (MacQuarrie et al. 2014).

Box 12. Key challenges in six major water management issues in the ASEAN region

1. Water supply management
   - Improving access of safe drinking water
   - Increasing water quality of drinking water to meet WHO guidelines
   - Increasing hours of water supplied per day
   - Reducing loss of pressure and leakage in water supply
2. Irrigation management
   - Increasing irrigation areas and irrigation water supply
   - Improving irrigation efficiency
   - Reducing damages from flood and drought
   - Improving agricultural production versus water utilization
3. Stormwater management
   - Improving early warning and forecasting systems as well as modelling tools
   - Developing and operating infrastructure to control stormwater
   - Setting up policies, legislation and regulatory agencies in managing stormwater
4. Flood management
   - Reducing flooded areas and the number of people/households affected by flood
   - Improving early flood warning system/real-time flood monitoring system and coverage in flood-prone areas
5. Water pollution management
   - Controlling and treating wastewater from domestic, industrial and agriculture uses
   - Improving water quality in the rivers to meet a defined ambient river water quality standard
   - Improving water quality monitoring programme
6. Sanitation management
   - Improving access of safe sanitation in rural and urban areas
   - Treating waste discharge

Impacts on biodiversity loss

Poor water quality and changing patterns of natural flow regimes and floodplains affect the biodiversity and ecology of river systems. There is considerable evidence of poor water quality leading to mass killings of fish and aquatic animals. Endangered freshwater fish and amphibians also face the risk of extinction (MRC 2011b). For example, water from the river in the Thach Lam commune in December 2013 turned black and smelly, and tons of fish were found dead. Thanh Hoa's Department of Natural Resources and Environment concluded that the incident was caused by wastewater from the Hoa Binh cassava processing plant in Hoa Binh province. Representatives from the plant later said that the wastewater drain was broken, leading to the release of around 120,000 cubic meters of untreated wastewater into the river (Le Hoang 2016).

Middle Mahakam Wetlands, located in East Kalimantan of Indonesia, face serious pollution threats from the oil palm industry. The wetlands serve as one of the most productive fisheries in Southeast Asia, in addition to providing freshwater and carbon storage in peat. Lakes are also threatened by expansion of oil palm plantations, as decreased oxygen levels and increased nitrate loading (eutrophication) have been correlated with the growth of the oil palm industry in the region (Petrenko et al. 2016)

The building of hydropower dams in Mekong River has raised major concerns about the effects of changes in the flow regime and the blocking of sediment and fish migration routes which could lead to adverse impacts on river ecosystems, fish habitat and productivity and the livelihoods of rural people (MRC 2011b, Aris et al 2014).

Impacts on human health and well-being

Water pollution, low water availability and poor sanitation can cause waterborne diseases and other human health impacts, especially in children. Typhoid, dengue, leptospirosis, and diarrhea are common waterborne diseases prevalent in the region (WHO 2016). Another factor affecting human health from water pollution is the accumulation of heavy metals in water bodies and plants that are then consumed as food. Many studies have looked at accumulations of arsenic, cadmium, copper, lead and mercury in vegetables, rice and other edible plants (UNEP, 2016).

Impacts on the economy

The developing economies of the ASEAN region are confronted by serious environmental problems that threaten to undermine future growth, food security, and regional stability. The degradation of freshwater resources, poor sanitation and insufficient wastewater treatment generate large economic costs, not just by increasing the cost of obtaining sufficient water quantity of acceptable quality for production i.e. agriculture and industrial production, but also through damaging impacts to environmental systems and human health (WEPA 2012 and ADB 2014). The deterioration of water quality can have a huge impact on economic sectors including agriculture, industry, fisheries and tourism (World Bank 2008). Most AMS have experienced severe floods, droughts and storms exacerbated by climate change in recent years, which caused wide-ranging, significant, and mostly negative impacts on their economies, particularly on infrastructure services, agriculture production, and ecosystem services (ADB 2009 and USAID 2014).

Box 13. Impacts of hydropower development on Mekong freshwater resource and ecosystems

The Mekong is one of the world's great rivers, flowing 4,909 km through six nations: China, Myanmar, Thailand, Lao PDR, Cambodia, and Viet Nam. It has the greatest mean annual flow in the world for a river basin of comparable size (Piman et al. 2013). Millions of people living across the basin depend on waters and riverine aquatic products for food, income, livelihood opportunities and their way of life. Seasonal variation in water level and the range of wetland habitats inundated are source of the river's great productivity. The inland fisheries of the Mekong Basin are among the world's largest, with an annual production of 2.1 million tonnes of fish (Baran et al. 2015). The Tonle Sap Lake and the Sekong, Sesan and Srepok (3S) river system are places of exceptional fish biodiversity by global standards. Fisheries therefore not only provide for local peoples' food and livelihoods, but also greatly contribute to the social and economic development of the basin's population (MRC 2010).

Freshwater and ecosystems in the Mekong Basin are increasingly under threat from large water resources developments, particularly hydropower development. Development of hydropower is accelerating in China, Cambodia, Lao PDR and the Viet Nam highlands, bringing both benefits and risks to the nations in the basin. There were 16 hydropower projects in 2000 and about 41 hydropower projects in 2011 (MRC 2011b). Large cascade hydropower projects in the Upper Mekong in China have almost completed and two mainstream dams in the Lower Mekong Basin in Loa PDR, Xayaburi and Don Sahong projects, are under construction. Over the next 20 years, an additional 30 tributary dams and 9 mainstream dams in the Lower Mekong Basin are planned (MRC, 2011b).

Impacts of hydropower development and operation on river flows and ecosystem services become more visible. The large hydropower dams, especially in China and 3S tributary, have modified the hydrology of the Mekong River by reducing and delaying wet season flows, and increasing dry season flows and water level fluctuations. The magnitude of these changes varies by location within the Mekong Basin (Wyatt and Baird 2007, Cochrane et al. 2014, Piman et al. 2016). Hydropower dams not only constitute obstacles to the free flow of water but also block sediment and nutrient transportation as well as fish migration (Wild and Loucks 2014, Kondolf et al. 2015). This loss of sediments, nutrients and fish habitats will have a serious negative impact downstream on ecosystem services, fish production and local livelihoods (MRC, 2011b, Arias et al. 2014, Baran et al. 2015)

6. Responses

National and sub-regional responses

Most of AMS have accepted and/or adopted integrated water resource management (IWRM) as a strategy for sustainable water development and management. A number of policies, strategies, plans, programmes, and actions on IWRM have developed and implemented at sub-regional and national levels for effective water management in AMS. With respect to governance and the fragmentation of water resources management between several agencies within the same nation, many AMS are aware of this and have put efforts into the improvement of institutional arrangements in order to increase interconnectivity and synergy. This section presents examples of national and sub-regional responses to increasing uncertainty in freshwater availability and water demands, and the degradation of water quality through IWRM approach in the ASEAN region.

At the end of 2013, the Governments of Indonesia and South Korea inaugurated Ciliwung River restoration project, which is one of the most heavily polluted rivers in Indonesia. This cooperation has the purpose of restoring the quality of Ciliwung River so that it becomes cleaner in a shorter time. This restoration of Ciliwung River will include improving the

river's ecology along its 470 metres length, such as mud dredging for 20,000 tonnes, installation of water gates and improving river edges using wetland plants. The waste water treatment plant (WWTP) capacity of 500 m3 per day was constructed to ensure that all of the waste dumped into the river is treated first. Efforts to recover the quality of the environment Ciliwung River by prioritizing community participation are also executed by various parties. For example, Ministry of Environment jointly with the Ministries of Public Works, Forestry, and Agriculture has executed various pilot activities to recover the quality of the environment of the of integrated Ciliwung Watershed, by placing river water quality as a common platform of activities between sectors and regions (MOE, 2014).

Malaysia have adopted IWRM as a holistic approach in order to resolve water crisis management as well as overcome some water issues such as water excesses, water shortage, water pollution, threat from climate change and issues in current state of governance. National Water Resource Policy (NWRP) has been launch in 2012 to ensure adequate and safe water for all, through sustainable use, conservation and effective management of water resources enabled by a mechanism of shared partnership involving all stakeholders. There are three policy directions in the NWRP including water resources security, water resources sustainability and collaborative governance (MNRE, 2012). The water resources information system has developed and taken the initiative under Department of Irrigation and Drainage (DID) to provide the real-time rainfall and water level data from 500 stations across Malaysia as well as flood warning information to support water resources management and flood management. Latest technology was applied in 2013 to increase the capacity of the website to receive and process real time data in shorter period. The data is also shared with other related agencies e.g. National Disaster Management Agency, Lembaga Urus Air Selangor and public domains[34] .

The Adopt-an-Estero/Water Body Program in the Philippines was launched in 2010 which aimed to build partnerships among concerned sectors and organizations to restore the healthy state of waterways in the Philippines, and to safeguard the well-being of its residents. Under the Program, Environmental Management Bureau encourages private establishments and institutions, non-government organizations or industry associations to enter into a Memorandum of Agreement (MOA) and assume responsibility for cleaning the esteros/waterbodies in Metro Manila and other urban cities. The effectivity of the program is validated through water quality monitoring on the adopted areas using Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD). In 2015, Out of 391 esteros/waterbodies adopted, 67 esteros/waterbodies have exhibited significant improvement either in terms of DO and 68 esteros/waterbodies in terms of BOD (EMB 2015).

During the last quarter of 2011, Thailand experienced its worst flooding since 1942. The floods affected almost 14 million people in 65 of Thailand's 77 provinces, with widespread damage and loss to homes, factories, businesses, transport and energy infrastructure, social service facilities, and crops and livestock. The government responded to the 2011 floods with measures to strengthen flood management in the overall context of water resources management. In January 2012, it passed the Master Plan on Water Resources Management. The master plan includes activities under eight major themes: (i) restoration and conservation of the forests and ecosystems; (ii) management of major water reservoirs and formulation of a national annual water management plan; (iii)

34. http://publicinfobanjir.water.gov.my/

restoration and efficiency improvement of current and planned physical structures; (iv) development of and information warehouse, forecasting, and disaster warning system; (v) response to specific geographical areas; (vi) designation of water retention areas and recovery measures; (vii) improvement of water management institutions; and (vii) creation of stakeholder awareness, acceptance, and participation in flood management (ABD 2012).

Singapore has limited natural water resources such as lakes and groundwater resources due to a small land area of 718 sq km compared with other counties in ASEAN. In an effort to ensure an adequate and sustainable supply of fresh water, the Singapore government has over the past two decades implemented various strategies to diversify its sources of water supply, manage water demand, and support the development of local water technology industry. Public Utilities Board (PUB) has implemented a mandatory water efficiency labelling scheme since 2009 for water fittings and appliances, which include water taps and mixers, urinal equipment, flushing cisterns and washing machines. The scheme is to encourage suppliers to introduce more water efficient products into the market. In June 2015, heavy non-domestic customers with water consumption of 60,000 m3 or more in a year are required to install private water meters for measuring and monitoring consumption, and submit their annual water efficiency management plan to PUB. PUB has also led research and development in water technologies to improve the water treatment and production processes, thereby increasing Singapore's water resources to meet future needs and reducing the operation costs. As at end-2015, there were over 180 local and international water companies and 26 water technology-related research institutions operating in Singapore (Research Office, 2016)

Regional responses

AMS have promoted regional cooperation towards IWRM to sustain the quality of freshwater resources and ensure equitable access of acceptable quality for the people of the ASEAN region. ASEAN initially defined its vision for water resources and the key challenges in its ASEAN Long-term Strategic Plan for Water Resources Management (ASEAN 2003), which was endorsed by the ASEAN Environment Ministers in 2003. In 2005, ASEAN adopted the ASEAN Strategic Plan of Action on Water Resources Management (ASPA-WRM), which defined key actions and a set of project activities aimed at facilitating the rapid attainment of improved IWRM as well as building knowledge and capacity across the ASEAN region (ASEAN, 2005). The ASPA-WRM contains actions on four key issues, (i) supply, demand and allocation, (ii) water quality and sanitation, (iii) climate change and extreme events, and (iv) governance and capacity building. ASEAN has established several regional platforms (working groups, learning forums, workshops, conferences, etc) to share knowledge and build capacity in IWRM. These activities support moving towards IRBM and building greater awareness of decision-makers. Following are regional initiatives that have been developed to respond to these four key issues in the ASPA-WRM.

ASEAN IWRM Country Strategy Guidelines/ASEAN IWRM Indicators Framework: the AWGWRM developed and adopted a set of IWRM performance indicators in 2009 (ASEAN 2015) to monitor and assess the progress and achievement of IWRM in the AMS for six water management issues: water supply management, irrigation management, storm water management, flood management, water pollution management and sanitation management. The IWRM Performance Indicators Framework was revised in 2015 to include four types of indicators: outcome indicators, enabling environment indicators,

institutional set-up indicators and management tools indicators (ASEAN 2015). The ASEAN IWRM website (http://aseaniwrm.water.gov.my), which was launched at the 26th Meeting of ASOEN in 2015, serves as the platform to share Annual Reports on the IWRM performance indicators in AMS. The website also provides an IWRM overview in each AMS and articles of water-related news and events in AMS. It is currently hosted by the Department of Irrigation and Drainage, Malaysia.

Box 14. Regional cooperation on the Mekong River Basin

Presently, Mekong River is facing a number of challenges in development needs related to water resources from regional and national perspectives for livelihood security, food security, energy security, improved navigation and resilience against sever floods and droughts. The key basin challenges are environmental degradation from developments in water and non-water sectors, especially from rapid hydropower development and dealing with impacts of clime change. The Mekong River Commission (MRC) which is established from Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin under Governments of Cambodia, Lao PDR, Thailand and Viet Nam (the Member Countries) in 1995 has updated the Basin Development Strategy (BDS) for 2016-2020 to response to above development needs and key basin challenges. The Strategy contributes to a wider adaptive planning process linking regional and national planning to achieve the basin-wide vision of an economically prosperous, socially just and environmentally sound Mekong River Basin. The BDS 2016-2020 has defined following 7 basin-wide strategic priorities for basin development and management for actions (MRC 2016).

- Reduce remaining knowledge gaps (i.e. capture fish ecology, biodiversity baseline, etc.) to minimise risks;
- Optimise basin-wide sustainable development and cost and benefit sharing;
- Strengthen the protection of mutually agreed environmental assets;
- Strengthen basin-wide procedures and national implementation capacity;
- Improve national water resources development;
- Enhance information management, communication and tools; and
- Increase cooperation with partners and stakeholders.

The ASEAN Secretariat has collaborated with MRC Secretariat since 2010 on water resources management in the Mekong River Basin, assessing impacts of climate change and enhancing the capacity of Cambodia, Lao PDR, Thailand and Viet Nam in disaster response and managing environmental pollution. On the 17th meeting of the ASEAN Working Group on Water Resources Management (AWGWRM) held on 17-18 April 2017 in Kuala Lumpur, Malaysia, the meeting discussed the updating of the MoU between ASEAN and MRC and areas of cooperation regarding to (i) basin development planning; (ii) strategic cooperation and water diplomacy; (iii) climate change adaptation; (iv) environment management; and (v) flood and drought management.

ASEAN Water Data Management and Reporting System: The web system was developed to provide a platform for ASEAN regional river monitoring system that would allow ASEAN to assess the status and broad trends of river conditions and water quality across the region (http://rhn.water.gov.my/awgwrm/). Key water quality parameters and water quality index (WQI) at monitoring stations in AMS are reported annually on the website.

Urban Water Demand Management Learning Forum: The objective of the learning forum is to share examples of world's best practice and experience in AMS on urban water

demand management through workshop and visit AMS. Singapore leads organization of the learning forum. The learning forum was started since 2009 until now. The knowledge, experience and practice on water demand management, water quality management, delivering water from source to tap and smart water technologies have been discussed and exchanged through a series of workshops and learning forums.

Water resources demand management learning forum for irrigation: The forum was held in 2011 to identify issues, challenges, best practices, and possible solutions for irrigation in AMS. Key issues are insufficient irrigation infrastructure, weakness in legal and policy framework, inadequate water supply and uneven distribution in the dry season, water conflicts and weakness in community cooperation and farmer's participation.

Risks and impacts from extreme flood events in the ASEAN region: The workshop was organized in 2010 to assess the management of floods and to learn how well each AMS could cope with different flood situations. It identified the required tools and actions to improve the current situation of flood management in AMS, individually and regionally.

Risks and impacts from extreme drought events in the ASEAN region: The workshop was organized in 2010 to identify issues and gaps on drought management. It shared information on best practices, and identified required tools and actions to improve the current situation of drought management in AMS individually and holistically. 19 action steps were identified in the workshop to address key gaps on drought management including lack of real time data, capacity building for monitoring and forecasting of drought events, limitations of government budget and lack of a coordinated strategy.[35]

ASEAN in coordination with UNDP is developing a USD 8 million project to be funded by GEF on Reducing Pollution and Preserving Environmental Flows in the East Asian Seas through the Implementation of IRBM in the ASEAN region. The Project aims to improve IWRM, reduce pollution loads from nutrients and other land-based activities, sustain freshwater environmental flows and reduce climate vulnerability through demonstrations and replications, planning and strengthening of IRBM in selected AMS.

ASEAN-ROK Project on Building Resilience for Sustainable ASEAN from Water-Related Disasters: The Project was implemented by Chuncheon Global Water Forum. Activities included compilation of national assessment report on the current status of water-related disasters and policy recommendations for each AMS and the ASEAN regional agenda for a safer ASEAN.

35. http://environment.asean.org/files/RIEE-Droughts-OnWeb-rev.pdf

7. References

ACE (2015) *The 4th ASEAN Energy Outlook 2013-2035*, ASEAN Center for Energy, Association of Southeast Asian Nations, Indonesia.

ADB (2009) *The Economics of Climate Change in Southeast Asia*: A Regional Review, Asian Development Bank, Philippines.

ADB (2012) *Kingdom of Thailand: Strengthening Integrated Water and Flood Management Implementation*, Technical Assistance Report, Asian Development Bank, Philippines.

ADB (2014) *ASEAN 2030 Toward a Borderless Economic Community*, Asian Development Bank, Philippines.

Almassy, D. (2014) *Handbook for ASEAN Government Officials on Climate Change and the UN Sustainable Development Goals*, Hanns Seidel Foundation Viet Nam, Viet Nam.

Alexandra E. V. Evans, Munir A. Hanjra, Yunlu Jiang, Manzoor Qadir and Pay Drechsel (2012) *Water pollution in Asia: The urgent need for prevention and monitoring, Global Water Forum*. www.globalwaterforum.org

Arias, M. E., Cochrane, T. A., Kummu, M., Lauri, H., Koponen, J., Holtgrieve, G. W., and Piman, T. (2014) *Impacts of hydropower and climate change on drivers of ecological productivity of Southeast Asia's most important wetland*, Ecological Modelling., 272, 252–263.

ASEAN (2003) *ASEAN Long Term Strategic Plan for Water Resources Management*, Association of Southeast Asian Nations, Indonesia.

ASEAN (2005) *ASEAN Strategic Plan of Action on Water Resources Management*, Association of Southeast Asian Nations, Indonesia.

ASEAN (2009) *Fourth ASEAN State of the Environment Report 2009*, Association of Southeast Asian Nations, Indonesia.

ASEAN (2015a) Report of the ASEAN Regional Assessment of MDG Achievement and Post-2015 Development, Association of Southeast Asian Nations, Indonesia.

ASEAN (2015b) *ASEAN Statistic Year Book 2014*, Association of Southeast Asian Nations, Indonesia.

ASEAN (2015c) *Project completion report: ASEAN IWRM Country Strategy Guideline Project*, Association of Southeast Asian Nations, Indonesia.

ASEAN (2016a) *ASEAN Socio Culture Community Blueprint 2025*, Association of Southeast Asian Nations, Indonesia.

ASEAN (2016b) *Development of the Post-2015 ASEAN Strategic Plan on Environment (ASPEN)*, Association of Southeast Asian Nations, Indonesia.

ASEAN (2017a) ASEAN Industrial Cooperation Scheme, Association of Southeast Asian Nations, Indonesia. http://asean.org/?static_post=asean-industrial-cooperation-scheme

ASEAN (2017b). ASEAN IWRM Country Strategy Guidelines, Association of Southeast Asian Nations, Indonesia. http://aseaniwrm.water.gov.my/about-us/ (Accessed 27 February 2017).

ASMC (2017). ASEAN Specialised Meteorological Centre, Association of Southeast Asian Nations, Indonesia. http://asmc.asean.org/asmc_asean_cof_about/ (Accessed 27 February 2017).

Baran E., Guerin E., Nasielski J. (2015) *Fish, sediment and dams in the Mekong*, Penang, Malaysia: WorldFish, and CGIAR Research Program on Water, Land and Ecosystems (WLE).

Cochrane, T.A., Arias, M.E., and Piman, T. (2014) *Historical impact of water infrastructure on water levels of the Mekong River and the Tonle Sap System*, Hydrological and Earth System Sciences, 18, 4529–4541. doi:10.5194/hess-18-4529-2014

DOE (2015) *Malaysia Environmental Quality Report 2015*, Department of Environment, Ministry of Natural Resources and Environment, Malaysia.

EMB (2015) *State of the Brown Environment (2008-2015)*, Environmental Management Bureau, Department of Environment and Natural Resources, Philippines.

FAO (2012) Irrigation in Southern and Eastern Asia in figures, AQUASTAT Survey – 2011, Food and Agriculture Organization of the United Nations, Italy.

FAO (2017). AQUASTAT, Food and Agriculture Organization of the United Nations, Italy. http://www.fao.org/nr/water/aquastat/water_res/index.stm (Accessed 16 February 2017)

IPCC (2014) Fifth assessment report, second Working group report. http://ipcc-wg2.gov/ar5/images/uploads/Wg2ar5_sPm_fiNal.pdf

IWMI (2010) *Land and Water Resources Management for Upland Farms in Southeast Asia*: *Some Lessons Learned*, Water Policy Brief, Issue 33, 2010, International Water Management Institute, Sri Lanka.

Kondolf G. M., Annandale, G. and Zan Rubin (2015) *Sediment starvation from dams in the lower Mekong river basin: magnitude of the effect and potential mitigation opportunities*, E-proceedings of the 36th IAHR World Congress, The Hague, the Netherlands.

Lauri, H., de Moel, H., Ward, P.J., Räsänen, T.A., Keskinen, M., Kummu M. (2012) *Future changes in Mekong River hydrology: impact of climate change and reservoir operation on discharge*, Hydrology and Earth System Sciences 16(12), 4603–4619. DOI: 10.5194/hess-16-4603-2012

Le Hoang (2016) Freshwater fish found dead in Thanh Hoa river, VN Express International, Viet Nam

http://e.vnexpress.net/news/news/freshwater-fish-found-dead-in-thanh-hoa-river-3397784.html (Accessed 1 March 2017).

MacQuarrie P. R., Viriyasakultorn V., and Wolf A. T. (2008) *Promoting Cooperation in the Mekong Region through Water Conflict Management*, *Regional Collaboration and Capacity Building*, GMSARN International Journal 2, 175 – 184.

MOE (2014) *State of The Environment Report Indonesia 2013*, Ministry of Environment, Indonesia.

MOF and WB (2012) *Thailand Flooding 2554 Rapid Assessment for Resilient Recovery and Reconstruction Planning*, the Ministry of Finance, Royal Thai Government and The World Bank.

MONRE (2010) *National State of Environment 2010*. Ministry of Natural Resources and Environment, Viet Nam.

MNRE (2012) *National water resources policy*, Ministry of natural resources and environment, Malaysia.

MRC (2010) *State of Basin Report 2010*, Mekong River Commission, Lao PDR.

MRC (2011a) *Technical Paper No. 3: Best Practice Guidelines for the Integrated Planning and Design of Economically Sound and Environmentally Friendly Roads in the Mekong Floodplains of Cambodia and Viet Nam*, Mekong River Commission, Lao PDR.

MRC (2011b) *Assessment of Basin-wide Development Scenarios in the Lower Mekong Basin*, Mekong River Commission, Lao PDR.

MRC (2016) *Integrated Water Resources Management-based Basin Development Strategy 2016-2020 For the Lower Mekong Basin*, Mekong River Commission, Lao PDR.

PCD (2016) *Thailand State of Pollution Report 2015*, Pollution Control Department, Ministry of Natural Resources and Environment, Thailand

Petrenko, C., Paltseva, J., and Searle S. (2016) Ecological Impacts of Palm Oil Expansion in Indonesia, International Council on Clean Transportation, US

Piman, T., Lennaerts, T., and Southalack, P. (2013) *Assessment of hydrological changes in the Lower Mekong Basin from basin-wide development scenarios*. Hydrological process, Wiley, 27, 2115–2125. doi: 10.1002/hyp.9764

Piman, T., Cochrane, T.A., Arias, M.E. (2015) *Effect of Emerging Large Dams on Water Flows and Hydropower Production in the Sekong*, *Sesan and Srepok Rivers of the Mekong Basin*, River Research and Applications, John Wiley & Sons, Ltd. doi: 10.1002/rra.3045.

Research Office (2016) Fact Sheet: Overview of water resources management in Singapore, Information Services Division, Legislative Council Secretariat, Singapore.

UNEP (2016) *GEO-6 Regional Assessment for Asia and the Pacific*. United Nations Environment Programme, Kenya.

UNESCAP (2015) *Disasters in Asia and the Pacific: 2015 Year in Review*, Thailand.

UN-Habitat and UNESCAP (2015) *The state of Asian and Pacific cities 2015: Urban transformations shifting from quantity to quality*, UN-Habitat and UNESCAP.

UNICEF (2014) *One Year After Typhoon Haiyan*, Philippines, Progress report.

USAID (2014) *Climate Change in the Lower Mekong Basin: An Analysis of Economic Values at Risk*, Mekong Adaptation and Resilience to Climate Change Program, United States Agency for International Development, U.S.

WB (2008) *Economic Impacts of Sanitation in Southeast Asia; A four-country study conducted in Cambodia, Indonesia, the Philippines and Viet Nam under the Economics of Sanitation Initiative (ESI)*, The World Bank, Indonesia.

WEPA (2012) *WEAP Outlook on Water Environmental Management in Asia 2012*, Water Environment Partnership in Asia, Ministry of the Environment, Japan and Institute for Global Environmental Strategies (IGES).

WHO (2010) *Drinking water quality in the South-East Asia Region*, World Health Organization, Regional Office for South-East Asia, India.

WHO and UNICEF (2014) *Progress on sanitation and drinking-water - 2014 update*, World Health Organization and UNICEF, Switzerland.

Wild, T. B., and D. P. Loucks (2014) *Managing flow, sediment, and hydropower regimes in the Sre Pok, Se San, and Se Kong Rivers of the Mekong basin*, Water Resources Research, 50, 5141–5157, doi:10.1002/2014WR015457.

Wyatt, Andrew B. and Baird, Ian G. (2007) *Transboundary Impact Assessment in the Sesan River Basin: The Case of the Yali Falls Dam*, International Journal of Water Resources Development, 23:3, 427 – 442.

2.5. Coasts and oceans

Southeast Asia has some of the longest coastlines and richest ocean resource, and the waters form part of the world's centre for marine biodiversity including rich mangrove areas, coral reefs and seagrass beds, alongside a productive fisheries industry. This chapter looks at the status of these resources and the threats from overfishing and degradation from overexploitation and climate change.

2.5. Coast and oceans

Key Messages

- The rich ocean resources of Southeast Asia are overfished and degraded. Key ecosystems such as coral reefs, mangroves, and seagrass meadows are under threat from overexploitation and climate change.
- Coastal development is increasingly affecting the health of the seas; marine debris pollution is a serious issue alongside climate change and overfishing.
- Climate change and subsequent sea-level rise will have deep impacts on the productivity of coasts and oceans in ASEAN, affecting the well-being of coastal inhabitants while poverty among the rising coastal populations continues to be of significant concern.
- Ongoing regional innovations in marine protected area management, no-take reserves and community-based coastal resources management can potentially reverse.
- ASEAN should enable a closer collaboration between the Environment and Fisheries working groups to ensure that there are complementarities in their interventions from the perspective of conservation, management and wise use of the region's coasts and oceans.
- ASEAN should move swiftly to address the problem of marine litter or debris pollution as it is becoming a major threat to the integrity of its coasts and oceans.
- A coordinated and coherent regional approach is needed, especially those resources that straddle exclusive economic zones (EEZ) of littoral states and the high seas. Actions on IUU fishing is critically needed.
- ASEAN should assist member states to achieve their Aichi targets especially on the creation of more marine protected areas in the region.

1. Introduction

"*The ASEAN region . . . is mega-diverse: it supports 75% of global coral species, six of the world's seven marine turtle species, and 51 of the 70-mangrove species worldwide, with many species endemic to the region. The annual estimated value of ecosystem services from coral reefs comes to US$ 112.5 billion; mangroves account for US$ 5.1 billion*" (ASEAN Centre for Biodiversity 2014, p.43) .

The coasts and oceans of ASEAN are abundant and well-known for their biodiversity. Different coastal and marine resources abound including coral reefs, mangroves, seagrass beds, pelagic fisheries, demersal fisheries, and seabed minerals. The region hosts the world's center for marine biodiversity, otherwise known as the Coral Triangle (Asian Development Bank 2014a).

Table 33. The coastlines and exclusive economic zone of ASEAN

ASEAN Member State	Costline* (kms)	Total Exclusive Economic Zone** (km^2)
Indonesia	54,716	6,024,450
Philippines	36,289	2,263,816
Malaysia	4,675	449,477
Viet Nam	3,444	1,295,096
Thailand	3,219	305,778
Myanmar	1,930	511,389
Cambodia	443	47,676
Singapore	193	673
Brunei Darussalam	161	25,340
Lao PDR	-	-

*Source: *US Central Intelligence Agency, 2017 and **Pauly and Zeller, 2015.*

The region has extensive exclusive economic zones (EEZ). Indonesia and the Philippines are the two largest archipelagic states in both demographic and geographic terms (United States Central Intelligence Agency 2017; Pauly and Zeller 2015) (Table 35). Fish is an important source of protein in the region, with a per capita fish consumption of 13.1 to 33.6 kg (FAO 2016).

Table 34. Volume (tonnes) of Marine Fishery Production among AMS

Region/ASEAN Member State	2010	2011	2012	2013	2014
Indonesia	5,039,416	5,328,637	5,400,977	5,707,020	5,967,139
Viet Nam	2,226,600	2,300,000	2,510,900	2,607,000	2,711,100
Myanmar	2,048,590	2,169820	2,332,790	2,483,870	2,702,240
Philippines	2,424,476	2,171,770	2,145,233	2,127,368	2,131,872
Thailand	1,617,399	1,633,651	1,612,073	1,630,047	1,559,746
Malaysia	1,428,881	1,373,105	1,472,239	1,482,900	1,458,126
Cambodia	85,000	114,695	110,000	110,000	120,250
Brunei Darussalam	2,351	2,154	4,523	2,825	3,186
Singapore	1,732	1,618	1,969	1,644	1,433
TOTAL	14,874,445	15,095,540	15,590,704	16,152,674	16,655,092

Source: SEAFDEC, 2017 and "Statistical Handbook of Viet Nam, 2014.

Marine fishery production in the region is an important component of the economies of coastal AMS, with Indonesia leading production followed by Viet Nam Myanmar, and Philippines (SEAFDEC 2017) (Table 35).

Like other coastal areas across the world, the coasts of ASEAN are highly exposed to various environmental and anthropogenic hazards and physical processes (cf. Kron 2012). Oceanographic processes determine its shape and structure. Many major towns and cities are located in low elevation coastal zones (LECZ) (Small and Nicholls 2003; Small and Cohen 2004; Kummu et al. 2016; Lichter et al. 2010; Neumann et al. 2015). Commercial hubs are located along coastal areas. The coasts are also becoming resource frontiers waiting to be exploited by a growing population as fishing becomes an occupation of last resort. Coastal and marine resources in ASEAN have been under threat due to a host of factors including rapid increase of coastal population, unplanned industrialization, land use conversion, infrastructure development, settlement change, climate change, increasing coastal tourism, and poverty.

This chapter discusses some of the critical issues affecting ASEAN's coasts and oceans. It highlights the challenges that AMS are faced with in managing its extensive coastal and ocean resources. As discussed in detail in the response section in this chapter and in Section 3, some issues can be dealt with at the national level while others demand a coordinated and coherent regional approach[36].

36. Issues regarding coastal and marine biodiversity in relation to Aichi targets are not discussed here but are extensively reviewed in the ASEAN Biodiversity Outlook 2 (ASEAN Centre for Biodiversity 2017, p.2). For detailed discussions on biodiversity, please refer to the Outlook.

Figure 38 illustrates the DPSIR model that guides the analysis in this chapter. It highlights the key drivers (e.g., climate change and demography) that drive the pressures (including excess capacity in nearshore fisheries, coastal degradation and poor governance) affecting the status of coasts and oceans in ASEAN. Many coastal fisheries in the region are overfished. The integrity of several coastal ecosystems is threatened. Ocean resources are poorly managed and governed. This has resulted in biodiversity loss and 'fishing down' of marine food webs, undermining the social and economic well-being of the region's inhabitants.

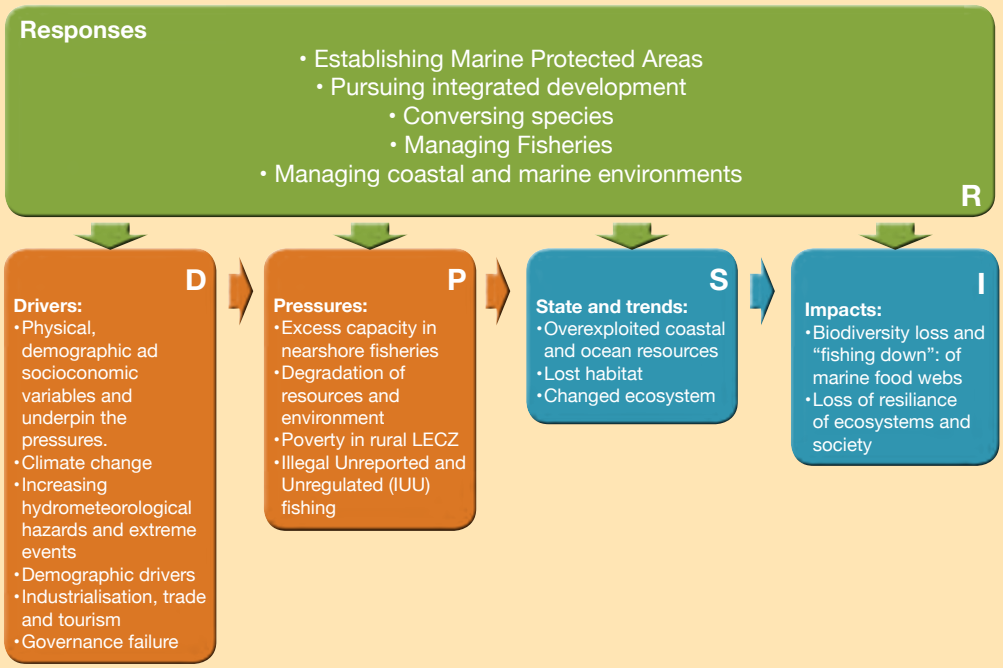


Figure 38. DPSIR framework of coasts and oceans in ASEAN

Low elevation coastal zones in ASEAN

An earlier definition of coastal areas was based on distance from the coastline (up to 100 km from nearest coast) and elevation (less than 100 m) (Small and Cohen 2004). This definition would practically make much of Southeast Asia coastal. For precision in identifying the coastal populations, especially those that are at risk to hazards, the term 'low elevation coastal zone' or LECZ is used. The term has been described earlier by McGranahan et al. (2007). LECZ refers to land below 10 m in elevation which is hydrologically connected to the sea (Lichter et al. 2010). Such elevation is currently above the predicted sea level rise, but usually lies within the reach of cyclones, storm surges and other indirect impacts of sea level rise (Balk et al. 2009). Using LECZ as a geographical reference will enable precise analysis especially with respect to two important elements in analyzing the drivers of population change in coastal areas: elevation and proximity (cf Kummu et al. 2016).

Eight percent of the region's total land area of 4,457,573 km^2 is LECZ (Table 36). Indonesia and Viet Nam have the largest LECZ, but as a proportion, Viet Nam and Singapore have the highest.

Table 35. Total land area of ASEAN Member States, their low elevation coastal zones (LECZ) and proportion (%) of LECZ with total land area

Region/ASEAN Member State	Total land area (Km^2)	LECZ area (km^2)	% LECZ of total land areaa
Southeast Asia	4,457,573	375,814	8
Indonesia	1,901,200	172,092	9
Myanmar	669,464	48,651	7
Thailand	516,525	35,375	7
Malaysia	330,615	19,506	6
Viet Nam	328,594	66,232	20
Philippines	295,298	20,165	7
Lao PDR	230,073	-	-
Cambodia	179,416	13,493	8
Brunei Darussalam	5,793	193	3
Singapore	595	107	18

Source: Adapted from Neumann et al., 2015

2. Drivers

Drivers are the physical, demographic and socio-economic processes that lead to pressures on the environment. In ASEAN, the key drivers that create pressures on the state and trends of the region's coasts and oceans include climate change, ongoing settlement transition in coastal areas driven by demographic change, and current social, developmental and economic drivers.

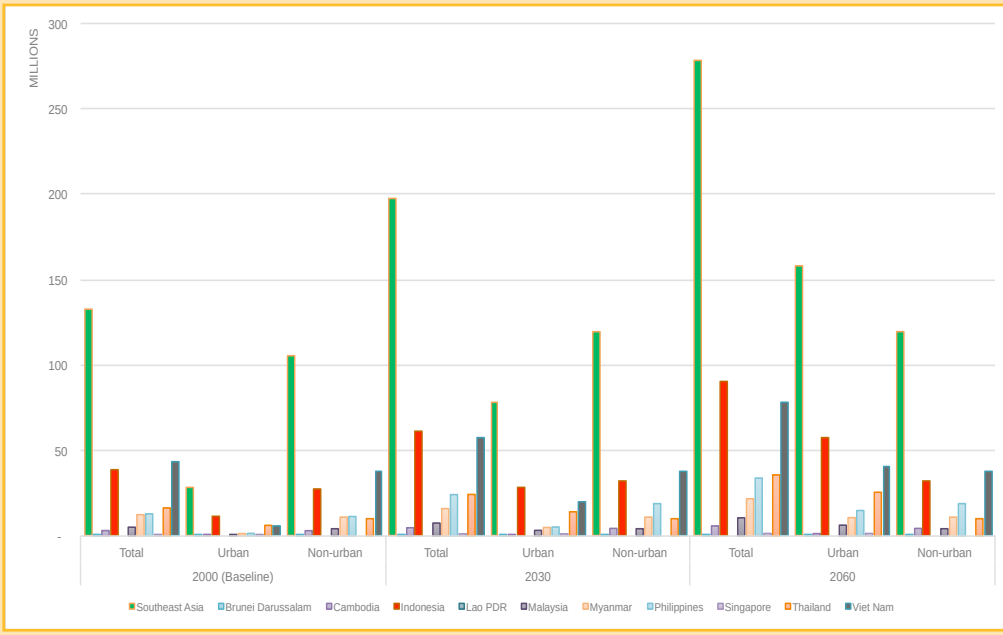
Increasing impacts of a changing climate on the coasts of ASEAN

With a temperature increase of 0.14°C to 0.20°C per decade since the 1960s, climate change will have deep impacts on the productivity of coasts and oceans in ASEAN, as well as affecting the well-being of coastal inhabitants (Hijioka et al. 2014; Nurse et al. 2014; Rijnsdorp et al. 2009). A coastal impact of climate change is sea-level rise (SLR), which is caused by the warming of the oceans and the consequent thermal expansion of sea waters and the melting of land ice (Cazenave and Cozannet 2014). Following Representative Concentration Pathway 8.5 (RCP8.5), temperature will increase by 2°C by 2041 in relation to preindustrial levels leading to a rise in global sea levels by a median of 22 cm. A 5°C warming will cause a median rise in global sea levels of 86 cm by 2100 (Table 37). Such level of change is "faster than at any time during human civilization" (Jevrejeva et al. 2016). Recent analysis shows that current emission scenarios are making it impossible for current temperature to stay below 2°C so that impacts are imminent and need preparation (Peters et al. 2012).

Table 36. Probabilistic projections (5%, 50%, and 95% quantiles) of sea level rise (meters) of selected AMS coastal cities with warming of 2 °C, 4 °C, and 5 °C

City	ASEAN Member State	Longitude	Latitude	2°C			4°C			5°C		
				0.05	0.50	0.95	0.05	0.50	0.95	0.05	0.50	0.95
Bangkok	Thailand	100.50	13.76	0.12	0.19	0.32	0.35	0.59	1.17	0.49	0.87	1.91
Davao	Philippines	125.46	7.19	0.14	0.21	0.35	0.38	0.64	1.26	0.52	0.94	2.05
Hai Phøng	Viet Nam	106.69	20.84	0.13	0.20	0.32	0.38	0.61	1.16	0.52	0.89	1.87
Ho Chi Minh City	Viet Nam	106.63	10.82	0.12	0.20	0.33	0.37	0.62	1.20	0.50	0.90	1.96
Jakarta	Indonesia	27.14	38.42	0.11	0.18	0.30	0.34	0.58	1.12	0.48	0.85	1.80
Kuala Lumpur	Malaysia	101.69	3.14	0.11	0.18	0.31	0.33	0.58	1.19	0.47	0.86	1.92
Manila	Philippines	120.98	14.60	0.13	0.20	0.34	0.37	0.63	1.22	0.51	0.92	1.99
Palembang	Indonesia	104.78	-2.98	0.13	0.21	0.34	0.39	0.64	1.26	0.53	0.94	2.03
Rangoon	Myanmar	96.15	16.78	0.12	0.20	0.32	0.34	0.59	1.16	0.47	0.85	1.86
Singapore	Singapore	103.82	1.35	0.13	0.20	0.34	0.37	0.62	1.23	0.52	0.92	2.00
Surabaya	Indonesia	112.75	-7.26	0.13	0.21	0.35	0.38	0.63	1.26	0.52	0.93	2.03
Ujung Pandang	Indonesia	119.43	-5.15	0.14	0.22	0.35	0.39	0.65	1.28	0.54	0.95	2.05

Source: Adapted from Jevrejeva et al., 2016



Adapted from the analysis conducted by Neumann et al (2015), using high end scenario of high population growth and exclusive social, political and economic governance.

Figure 39. Urban and non-urban population of the LECZ for 2000, 2030 and 2060

The magnitude of the projected SLR will affect Southeast Asia heavily due to its long low-lying coastlines, large number of islands, location of populations along LECZ, and the concentration of settlements in delta environments, prone to land subsidence and inundation (Erkens et al. 2015; Schmidt 2015; Jevrejeva et al. 2016; Ingebritsen and

Galloway 2014). Coastal flooding due to storm surge and inundation are expected to put millions of coastal households in the region, at risk (Hijioka et al. 2014). Archipelagic states, island nations and countries with low lying coastal regions such as the Philippines, Indonesia, Viet Nam, Malaysia, Thailand, and Singapore, will be particularly affected. Cities in these countries that will be critically affected by SLR include Bangkok, Ho Chi Minh, Jakarta, Kuala Lumpur and Manila (see Table 37) (Jevrejeva et al. 2016). Table 37 shows projected sea level rise estimated by Jevrejeva et al (2016) for different levels of warming (2°C, 4°C, and 5°C). The data shows that a 2°C warming will result in a sea level rise in the region of at least 0.30 meters for 95% of observations.

Land subsidence

The impacts of sea level rise will also be intensified by extensive groundwater withdrawal resulting in land subsidence (Zeitoun and Wakshal 2013; Wada et al. 2012; Erban et al. 2014). Flooding will be accelerated and salinity will intrude further into deeper aquifers in areas that are subsiding due to heavy extraction of groundwater. Several coastal cities in AMS are presently facing problems of land subsidence. In Bangkok, Southeast Asia's most primate city, land subsidence is still occurring despite years of interventions by the metropolitan government. Zeitoun and Wakshal (2013) noted that most parts of Bangkok have subsidence rates of less than 2 cm/year, but in other coastal provinces (e.g., Samut Prakan in the south, Bang Pli in the southeast, and Samut Sakhon in the southwest) subsidence rates of 2 to more than 5 cm/year were observed. They have noted further that areas that are now subsiding in Bangkok are also areas of depressed groundwater tables.

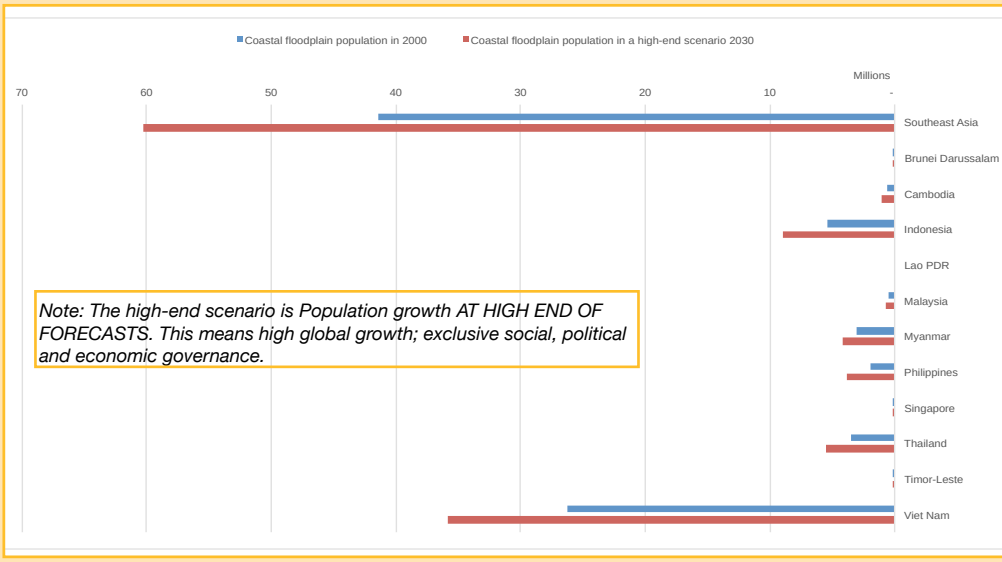
In the Mekong delta, the subsidence rate is 1-4 cm per year (Erban et al. 2014). In Indonesia, rates of up to 22 cm per year are detected near Lhokseumawe, in Medan, Jakarta, Bandung, Blanakan, Pekalongan, Bungbulang, Semarang, and in the Sidoarjo regency. The highest levels of subsidence are generally found around coastal and urban areas (Chaussard et al. 2013). In the case of Jakarta, Chaussard et al (2013) suggest that in 20 years, at current level of subsidence of 9.5 cm to 21.5 cm per year, the coastal part of Jakarta will be below relative sea level.

In Manila, subsidence rates of 1.7-8.3 cm per year have been recorded (Rodolfo and Siringan 2006). However, a recent study showed that there are localized subsidence across Manila in the order of 15 cm per year (Raucoules et al. 2013). Although some authors (World Bank 2010) argued that land subsidence is a far greater cause of flooding than sea level rise, the interaction of these two hazards in one location can have severe impacts especially when stronger and more frequent tropical cyclones are considered (Woodruff et al. 2013). Some of the recent extensive flooding in Manila, Jakarta and the Mekong Delta has been caused by these three processes acting together (Rodolfo 2014; World Bank 2010; Jago-on et al. 2009; Taniguchi 2011; Takagi et al. 2016; Erkens et al. 2015; Woodruff et al. 2013).

Demographic drivers

The nature and dynamics of population structure and change of cities and towns along coastal areas drive changes in the coastal regions. Recent analyses have shown that the future of the coastal areas in the region is heavily affected by demographic changes primarily urbanization[37]. (See Section 1 for urbanization trends in the region).

37. Urbanization as used in this chapter follows the definition provided by Seto et al (2013, p.4) which describes it "as a multidimensional process that manifests itself through rapidly changing human population and changing land cover".



Adapted from Neumann et al., 2015

Figure 40. Population of coastal floodplain in ASEAN region in 2000 and 2030

Table 37. Population in low elevation coastal zone in key urban agglomerations in ASEAN based on LandScan 2002 data

Urban agglomeration	Population in low elevation coastal zone	Overall population based on LandScan 2002	% LECZ
Jakarta	5,916,096	11,650,674	50.8
Manila	3,360,331	9,263,238	36.3
Bangkok	6,979,214	7,859,238	88.8
Ho Chi Minh City	4,209,966	5,223,407	80.6
Singapore	571,743	4,300,798	13.3
Yangon	1,678,830	4,043,847	41.5
Kuala Lumpur	780,778	3,434,754	22.7

Source: Adapted from the Supplementary Information in Hallegate et al. 2013

Urbanization, in concert with the region's geography, have made the AMS, especially Indonesia and Viet Nam highly exposed to the impacts of sea-level rise (Neumann et al. 2015). Urbanization drives the population dynamics whether in coastal or inland areas (Merkens et al. 2016, p.64). Changing land uses and the increase in built up environments expand impervious concrete spaces which increase run-off and flooding (Secretariat of the International Human Dimensions Programme on Global Environmental Change (UNU-IHDP) 2015). Furthermore, these changes in land use and land cover have made cities warmer than surrounding non-built up areas, leading to the so-called urban heat island effect (Estoque et al. 2017; Li et al. 2017).

Globally, it is projected that urban land cover will increase by 200% from 2000 to 2030, while global urban population is growing slower at only 70% (Seto, K et al. 2013; Fragkias et al. 2013). This means that the built environment is expanding despite a slowing population with major implications for global environmental change.

The growth of urban areas in LECZ is faster than in other places globally (Seto et al. 2011). In 2000, the region's LECZ hosted a total population of 133,223,744 people. Projections for 2030 and 2060 show a rise of 197 million and 278 million people, respectively, in LECZ, using high end (or worst case) scenario of high global growth and exclusive social, political and economic governance. The share of LECZ areas defined as urban will change to at least 39% of total population in 2030 and a staggering 57% by 2060 from a low of only 21% in 2000 (Neumann et al. 2015) (see Table 39). This means that current LECZs in ASEAN are urbanizing; land use and land cover are changing; and the urban population will outstrip growth in non-urban areas by 2060 if existing trends continue. Analysis by Seto et al. (2011) showed that the trend of increasing urban expansion in LECZ has been set since 1970-2000 where the global average rate of urban expansion was greater than 5.7%, which is statistically higher than other urban areas.

Urban land use and its footprint are projected to expand worldwide (Grimm et al. 2008). As a result, urbanization has become "the most irreversible and human-dominated form of land use" of all human activities (Seto et al. 2011, p.2). Urbanization is often accompanied by land use and land cover change resulting in altered biogeochemical cycles, climate change, altered hydrological cycles and degradation of biodiversity at global, regional and local scales (Grimm et al. 2008). Future expansion of LECZ in the region follows a trend of high overall urban land expansion in the region at 14% between 1970-2000 (Seto et al. 2011).

Seto et al. (2011) has calculated that an urban area located in the coastal zone increases the rate of urban land expansion up by 0.829 percentage points compared to non-coastal zones. This means that the location of urbanizing settlement along coastal areas already predisposes the region for more, or an increase in, urbanization. While this could partly explain why large urban agglomerations are found along coastal zones, there are other factors to consider such as the role of GDP and non-demographic factors including land-use policies, transportation costs and income in fueling urban expansion (Fragkias et al. 2013). Except for Vien-tiane, most capital cities and most of the secondary urban centres in ASEAN region are located in deltas or coastal areas. Increasing urbanization rates and the concentration of these population within a narrow coastal zone will not only have tremendous impacts on in situ coastal ecosystems and but also expose them to coastal hazards (Small and Nicholls 2003).Their continued expansion, therefore, imposes serious social, economic and environmental sustainability challenges. But the risks in these areas will be severe especially if they have low private and public incomes and lack protective infrastructure (Balk et al. 2009).

Estimates for the region showed huge increases in populations located in coastal floodplains from a population of over 41 million in 2000 to more than 60 million in 2030 based on worst case projections (Neumann et al. 2015). Several countries – notably Viet Nam, Indonesia, Thailand, Philippines, and Myanmar – will see substantial jump in their populations (Figure 38 and 40). Viet Nam, in particular, registers a massive increase due to a huge population already located along coastal floodplains. Migration into coastal environments from marginal areas such as drylands, mountain areas, and drought-prone areas has been documented to characterize developing countries between 1970 to 2000 (de Sherbinin et al. 2012).

Table 38. Growth (%) of rural LECZ population between 2000 to 2010 in selected AMS

ASEAN Member State	Percent growth rate
Myanmar	0.20%
Cambodia	12.00%
Indonesia	13.40%
Philippines	25.00%
Viet Nam	11.30%
Thailand	11.30%

Source: Barbier, 2015

Hallegate et al (2013) showed that cities that grow rapidly, have large populations, are poor, exposed to tropical storms, and prone to subsidence are vulnerable to climate-induced hazards in 2050. In Table 39, the population in LECZ of key urban agglomerations in ASEAN are shown, based on the analysis provided by LandScan which Hallegatte et al. (2013) used. Bangkok and HCMC have between 80-89% of their population in LECZ. In comparison, Jakarta, Yangon, and Manila, respectively, only have 51%, 42%, and 36%. This means that Bangkok and HCMC hold the most number of people that will be affected by climate-related impacts followed by Jakarta, Yangon and Manila.

The population of LECZs defined as rural have been growing since 2000, for which highly noticeable growth is noted in the Philippines (Table 40) especially when compared to the global LECZ's rural population growth rates of only 17.5% (Barbier 2015). Myanmar's LECZs are not growing that much at present, but future growth is likely.

Industrialization, trade and tourism

Aside from urbanization and demographic change, the current and future status of the coasts and oceans in ASEAN is further complicated by deepening industrialization brought about by increasing trade and government policies to encourage coastal tourism. Despite a decline in foreign direct investments to the ASEAN region of 8% from US$ 130 billion in 2014 to 120 billion in 2015 (ASEAN Secretariat and UNCTAD 2016), trade in the region is still brisk. For instance, since 2000, the number of transits of vessels over 300 gt in the Straits of Malacca has increased from about 56,000 to 79,000 transits in 2014. Containerships are the largest users of the Straits (Hand 2015). New industries continue to be located in the coastal zone close to ports that serve as gateways to the world, where commerce and trade flow in and out of the country. Ports therefore could serve as a useful indicator on the nature and level of industrialization of a country and their connections with the world. Singapore's and Malaysia's ports are ranked third and fifth, respectively, in the world in terms of container traffic (IAPH Secretariat 2015). Table 41 lists the top ports in Southeast Asia in 2015 and their growth rates. The volume of traffic hosted by ports in the region is increasing. The growth of industries in coastal areas and the rise in shipping traffic in the region's oceans means marine pollution and overexploitation of resources are highly likely.

Table 39. Top ports in ASEAN from 2010 to 2014

Rank	Port	Traffic (x 1,000 TEU)					ASEAN Member State
		2010	2011	2012	2013	2014	
1	Singapore	28,431	29,937	31,649	32,240	33,869	Singapore
2	Port Klang	8,870	9,603	10,000	10,350	10,946	Malaysia
3	Tanjung Pelepas	6,530	7,520	7,700	7,628	8,550	Malaysia
4	Tanjung Priok	4,715	5,649	6,460	6,590	6,590	Indonesia
5	Laem Chabang	5,068	5,731	5,830	6,041	6,583	Thailand
6	Ho Chi Minh	3,856	4,815	5,060	5,542	6,390	Viet Nam
7	Manila	3,154	3,467	3,705	3,770	3,650	Philppines
8	Tanjung Perak	3,030	2,643	2,849	3,001	3,106	Indonesia
9	Bangkok	1,453	1,454	1,397	1,509	1,536	Thailand
10	Penang	1,522	1,580	1,580	1,470	1,470	Malaysia

Source: IAPH Secretariat, 2015

Tourism is also changing the character of ASEAN, where it is not only an employer and source of income, but also a vehicle for regional development (Dolezal and Trupp 2015). Although Figure 41 does not differentiate between coastal and non-coastal tourism forms, tourism in ASEAN is increasing with Malaysia, Thailand and Singapore the top three major tourist destinations. The growth of tourism will have substantial impact on the coasts of the region, especially once the ASEAN single branding campaign comes into effect (Thirumaran and Arumynathan 2016). Tourism's environmental impacts on water resources have already been reported in Bali (Byrne 2013; Cole 2012) and some destinations in Malaysia and Thailand (Wongthong and Harvey 2014; Karim 2016).

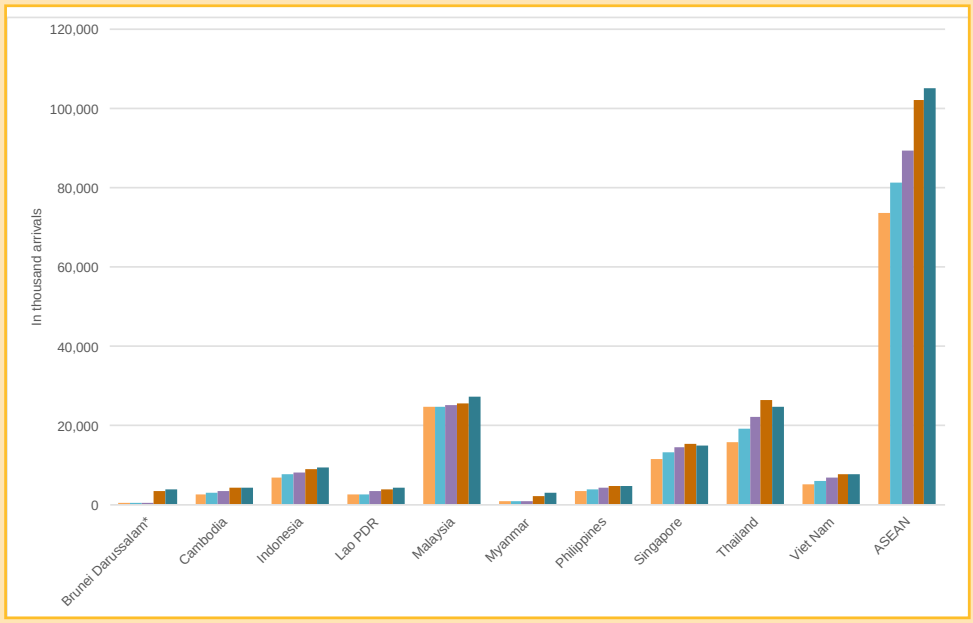
Industrialization, trade and tourism interact with other conditions in a country's wider political economy to produce situations where there are differences in income, job opportunities, and developments between the rural or urban; core or periphery; coastal or inland; and, resource rich or resource poor areas attracting mobile labor (Hugo 2015). In the case of LECZs, migrant labor and capital are attracted to this zone in a major way, due to cheaper transport costs (Balk et al. 2009). Thus, settlement transition in coastal areas and trade are closely intertwined (de Sherbinin et al. 2012).

All these drivers are underlain by unregulated expansion of industries, poor coastal planning and ineffective management (Chua 2013). These arise due to several 'institutional traps', defined as inefficient but stable governance practices (Balatsky 2013). Lebel et al (2010) describe five institutional traps: fragmentation, rigidity, scale, elite capture, and crisis[38].

The governance of coasts and oceans in ASEAN is fragmented and distributed across different sectoral ministries, departments, offices and authorities. For instance, fisheries

38 Fragmentation refers to the separation of tasks across the different actors in the bureaucracy, giving rise to problems of coordination and institutional competition. Rigidity refers to too much focus on control, stability and seeking to eliminate uncertainties in governing resources and environment. Scalar traps refer to the inability to cross other scales in responding to governance challenges and the failure to think about the implications of decisions made on one scale over another. Elite capture refers not only on the use of experts and their tools to make decisions but also to the exclusive access of resources in the coastal zone by the powerful and politically influential. Finally, crisis refers to reactive policymaking and planning in response to political pressures instead of a more strategic, inclusive and well-thought out policymaking (Lebel et al. 2010).

management could be under the domain of a ministry or department of fishery, but coastal resources management could be under a ministry or department of the environment and natural resources management. Different uses, such as tourism, shipping, hydrocarbon development, mining and human settlement in the coastal zone are also apportioned into sectoral agencies or authorities. As a result, there is no coherent policy that governs how the coastal zone is being used and the policy frameworks are fragmented. The case of mangrove conversion into oil palm plantations in Malaysia and Sumatra and Borneo in Indonesia is an example where oil palm is seen as a terrestrial commodity managed by terrestrial government agencies but mangroves is a coastal ecosystem under the purview of marine government agencies (Richards and Friess 2016).



Source: ASEAN statistics of tourism (http://asean.org/?static_post=tourism-statistics-2).
Note: *Prior to 2013, Brunei Darussalam data only covers visitor arrivals by air.

Figure 41. Tourist arrivals in ASEAN as of 30 September 2015

Scalar implications of certain uses in the coastal zone are not also considered, such as the case of sand mining for export that leads to destruction of fragile coastal ecosystems such as coral reefs and seagrass meadows, coastal erosion and other changes in coastal geomorphology (Franke 2014; Marschke 2012). Elite capture and rigidity in the management of the coastal zone can be seen in the lack of involvement of traditional or indigenous communities in coastal and fisheries management.

ASEAN have had enduring fisheries management practices and institutions such as *sasi laut* in Maluku (Harkes and Novaczek 2002; Novaczek 2001), *the nagari system* in West Sumatera (Siry 2011), or *the Panglima Laot* in Aceh (Wilson and Linkie 2012; Utomo 2010; Nurasa et al. 1993; Campbell et al. 2012) which could play an important role in coastal and ocean management in the region.

A crisis in policy-making mentality and without a thorough grounding on the broader construction of vulnerability can also lead to institutional traps. For instance, in the aftermath of disasters, the coastal zones in the region are being managed with a heavy

infrastructure focus in response to a future threat, without recognizing its associated impacts on coastal livelihoods, settlements and ecosystems, as well as on the social causes of vulnerability. This is seen in the responses to the 2004 tsunami which heavily devastated Southern Thailand (Cochard et al. 2008) and Tyhoon Haiyan in the Philippines, where infrastructure fixes in the form of dykes were the main ingredient of post-disaster reconstruction and preparedness (Santos et al. 2016; Atienza et al. 2015; Co et al. 2016; Field 2017).

3. Pressures

The drivers discussed above, together with the state of land (chapter 2.2), freshwater (chapter 2.4), air (chapter 2.1), ecosystems and biota (chapter 2.3), and the nature of our production and consumption (chapter 2.6), create pressures on coasts and ocean in the ASEAN region.

Large marine ecosystems in this region have been progressively degraded in a span of over five decades alongside being overfished[39] (Chua 2013; Lavides et al. 2016) due to unregulated fishing (Stobutzki et al. 2006). Demersal fisheries are depleted (Sumaila et al. 2010). Pelagic and high seas fisheries are also showing signs of depletion (Cullis-Suzuki and Pauly 2010; Stokke 2001). Some of the overfished fisheries include elasmobranchs (Campana et al. 2016) and sea cucumbers (Lane and Limbong 2015). The historical landings of *Chondrichthyes* (sharks, rays and chimeras) in key markets in Southeast Asia have been reduced (Group of Experts and the Pool of Experts 2016b).

Reef fisheries are usually small-scale, artisanal, subsistence and operating in usually remote locations far from regulated landing sites. Reef fisheries[40] also include fishing in associated ecosystems, such as seagrass meadows and mangrove areas. It is estimated that there are 6 million reef fishers in 99 reef countries and territories worldwide. At least 25% of them are reef gleaners who are often women and children. Slightly over a quarter of the world's small-scale fishers fish on coral reefs. Half of these coral reef fishers are found in ASEAN (Figure 42). Indonesia has the most number of reef fishers followed by the Philippines. Other member states have reef fishers but not as substantial as these two countries (Teh et al. 2013).

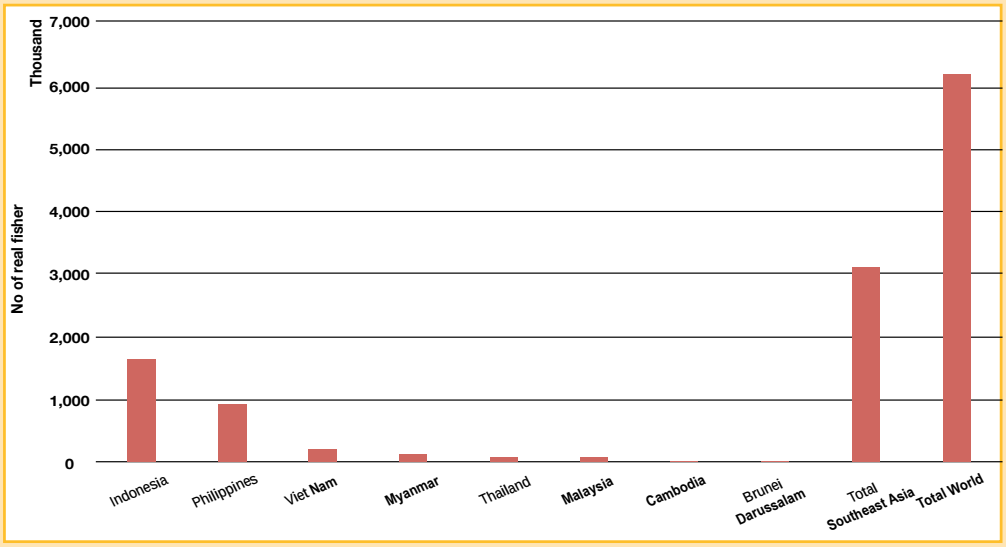
Poverty is an important driver of change in the coastal zone of the region especially in rural LECZs where poverty is higher than urban areas. Barbier (2015) estimated the population of rural LECZs and their share in poverty, using two proxies of poverty with gridded population data: infant mortality and number of malnourished children. He found that there are 15 developing countries[41] that contain over 90% of the world's LECZ rural

39. Overfishing is a complicated phenomenon and has many dimensions. Pauly (1987; 1988; 1994) has identified different aspects of overfishing: growth, recruitment, biological, ecosystem, economic, and Malthusian. Growth overfishing happens when fish is caught before they have time to grow. Recruitment overfishing happens when spawning stocks are reduced and are not able to replenish the fishery with new "recruits". Economic overfishing occurs when returns from fishing is not commensurate with the amount of effort. Ecosystem overfishing materializes when an imbalance develops in the ecosystem, leading to the depletion of certain stocks and the increase of another, but which are unable to replenish depleted species. Finally, Malthusian overfishing arise when too many fishers chase too little fish and have to increase their effort to harvest the usual catch (Pauly 1988). Of these, Malthusian overfishing is easily observable by virtue of its unit of analysis or demography (i.e. number of people) and population narrative (e.g., Decker and Reuveny 2005; Teh and Sumaila 2007). Essentially, various forms of overfishing results from the overexploitation of the reef and the removal of keystone species due to excess capacity in nearshore areas, poverty across a number of coastal communities, and the growth of illegal, unreported and unregulated (IUU) fishing.

40. Other authors (e.g., Blaber et al. 2000; Ruddle and Hickey 2008; Wedding et al. 2008) use the term nearshore fisheries.

41. These countries are: India, Bangladesh, Myanmar, Cambodia, Nigeria, Pakistan, Iraq, Mozambique, Senegal, Brazil, China, Indonesia, the Philippines, Viet Nam and Thailand. They account for 92.0% of all rural LECZ populations with high infant mortality in developing countries and 94.7% of all rural LECZ populations with malnourished children in developing countries (Barbier 2015).

poor. Six of these countries are AMS and their rural populations and share of areas of high infant mortality rates and malnourished children are presented in Table 40.



Source: Teh et al., 2013

Figure 42. Estimated number of reef fishers among AMS in 2010

Myanmar and Cambodia have nearly all of its rural LECZ populations experiencing high infant mortalities. In the LECZs of all developing countries, the incidence of high infant mortality is just over 27%. In terms of number of malnourished children, only Thailand among coastal AMS has less than 20% of its rural LECZ population with malnourished children, where all developing countries' LECZs have an average share of 26% (see Table 41) (Barbier 2015). Thailand's middle-income status could partly explain why poverty is lesser in its LECZ, but higher in other AMS. Clearly, dependence on coastal fisheries, other marine resources, and opportunities in the coastal zone is critical to the well-being of poor households in the ASEAN region. This high level of poverty continues to have serious implications on the state of the coastal and marine environment in ASEAN.

Table 40. Countries with high rural low elevation coastal zone poverty, 2000

ASEAN Member State	Areas of high infant mortality			ASEAN Member State	Areas of malnoutrished children		
	Rural LECZ population in areas of high infant mortality ('000)	Share (%) of rural LECZ population in areas of high infant mortality	LECZ share (%) of rural population in areas of high infant mortality		Rural LECZ population in areas with malnoutrished children ('000)	Share (%) of rural LECZ population in areas with malnoutrished children	LECZ share (%) of rural population in areas with malnoutrished children
Myanmar	7,791.00	99.70%	21.10%	Viet Nam	10,764.00	33.00%	53.70%
Cambodia	3,306.50	99.50%	30.60%	Indonesia	4,466.60	26.30%	12.80%
Indonesia	416.00	2.40%	13.50%	Myanmar	3,001.20	38.40%	22.90%
Philippines	359.60	6.40%	10.50%	Philippines	1,564.40	27.90%	10.50%
Viet Nam	314.50	1.00%	24.70%	Cambodia	1,384.50	41.70%	27.80%
Thailand	9.40	0.20%	0.40%	Thailand	955.00	18.60%	11.80%
All Developing	64,335.10	27.20%	5.00%	All Developing	62,360.10	26.40%	9.20%

Adapted from Barbier, 2015

Note: High infant mortality is 50 or more deaths within the first year of life per 1000 births (or 500 deaths/10,000 live births). Child mallnutrition counts are the product of malnutrition rates and population counts. Malnutrition rates are based on the perentage of children with a weight-for-age z-score more than two standard deviations below the median of the NCHS/CDC/WHO International Reference Populations

There has been an increase in illegal, unreported and unregulated (IUU) fishing[42] in ASEAN (SEAFDEC 2016; USAID 2015; Ventura 2015) largely due to the failure of coastal states and the international community to properly enforce domestic and international laws on fisheries management and conservation in nearshore areas and the high seas. More needs to be done to enable effective monitoring, control and surveillance systems including proper catch documentation and labelling, up-to-date registry of commercial fishing vessels, training of enforcement officers and agencies, and a monitoring and policing infrastructure that befits the purpose. Documentation and reporting of marine fishery production in the region needs to be improved as SEAFDEC data shows that unidentified marine species account for more than half of marine fish catch in 2014 (SEAFDEC 2017, see Table 42).

Table 41. Economically important marine species caught in the region in 2014

Group	Species	Quantity (MT)	Percentage of total quantity of marine capture production (%)	Value (US$1,000)	Percentage of total quantity of marine capture production (%)	Price (US$/MT)
Tuna	Frigate, Bullet, Kawakawa, Skipjack, Longtail, Albacore, Southern Bluefin, Yellowfin and Bigeye	1,985,254	17	3,081,123	19	1,552
Scads	Scads Nei, Bigeye, Yellowstripe, Hardtail	1,297,093	11	1,758,904	11	1,356
Mackerels	Scomber mackerels nei, Other restrelliger mackarels, Queenfishes nei	1,063,810	9	1,988,106	12	1,869
Anchovies	Stolephorus and others	429,510	4	466,825	3	1,087
Crustaceans		627,640	5	1,692,542	11	2,697
Mollusks		391,122	3	1,026,756	6	2,625
Other undentified marine species		6,115,488	51	6,089,825	38	996
TOTAL		11,909,917	100	16,104,081	100	

Source: SEAFDEC (2017).

Several commercially important species caught in the region (Table 43) are in danger of being decimated through rampant IUU fishing, leading to the degradation of the region's coastal and marine biodiversity and threatening food security. Such extensive exploitation has removed some apex species from most of the reefs in the region (Chelliah et al. 2015). Other marine flora and fauna are now listed in CITES Red List as endangered or critically threatened (Polidoro et al. 2009). The removal of predators and eutrophication are causing harmful algal and jellyfish blooms.

Species known to have been illegally harvested from the wild include live coral reef fish, humphead wrasse, sharks, marine turtles, cucumbers and many more (Cinner 2014; Dirhamsyah 2012; Sadovy 2010; Warren-Rhodes et al. 2003; Johns 2013; Ventura 2015; Metuzals et al. 2010; Anderson et al. 2011). Based on estimates coming from 54 countries and on the high seas, Agnew et al (2009) indicated that the total value of current illegal and unreported fishing losses worldwide are between US$ 10 billion and 23.5

42. IUU fishing has coastal and ocean components, and involves the following: illegal fishing activities such as fishing with fake or without license, registration; use of prohibited fishing gears and methods; landing of fish in unauthorized ports; and transfer of catch at sea; landing of catch across borders, double flagging; and, poaching in other country's exclusive economic zones (EEZ) (SEAFDEC 2016).

billion annually, representing between 11 and 26 million tonnes. No similar estimates can be found for ASEAN but we can assume that the tally is likely to be high, given the region's extensive EEZ (see Table 37) and high seas. If we infer from global analysis showing a decline in global marine fish catch from 1950 to 2005 despite the exploitation of new fishing grounds and that the only remaining frontier fishing grounds are the Arctic and Antarctic (Swartz et al. 2010), we can imagine that ASEAN's real picture is one where the potential catch is declining, contrary to the picture presented in Table 38, especially if we include by-catch and IUU fishing.

Table 42. Selected coral reef statistics in ASEAN

ASEAN Member State	No. of Reef Fish Species*	No. Coral Species*
Brunei Darussalam	219	400
Cambodia	276	337
Indonesia	2,103	602
Lao PDR	-	-
Malaysia	820	568
Myanmar	299	277
Philippines	1,881	557
Singapore	319	186
Thailand	814	428
Viet Nam	1162	364

** Data above was taken from Fishbase (Froese and Pauly 2017) but Huang et al (2009) reported that there are 255 species of corals in Singapore*

4. Status and trends

Coral reefs

Except for landlocked Lao PDR, coral reefs abound in all AMS with the largest concentration of species located in insular or archipelagic Southeast Asia (Froese and Pauly 2017). The region has "the most extensive and diverse coral reefs in the world", which accounts for more than 28% (almost 70,000 km2)[43] of the global total and largely consist of fringing reefs (Burke et al. 2011, p.53). With Philippines on top and Malaysia and Indonesia at the base, a highly biodiverse region known as the Coral Triangle is formed. Biodiversity tapers off further away from this area (Veron et al. 2009). Table 44 provides some statistics on the coral reefs of AMS. The conditions of coral reefs are determined by the density of local populations with access to reefs; presence of markets; available transport, gear and storage technology; access to roads; and level of economic development (Brewer et al. 2012; Cinner et al. 2012; Williams et al. 2015; Maire et al. 2016). Aside from these factors, global warming is threatening the survival of coral reefs (Bruno and Valdivia 2016).

A growing coastal population and extant poverty in LECZ, alongside anthropogenic threats including overfishing, destructive fishing practices such as blast and poison fishing, sedimentation and pollution from human settlements and from agriculture, is threatening the reefs (Burke et al. 2011). Rapid urbanization, coastal industrialization, and expansion of the built-up environment also worsen the situation. Coral reef experts surveyed in a study agreed that overfishing and coastal development are the two key threats that should be addressed at a global scale to reverse the fate of coral reefs worldwide (Wear 2016). With deepening impacts of climate change, global environmental threats such as thermal stress due to increasing temperatures and CO2 concentrations have led to coral bleaching and ocean acidification, respectively (Burke et al. 2011).

43. In Wilkinson (2008), the region's reef area is about 91,700 km2.

IPCC's Assessment Report 5 (AR5) concluded that coral reefs are highly vulnerable to an additional warming of 2°C. The climatic and non-climatic factors that drive the health of coral reefs will degrade habitats, subject coastlines to increasing exposure to waves and storms and diminish the environmental features critical to fisheries and tourism. However, options to enable adaptation of coral reef systems are generally limited to reducing other stressors, such as managing water quality and reducing pressures from tourism and fishing. Even if these options are available, their efficacy will be severely reduced due to the increase in thermal stress and ocean acidification (IPCC 2014). Of late, "[C]oral reefs across the world's oceans are in the midst of the longest bleaching event on record (from 2014 to at least 2016)" claimed one recent study (Heron et al. 2016, p.1). This trend already has significant ramifications on the status of coral reefs worldwide with reports of reefs dying (Cave and Gillis 2017; Editorial Board 2017; Betacoros 2017). In Thailand, Indonesia and Malaysia, the coral bleaching episode in 2010 incurred a loss of about US$ 50 million to 80 million (Doshi et al. 2012).

As a result of these drivers of degradation, reefs in the ASEAN region are "the most threatened in the world", based on a 2011 risk assessment. Around 95% of the reefs suffer from high to very high categories of local threats (Burke et al. 2011, p.55). In 2008, an assessment by Wilkinson (2008) noted that 40% of the region's coral reefs are effectively lost, 20% are in critical conditions, and 25% threatened. Only 15% of the reefs have low threat levels.

Despite notable successes in introducing marine protected areas in the region, the threats continue and the impacts have been massive, with only remote reefs in relatively pristine conditions as shown by recent country level analyses. A survey by end of 2011 in Indonesia showed that only around 5.6% of coral reefs are in excellent condition (Asian Development Bank 2014b). In the Philippines, there are recent surveys being wrapped up at the time of writing of this chapter under the auspices of Ecofish and National Assessment of Coral Reefs for which the results will be presented in July 2017. In Malaysia, 184 transect surveys conducted by Reef Check Malaysia indicated that 48.11% of the reefs are in fair condition (Reef Check Malaysia 2015). Thailand's coral reefs suffered substantially from the coral reef bleaching event in 2010 as did Malaysia and Indonesia. As a result, live coral cover was reduced to an average of only about 22% at the six sites surveyed in the Andaman Sea in 2011 to 2012 (Phongsuwan et al. 2013).

It appears that there are no recent comprehensive national assessments of Viet Nam's reefs but some information exists for certain locations in the western South China Sea part of Viet Nam. In Ninh Hai, its fringing reefs are in relatively good condition with average live coral cover of more than 25% (Vo et al. 2014) but in Nha Trang Bay the reefs are severely degraded with coral cover reduced to 0.6% from 75% due to coastal development, dredging and dumping activities, overfishing and expansion of marine cage culture (Tkachenko et al. 2016). Singapore's coral reefs, although minuscule compared with other AMS, holds relatively diverse reef species (Huang et al. 2009) (Table 5.10). Although there have been no comprehensive biodiversity assessments of its reefs conducted, long-term monitoring has been made since 1986. These monitoring activities showed an overall decline in live coral cover and a reduction in the abundance of reef-associated invertebrates due to sedimentation (Chou et al. 2012). Among coastal AMS, Myanmar seems to have less studies on the status and issues of its reefs. Comprehensive assessment of Myanmar's coral reefs is non-existent but some information is available on some aspects of Myanmar's Andaman Sea coast, such as the impacts of storm damage on the reefs and discovery of some species of scleractinian coral (Krishnan et al. 2013; Tun and Bendell 2011).

Mangroves

ASEAN hosts the widest expanse of mangroves in the world (Hamilton and Casey 2016). Mangroves play important roles and provide for the livelihoods of the people who resides in and around these habitats. They also protect households and communities against storms. They provide food and materials for housing construction. They also serve as important breeding and nursery grounds for various fisheries, store carbon and play a host of other important ecological functions (Brander et al. 2012; Barbier 2016; Hogarth 2015; Sandilyan and Kathiresan 2015; Spalding 2010). While global patterns of mangrove deforestation have been decreasing since 2000, deforestation in ASEAN continues, but spread unevenly across the region. In 2000, Southeast Asia has more than 4.6 million ha of mangrove forests, but lost about 2% between 2000 and 2012 (Table 45). Deforestation rate occurs at an average of 0.18% per year (Table 45). Proximate drivers of mangrove deforestation are related to land use and land cover change caused by aquaculture, urbanization, forestry, agriculture, and oil palm plantations (Table 46). The impacts of each of these drivers on the rate of deforestation differ across the region and by year (Richards and Friess 2016).

Table 43. Status of mangroves in Southeast Asia

ASEAN Member State	Total mangrove in 2000 (ha)	Mangrove deforestation (ha)	Mangrove habitat area lost (ha)	Percentage mangrove loss 2000-2012 (%)
Indonesia	2,788,683.00	60,906.00	48,025.00	1.72
Myanmar	502,466.00	27,957.00	27,770.00	5.53
Malaysia	557,805.00	18,836.00	15,809.00	2.83
Thailand	245,179.00	3,504.00	3,344.00	1.36
Philippines	257,575.00	1,423.00	1,296.00	0.50
Cambodia	47,563.00	1,218.00	1,086.00	2.28
Viet Nam	215,154.00	531.00	528.00	0.25
Brunei Darussalam	11,054.00	48.00	41.00	0.37
Singapore	583.00	-	-	-
Southeast Asia	4,626,545.00	114,424.00	97,901.00	2.12

Source: Richards and Friess, 2016

The rate of mangrove conversion to aquaculture ponds declined from 2000, but rose to the pre-2000 level in 2010 and 2011. Pond conversion is now largely restricted to Kalimantan and Sulawesi in Indonesia. Rice field conversion climbed steadily during 2000 to 2009 but fell again in 2010. This form of conversion happens largely in the Rakhine state of Myanmar. The replacement of mangrove forests with oil palm, however, consistently increased from 2000 to 2012, but not widely known until recent studies, due to the assumption that oil palm is a terrestrial crop. This form of conversion is widely occurring in Malaysia and Sumatra and Borneo in Indonesia (Table 46). As a result, hotspots for deforestation in the region are the Rakhine state in Myanmar, Sumatra and Borneo in Indonesia, and Malaysia. The rate of deforestation there is higher than those in Thailand, Viet Nam and the Philippines, previously known hotspots of mangrove deforestation in the region. Indonesia has lost most habitats followed by Myanmar and Malaysia (Table 46) (Richards and Friess 2016). Deforestation rate in Indonesia is twice

the global average (Hamilton and Casey 2016). It is important to note that the case of Myanmar has not been known until recently and is considered a "frontier for mangrove deforestation" (Hamilton and Casey 2016, p.736).

Table 44. The rate of deforestation accounted for by each proximate driver of mangrove deforestation in Southeast Asia (2000 - 2012)

Country (ordered in terms of total mangroves lost)	Aquaculture	Rice	Oil palm	Mangrove forest	Urban	Other category
Indonesia	48.6	0.1	15.7	22.6	1.9	11.2
Myanmar	1.6	87.6	1.1	0.5	1.6	7.6
Malaysia	14.7	0.1	38.2	17.6	12.8	16.7
Thailand	10.8	5.6	40.0	5.1	14.4	24.1
Philippines	36.7	0.9	11.1	7.3	2.7	41.3
Cambodia	27.7	1.5	8.9	9.8	4.6	47.6
Viet Nam	21.0	10.4	0.5	0.6	62.5	4.9
Brunei Darussalam	29.2	-	27.7	12.5	15.9	14.8
Singapore	-	-	-	-	-	-
Total	29.9	21.7	16.3	15.4	4.2	12.3

Source: Richards and Friess, 2016

Seagrass meadows

Another important but underappreciated coastal ecosystem in ASEAN region is the seagrass meadows. Like that of corals and mangroves, ASEAN has also the most diverse seagrass ecosystem in the world (Green and Short 2003) with about 24 species especially in the Philippines, the centre of seagrass diversity (Short et al. 2001). Although seagrasses are not directly used like mangroves, they provide critical services to coastal ecosystems and inhabitants. These include providing shelter and nutrition to many commercially important species of mollusk, crustacean, and fish while also protecting coastlines and coastal communities from hazards by attenuating waves and currents (Hogarth 2015). Seagrass meadows have also shown strong potentials for carbon storage (Alongi et al. 2016; Russell et al. 2013). They also purify water, treat waste and have recreation, ecotourism, and educational values (Nakaoka et al. 2014). In the Coral Triangle, food security is tied to the integrity of seagrass meadows where seagrass associated fauna contribute at least 50% of the fish based food, which is equivalent to about 54% to 99% of daily protein intake (Unsworth, Hinder, et al. 2014).

Threats to the integrity of seagrass meadows are both natural and human created. Natural threats include damage due to cyclones and hurricanes as well as overgrazing by sea urchins or mollusks. Human created threats, the major threat of seagrasses, include dredging and reclamation from coastal construction where seagrasses are smothered with sediments preventing light penetration and eventually reducing photosynthesis (Hogarth 2015). A global consensus emerged that, although with some variations across different regions, urban/industrial runoff, urban/port infrastructure development, agricultural runoff and dredging are the primary drivers of destruction of seagrass meadows. The impacts of these largely land-based factors will be amplified with projected sea level rise and increases in the severity of cyclones, the key climate threats (Grech et al. 2012). Climate change, therefore, is a major long-term threat to the survival of seagrasses (Unsworth, Keulen, et al. 2014).

As result of these threats, seagrasses globally are threatened and its future uncertain unless there is a recognition of their values and contributions to humankind as well as concerted action (Bertelli and Unsworth 2014; Cullen-Unsworth and Unsworth 2013; Unsworth et al. 2015; Unsworth and Cullen 2010). Its loss is accelerating globally from a median of 0.9% per year before 1940 to 7% per year since 1990. A comprehensive global assessment showed that seagrasses have been disappearing at a rate of 110 km2 per year since 1980 and that 29% of the known areal extent has disappeared since record began in 1879 of seagrass areas (Waycott et al. 2009). Furthermore, a risk assessment reported that 10 seagrass species are at elevated risk of extinction (14% of all seagrass species) and three species are already endangered (Short et al. 2011). In the coastal Asian region in general, the ability of seagrass meadows to provide for food is declining due to overfishing and degraded due to pollution and land development. Its regulation services (eg, climate regulation, erosion regulation, and water purification) are also diminishing (Nakaoka et al. 2014). The ASEAN region has extensive seagrass meadows but are unmapped and a regional understanding of its status remains incomplete (Duarte et al. 2008). In fact, most of the studies on seagrasses in the region are done in only a few sites such as Northwest Luzon in the Philippines and South Sulawesi in Indonesia (Ooi et al. 2011).

Marine litter pollution

The problem of marine litter, or marine debris, pollution has recently gained attention worldwide specifically in the ASEAN region with reports of floating islands of garbage sighted at sea recently made headlines (Barker 2017; Rujivanarom 2017; The Nation 2017). Any visitor to the region's beaches and islands will encounter litter, especially plastics, of various kinds strewn all over. But the problem of marine debris pollution is global (Arthur et al. 2014; Barnes et al. 2009; Eriksen et al. 2014; Gross 2013; Jambeck et al. 2015). It is widespread and found on the water surface, water column and even remote ocean floors while some, such as microplastics, are found ingested by zooplanktons (Sussarellu et al. 2016; Hüffer et al. 2017; Pham et al. 2014). It is becoming "one of the fastest-growing threats to the health of the world's oceans", according to the first World Oceans Assessment (Group of Experts and the Pool of Experts 2016a, p.1), and a major planetary boundary threat alongside climate change, ozone depletion, and ocean acidification (Galloway and Lewis 2016).

Anything that is "persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment" is considered a marine litter (UNEP 2009, p.13). Plastics coming from land, accounting for 80%, is the main source of marine litter (Jambeck et al. 2015). Jambeck et al (2015) calculated that there are 275 million metric tons (MT) of plastic waste generated in 192 coastal countries in 2010, with 4.8 to 12.7 million MT entering the ocean. There are also more than 5 trillion particles weighing 268,940 tons afloat at sea (Eriksen et al. 2014). The lack of proper disposal (or mismanagement) of plastic wastes at their source is a major reason why they have polluted the seas. As discussed in Section 2.6, waste management is a major problem in the region and one that will have serious ramifications on the health of our oceans if nothing is done. The top 20 countries ranked by size of mismanaged plastic waste include six AMS (Table 46). This shows that the region is an overwhelming source of global marine litter pollution and the news coming from Thailand in early 2017 (Barker 2017; Rujivanarom 2017; The Nation 2017) are proof that it is an obvious and urgent ASEAN concern.

Table 45. Waste estimates for 2010 of AMS who are in the top 20 countries ranked by mass of mismanaged plastic waste (in units of millions of metric tons per year)

Global Rank	Country	Waste gen. rate [kg/ppd]	% plastic waste	% mismanaged waste	Mismanaged plastic waste [MMT/year]	% of total mismanaged plastic waste	Plastic marine debris [MMT/year]
2	Indonesia	0.52	11	83	3.22	10.1	0.48–1.29
3	Philippines	0.50	15	83	1.88	5.9	0.28–0.75
4	Viet Nam	0.79	13	88	1.83	5.8	0.28–0.73
6	Thailand	1.20	12	75	1.03	3.2	0.15–0.41
8	Malaysia	1.52	13	57	0.94	2.9	0.14–0.37
17	Myanmar	0.44	17	89	0.46	1.4	0.07–0.18

Source: Jambeck et al., 2015

The impacts of marine litter pollution on marine and coastal ecosystems have already been reported and well documented. Sea turtles, marine mammals and seabirds are known to ingest or get entangled by marine debris leading to physical deformities and other problems (Wilcox et al. 2015; Kühn et al. 2015). Many more marine life are affected by anthropogenic marine litter (Bergman et al. 2015).

Marine litter pollution is further worsened when discarded plastic waste breaks down into microscopic and nanoscopic fragments, known as microplastics. There are grounds to be worried about microplastics as their size range overlaps with the preferred particle size animals at the base of the marine food web ingest. This means that they are easily taken in by detritus, suspension, and filter feeders which will lead to uptake and transfer of the plastics themselves and any chemicals they harbor or absorbed from seawater across the trophic pyramid. These chemicals could be harmful to commercially or ecologically important species (Galloway and Lewis 2016) or will have detrimental impacts on major fisheries as they bioaccumulate in the food chain (Li, Tse, et al. 2016). For example, the ingestion of microplastics has affected the reproduction of oysters (Sussarellu et al. 2016) and the energy budgets in crabs (Watts et al. 2015). The problem of microplastic pollution is expected to rise due to the huge amount of plastic waste already in the ocean and the predicted increase of plastic manufacturing globally to 33 billion tons by 2050 (Katsnelson 2015). In China, the number one producer of plastic waste (Jambeck et al. 2015), microplastic pollution has already contaminated table salts (Yang et al. 2015), mussels (Li, Qu, et al. 2016), and fish (Jabeen et al. 2017).

Table 46. Climate change vulnerability of countries with the largest poor rural LECZ populations

Country	Direct impacts			
	% of coastal GDP exposed	% of coastal agricultural area exposed	% of coastal wetlands area impacted	Vulnerability to climate change impacts on fisheries
Myanmar	48.90%	22.90%	50.20%	–
Cambodia	2.70%	1.00%	1.50%	High
Indonesia	38.70%	26.10%	27.00%	Moderate
Philippines	52.30%	30.70%	45.00%	Low
Vietnam	31.70%	23.80%	29.40%	High
Thailand	31.60%	11.60%	14.70%	Low

Source: Barbier, 2015

Note: The low elevation coastal zone (LECZ) is the contiguous area along the coast that is less than 10 m above sea level. Data for % of coastal GDP, agricultural area and wetlands exposed to a 1 meter (m) sea-level rise accompanied by a 10% intensification of storm surges are from Dasgupta, S., Laplante, B., Murray, S. and Wheeler, D. 2009. "Sea-Level Rise and Storm Surges: A Comparative Analysis of Impacts in Developing Countries." Policy Research Working Paper 4901, the World Bank, Washington, D.C. April. Data on vulnerability of fisheries from Allison, E.H., Perry, A.L., Badjeck, M-C., Adger, W.N., Brown, K., Conway, D., Halls, A.S., Pilling, G.M., Reynolds, J.D., Andrew, N.L. and Dulvy, N.K., 2009. "Vulnerability of national economies to the impacts of climate change on fisheries." Fish and Fisheries 10:173e196. For the 132 countries, "high" is for the upper quartile (highest vulnerability), "moderate" for the second quartile, "low" for the third quartile, and "very low" for the bottom quartile.

5. Impacts

The status and trends described above will continue to result in a range of impacts on coastal and marine ecosystems and the social and economic well-being of the wider population in ASEAN, but more so among its coastal inhabitants. Biodiversity has been diminished, coastal protection eroded, cultural and heritage values degraded, and the full utilization of the recreational values of the region's resources remains unfulfilled. The degradation of coastal habitats, reduction in ecosystem integrity and biodiversity loss has led to the over-fished state of coasts and oceans in ASEAN (Teh et al. 2016).

Of the six AMS with the largest poor and rural LECZ populations, only Cambodia will have limited impacts on its coastal GDP as a function of its size (Table 48). Cambodia has smaller LECZ compared with these countries (see Table 39). In comparison, Philippines, Myanmar, Indonesia, Viet Nam and Thailand will be heavily exposed. Similarly, climate change will have direct impacts on coastal agricultural areas of these countries with 11 to 31% of coastal agricultural areas exposed (Table 46). Climate change will also have significant direct impacts on the coastal wetlands of these countries and their fisheries, especially in the agricultural areas in LECZ and wetlands ecosystems. These will hurt the poor the most, as poverty is high in these regions and people are dependent on these ecosystems for their livelihoods so much so that enabling adaptation and resilience building measures will be critical to protect their well-being.

Hallegate et al (2013) modelled the impacts of future flood losses due to sea level rise and land subsidence of 136 coastal port cities using various scenarios. Ten cities[44] in

44. These are Bangkok, Jakarta, Ho Chi Minh City, Hai Phong, Palembang, Manila, Rangoon, Surabaya, Kuala Lumpur, Ujung Panjang, Davao and Singapore.

ASEAN were included. A 100-year flooding, without taking into consideration sea level rise, will lead to massive losses for Bangkok and HCMC. But with a sea level rise of 20 cm, subsidence, and if no adaptation is made, Bangkok and Jakarta will suffer the most. However, considering the ability to adapt and existing adaptation interventions (i.e., coastal defenses), HCMC will suffer more with a mean annual loss of 0.83% of the city's GDP equivalent to about $1,953 million (Table 49). This ranking is the fourth highest after Guayaquil, New Orleans and Guangzhou. It is not only this city that will be affected by sea level rise and land subsidence but also its neighbouring Mekong delta, the region's largest delta and Viet Nam's key agricultural producing area, will also suffer from increasing salinity (Smajgl et al. 2015).

The rural coastal poor are facing a poverty-environment trap with high rates of infant mortalities and undernourishment among rural LECZs in ASEAN, the high dependence of coastal families on coastal resources, their lack of assets, and the threat of climate change. Without appropriate and successful interventions, people in rural LECZs will further degrade the environment and overexploit the resources, while also diminishing their resilience to future hazards (Barbier 2015). As Jevrejeva et al. (2016) demonstrated and as discussed above, sea level rise and other coastal hazards such as storm surges, coastal erosion and salt-water intrusion will lead to livelihood disruptions, loss of resilience of households, and eventually displacement of coastal inhabitants in ASEAN. Together with intrinsic in situ social and developmental vulnerabilities, climate change impacts will contribute to marine and coastal resource degradation, which will lead to declines in productivity and incomes. In turn, this will drive coastal households to search for more work and other alternative income sources. Their presence in greater numbers within a particular location will likely depress wages. When wages are low or falling, coastal households will eke out supplemental living by exploiting more coastal and marine resources leading to further resource degradation. The cycle continues until the trap is disrupted (cf. Barbier 2015).

6. Responses

As can be gathered from the analyses of drivers and pressures on the status and trend of the coastal and ocean environments in the region, appropriate and scale-specific responses are clearly necessary. The region needs to think holistically and act locally. Climate change alongside population growth, economic development and rapid urbanization will put coastal systems and the societies that depend on them at risk (IPCC 2014). In light of the magnitude and manifold challenges in governing the coastal zone and oceans in ASEAN, Chua Thia Eng (Chua 2013, p.99) counseled "that the complexity of managing coasts, seas, and oceans in a sustainable manner requires a comprehensive, integrative, and coordinated approach in terms of policy, legislation, institutional arrangement, financial investment, management measures, stakeholders support, and participation".

Table 47. Projected impacts in 2050 of sea level rise and land subsidence in key coastal cities in ASEAN with an optimistic scenario (20 cm sea level rise by 2050)

Urban Agglomeration	No change in sea level					20cm sea level rise and subsidence (no adaptation)		20 cm sea level rise and subsidence (adaptation at constant probability, adaptation scenario P0 (present design)		
	100-yr exposition (M$)	100-yr losses with no protection (M$)	Protection level in 2005 (return period in years)	Mean annual loss (M$)	Mean annual loss (% city GDP)	Mean annual loss (M$)	Mean increase due to SLR and subsidence	Mean annual loss (M$)	Mean annual loss (% city GDP)	Mean increase due to SLR and subsidence
Bangkok	49,065	16,462	50	596	0.07%	20,778	3387%	734	0.09%	23%
Jakarta	9,577	2,553	10	1,139	0.14%	16,354	1336%	1,750	0.22%	54%
Ho Chi Minh City	42,093	20,216	50	1,743	0.74%	7,335	321%	1,953	0.83%	11%
Hai Phòng	14,283	4,728	50	320	0.37%	6,209	941%	383	0.44%	30%
Palembang	2,612	934	10	418	0.39%	4,764	1040%	506	0.48%	21%
Manila	2,339	872	10	254	0.05%	2,846	1019%	329	0.06%	29%
Rangoon	4,177	1,387	10	163	0.17%	1,818	1017%	202	0.21%	24%
Surabaya	727	163	10	80	0.04%	1,052	1222%	110	0.06%	39%
Kuala Lumpur	19,437	6,696	100	56	0.03%	253	355%	63	0.04%	13%
Makassar	156	33	10	11	0.01%	67	515%	12	0.02%	12%
Davao	61	22	10	5	0.01%	56	921%	6	0.01%	7%
Singapore	3,412	2,020	2000	2	0.00%	27	1222%	2	0.00%	3%

Adapted from Hallegatte et al. 2013

Note:

- In 2050, without sea level rise and with 20 cm of sea level rise and subsidence (40cm in cities prone to subsidence)
- With socio-economic change, and city population limited to 35 million inhabitants
- The protection level is taken at its optimistic bound (maximum protection).

Despite the enormity of the problems affecting the coastal and oceanic resources in ASEAN, several efforts are underway to respond to the challenges of coastal and ocean resources management in the region. One important outcome that ASEAN should undertake is the establishment of transboundary marine protected areas (MPAs) such as the Sulu-Sulawesi Ecoregion under the ASEAN Heritage Parks Programme. Others are set up under the UNESCO-Man and Biosphere, UNESCO World Heritage Convention, the Ramsar Convention, and as required by the Convention on Biological Diversity. These MPAs have been responsible for replenishing depleted fish stocks in the region. More parks should be created especially in areas in shared jurisdictions such as the Spratly Islands (McManus 1994; McManus et al. 2010; Mackelworth 2012).

Table 48. Coverage of existing marine protected areas in ASEAN Member States based on data available at the World Database on Protected Areas (WDPA) as of May 2017

ASEAN Member State	Total Marine Area (KM^2)	Marine Area Protected (km^2)	Coverage (%)
Brunei Darussalam	25,698.40	52.00	0.20
Cambodia	47,966.90	89.00	0.19
Indonesia	5,947,954.20	171,453.00	2.88
Lao PDR	-	-	-
Malaysia	451,741.50	6,357.44	1.41
Myanmar	514,147.20	558.69	0.11
Philippines	1,835,028.00	21,269.00	1.16
Singapore	762.70	-	-
Thailand	306,890.50	5,774.00	1.88
Viet Nam	647,232.20	3,630.00	0.56

Source: IUCN and UNEP-WCMC, 2017

At national levels, efforts, in both policy and project levels, are ongoing to manage the coastal and ocean environments in the region especially among key coastal states in AMS. In the Philippines, integrated coastal management (ICM) is an important policy framework guiding interventions in the coastal and marine environments. Two major initiatives are going to implement ICM: National Integrated Coastal Management Program; and, Sustainable Coral Reef Management Program. In Indonesia, a Draft of Government Regulation for the Protection and Management of Mangrove, Seagrass Field and Coral Reef Ecosystems was proposed and reported in Indonesia's 2013 State of the Environment Report (Ministry of Environment, Indonesia 2013a). The Viet Nam Coastal Resources for Sustainable Development Project is currently being implemented with funding provided by the World Bank and GEF. In Thailand, a Promotion of Marine and Coastal Resources Management Act has recently been passed.

Despite these developments, only less than 2% of marine areas in the region have been declared as MPAs so far (IUCN and UNEP-WCMC 2017) (Table 50). Although having MPAs is just one way to protect and conserve the marine environment (Boonzaier and Pauly 2015), existing MPAs in ASEAN are way below the target required in Aichi Target 11 to effectively conserve at least 10% of coastal and marine areas by 2020.

Broadly, the region needs to recognize the complexity of the problem and develop regional solutions accordingly. While we can identify challenges, a coherent and effective regional response is needed now built on the lessons and insights from past and ongoing initiatives. As discussed above, global environmental change is only one of the drivers leading to current state of the coasts and oceans in the regions. The state of coasts and oceans is driven by demographic, social, political and economic factors. As a result, we need to take a system's perspective (Brown et al. 2014) in responding to the challenge. There has been a number of assessments and management plans on the state of coastal and marine resources in ASEAN formulated, but very few actually implemented (Chua 2013).

Box 15. Turtle Islands

Turtle Islands is part of the Sulu Archipelago. It is composed of approximately 400 islands of varying shapes and sizes and located at the southwestern tip of the Philippines, about 1,000 km southwest of Manila. It is the only major nesting habitat of Green sea turtles (Chelonia mydas) in the Philippines and the only major nesting ground in the whole ASEAN Region and the 11th major nesting site in the world.

The Republic of the Philippines and the Government of Malaysia was signed a Memorandum of Agreement (MOA) on May 31, 1996 declaring Turtle Islands as Turtle Islands Heritage Protected Area (TIHPA). It is the first transboundary protected area on sea turtles in the world aiming for the conservation and protection of the area.

As of this writing, we are beginning to see regional efforts directed at managing future risks (e.g., ASEAN Agreement on Disaster Management and Emergency Response); protecting key marine features (Coral Triangle Initiative and Sulu-Sulawesi Marine Ecoregion); enabling integrated development (e.g., Mangroves for the Future); conserving important species (e.g., Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and national endangered species laws and the Indian Ocean-Southeast Asia Marine Turtle Memorandum of Understanding for marine turtles); managing fisheries and combatting IUU fishing, and managing the coastal and marine environment (e.g, Partnerships in Environmental Management for the Seas of East Asia, PEMSEA).

Attention for IUU fishing is gaining momentum and there are several regional initiatives to address the issue. Some of these initiatives are listed below:

- FAO and Global Environment Facility (GEF) project Strategies for Trawl Fisheries Bycatch Management (REBYC-II CTI)
- ASEAN Food, Agriculture and Forestry, the Vision and Strategic Plan (2016-2025)
- ASEAN Sectoral Working Group on Fisheries
- ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain
- ASEAN Catch Documentation Scheme for Marine Capture Fisheries]
- Joint ASEAN-SEAFDEC Declaration on Regional Cooperation for Combating IUU Fishing and Enhancing the Competitiveness of ASEAN Fish and Fishery Products
- ASEAN Level
    - o ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain;
    - o Regional Fishing Vessels Record for Vessels 24 Meters in Length and Over (RFVR-24 m);
    - o Regional Plan of Action for Management of Fishing Capacity;
    - o Implementation of the Port State Measures in the ASEAN Region
- USAID Oceans and Fisheries Partnership

What is important to note is that addressing IUU fishing needs collaboration across countries not only in the region but also those who share our oceans. Furthermore, as ASPEN is shaped and implemented moving forward, ASEAN should enable a closer collaboration between the Environment and Fisheries working groups to ensure that there are complementarities in their interventions from the perspective of conservation, management and wise use of the region's coasts and oceans. Both working groups may develop complementary outputs and outcomes which they will monitor regularly so as not to duplicate efforts but build on each other's strengths and mandates.

To help protect shared marine waters in the region, ASEAN has adopted the ASEAN Marine Water Quality Criteria (AMWQC) in 2002. Seventeen parameters were unanimously agreed and adopted as ASEAN common marine water quality for the protection of the coastal and marine environment and human health. Following the adoption of the AMWQC, ASEAN published the ASEAN Marine Water Quality Criteria: Management Guidelines and Monitoring Manual in 2008. The ASEAN Mechanism to Enhance Surveillance against Desludging and Disposal of Tanker Sludge at Sea was also adopted by ASEAN Environment Ministers during the 11th ASEAN Ministerial Meeting on the Environment (AMME) in October 2009. The objective of the Mechanism is to ensure coordinated

efforts among ASEAN Member States in controlling tanker desludging activities and in promoting proper disposal of the tanker sludge at approved disposal facilities.

An important response moving forward is to assess how far existing efforts are addressing critical regional concerns while addressing the known gaps. In other words, we need to ensure that responses sufficiently affect or impact on outcomes. Different policy interventions need to be recommended and formulated depending on the proximate driver of ecosystem change in a particular locality. This means that, while a regional action is needed to drive the required change forward and to ensure cross-border sharing of information, national and sub-national actors also need to act together to determine the right course of action based on their appreciation and understanding of the causes that led to environmental and ecosystem change. At the end of the day, actions need to be driven by the citizens of the region, with ASEAN itself through the Secretariat and its other instrumentalities playing a supporting but proactive role.

7. References

Agnew, D. J., Pearce, J., Pramod, G., Peatman, T., Watson, R., Beddington, J. R. and Pitcher, T. J. (2009) 'Estimating the worldwide extent of illegal fishing'. *PloS one*, 4(2). e4570.

Alongi, D. M., Murdiyarso, D., Fourqurean, J. W., Kauffman, J. B., Hutahaean, A., Crooks, S., Lovelock, C. E., Howard, J., Herr, D. and Fortes, M. (2016) 'Indonesia's blue carbon: a globally significant and vulnerable sink for seagrass and mangrove carbon'. *Wetlands Ecology and Management*, 24(1). 3–13.

Anderson, S. C., Flemming, J. M., Watson, R. and Lotze, H. K. (2011) 'Serial exploitation of global sea cucumber fisheries'. *Fish and Fisheries*, 12(3). 317–39.

Arthur, C., Sutton-Grier, A. E., Murphy, P. and Bamford, H. (2014) 'Out of sight but not out of mind: harmful effects of derelict traps in selected U.S. coastal waters.' *Marine Pollution Bulletin*, 86(1-2). 19–28.

ASEAN Centre for Biodiversity (2017) *ASEAN Biodiversity Outlook (2nd Ed.).* Philippines.

ASEAN Centre for Biodiversity (2014) *Stats & Stories: Storytelling for Biodiversity. Southeast Asia & Beyond*. ASEAN Centre for Biodiversity.

ASEAN Secretariat and UNCTAD (2016) *ASEAN Investment Report 2016*. *Foreign Direct Investment and MSME Linkages*. ASEAN Secretariat, Jakarta.

Asian Development Bank (2014a) *Coral Triangle Marine Resources: Their Status, Economies, and Management*. Asian Development Bank, Manila.

Asian Development Bank (2014b) *State of the Coral Triangle: Indonesia*. Asian Development Bank.

Atienza, M. E., Eadie, P. and Tan-Mullins, M. (2015) *Poverty Alleviation in the Wake of Typhoon Yolanda Workshop Findings: Working Paper I*. Poverty Alleviation in the Wake of Typhoon Yolanda.

Balatsky, E. V. (2013) 'Institutional and Technological Traps'. *Problems of Economic Transition*, 56(2). 3–25.

Balk, D., Montgomery, M., McGranahan, G., Kim, D., Mara, V., Todd, M., Buettner, T. and Dorelien, A. (2009) 'Mapping urban settlements and the risks of climate change in Africa, Asia and South America'. *Population dynamics and climate change*, J. M. Guzmán, G. Martine, G. McGranahan, D. Schensul, and C. Tacoli (eds.). United Nations Population Fund, New York. 80–103.

Barbier, E. B. (2016) 'The protective service of mangrove ecosystems: A review of valuation methods.' *Marine Pollution Bulletin*, 109(2). 676–81.

Barbier, E. B. (2015) 'Climate change impacts on rural poverty in low-elevation coastal zones'. *Estuarine, Coastal and Shelf Science*, 165. A1–13.

Barker, D. (2017) 'Ocean of trash: An "island" of garbage is moving in on Thailand's tourist resorts'. *Natural News*. 2017-02-16-ocean-of-trash-an-island-of-garbage-is-moving-in-on-thailands-tourist-resorts.html.

Barnes, D. K., Galgani, F., Thompson, R. C. and Barlaz, M. (2009) 'Accumulation and fragmentation of plastic debris in global environments'. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1526). 1985–98.

Bergman, M., Gutow, L. and Klages, M. (2015) *Marine Anthropogenic Litter*. Springer, Dordrecht.

Bertelli, C. M. and Unsworth, R. K. F. (2014) 'Protecting the hand that feeds us: seagrass (Zostera marina) serves as commercial juvenile fish habitat.' *Marine Pollution Bulletin*, 83(2). 425–29.

Betacoros, E. (2017) 'More than 90 percent of coral reefs will die out by 2050'. *The Independent*, 13 March. http://www.independent.co.uk/environment/environment-90-percent-coral-reefs-die-2050-climate-change-bleaching-pollution-a7626911.html.

Blaber, S. J., Cyrus, D. P., Albaret, J.-J., Ching, C. V., Day, J. W., Elliott, M., Fonseca, M. S., Hoss, D. E., Orensanz, J. and Potter, I. C. (2000) 'Effects of fishing on the structure and functioning of estuarine and nearshore ecosystems'. *ICES Journal of Marine Science*: *Journal du Conseil*, 57(3). 590–602.

Boonzaier, L. and Pauly, D. (2015) 'Marine protection targets: an updated assessment of global progress'. *Oryx*, 50(01). 27–35.

Brander, L., J. Wagtendonk, A., S. Hussain, S., McVittie, A., Verburg, P. H., de Groot, R. S. and van der Ploeg, S. (2012) 'Ecosystem service values for mangroves in Southeast Asia: A meta-analysis and value transfer application'. *Ecosystem Services*, 1(1). 62–69. doi:10.1016/j.ecoser.2012.06.003.

Brewer, T. D., Cinner, J. E., Fisher, R., Green, A. and Wilson, S. K. (2012) 'Market access, population density, and socioeconomic development explain diversity and functional group biomass of coral reef fish assemblages'. *Global Environmental Change*, 22(2). 399–406. doi:10.1016/j.gloenvcha.2012.01.006.

Brown, S., Nicholls, R. J., Hanson, S., Brundrit, G., Dearing, J. A., Dickson, M. E., Gallop, S. L., Gao, S., Haigh, I. D. and Hinkel, J. (2014) 'Shifting perspectives on coastal impacts and adaptation'. *Nature Climate Change*, 4(9). 752–55.

Bruno, J. F. and Valdivia, A. (2016) 'Coral reef degradation is not correlated with local human population density.' *Scientific Reports*, 6. 29778.

Burke, L., Reytar, K., Spalding, M. and Perry, A. (2011) *Reefs at Risk Revisited*. World Resources Institute.

Byrne, D. R. (2013) 'Gateway and garden: a kind of tourism in Bali'. *Heritage and tourism place, encounter, engagement*, R. Staiff, R. Bushell, and S. Watson (eds.). Routledge, London. 26–44.

Campana, S. E., Ferretti, F. and Rosenberg, A. (2016) 'Sharks and other elasmobranchs'. *The first global integrated marine assessment*, *World Ocean Assessment I, United Nations*, . 1437–51.

Campbell, S. J., Cinner, J. E., Ardiwijaya, R. L., Pardede, S., Kartawijaya, T., Mukmunin, A., Herdiana, Y., Hoey, A. S., Pratchett, M. S. and Baird, A. H. (2012) 'Avoiding conflicts and protecting coral reefs: customary management benefits marine habitats and fish biomass'. *Oryx*, 46(04). 486–94. doi:10.1017/S0030605312000348.

Cave, D. and Gillis, J. (2017) 'Large Sections of Australia's Great Reef Are Now Dead, Scientists Find'. *The New York Times*, 15 March. https://www.nytimes.com/2017/03/15/science/great-barrier-reef-coral-climate-change-dieoff.html.

Cazenave, A. and Cozannet, G. L. (2014) 'Sea level rise and its coastal impacts'. *Earth's Future*, 2(2). 15–34.

Chaussard, E., Amelung, F., Abidin, H. and Hong, S.-H.-. H. (2013) 'Sinking cities in Indonesia: ALOS PALSAR detects rapid subsidence due to groundwater and gas extraction'. *Remote Sensing of Environment*, 128. 150–61.

Chelliah, A. J., Chen, S. Y., Amri, A. Y., Adzis, K. A. A. and Hyde, J. (2015) 'Status of reefs in selected Southeast Asia countries'. *Platax*, 12. 39–49.

Chou, L. M., Toh, K. B., Tay, Y. C. and Phang, V. X. H. (2012) 'Coral reefs in Singapore: past, present and future'. *Proceedings of the 2012 Asian Conference on Sustainability*, Energy and the Environment , Osaka, Japan.

Chua, T.-E. (2013) 'Coastal and Ocean Governance in the Seas of East Asia: PEMSEA's Experience'. *Coastal Management*, 41(2). 99–119.

Cinner, J. (2014) 'Coral reef livelihoods'. *Current Opinion in Environmental Sustainability*, 7. 65–71.

Cinner, J. E., McClanahan, T. R., Graham, N. A. J., Daw, T. M., Maina, J., Stead, S. M., Wamukota, A., Brown, K. and Bodin, O. (2012) 'Vulnerability of coastal communities to key impacts of climate change on coral reef fisheries'. *Global Environmental Change*, 22(1). 12–20. doi:10.1016/j.gloenvcha.2011.09.018.

Cochard, R., Ranamukhaarachchi, S. L., SHIVAKOTI, G. P., Shipin, O. V., Edwards, P. J. and Seeland, K. T. (2008) 'The 2004 tsunami in Aceh and Southern Thailand: A review on coastal ecosystems, wave hazards and vulnerability'. *Perspectives in Plant Ecology, Evolution and Systematics*, 10(1). 3–40. doi:10.1016/j.ppees.2007.11.001.

Co, E. E. A., Pamintuan, M. J. B. and Dino, L. M. F. (2016) *Building Back Better: A Democratic Accountability Assessment of Service Delivery after Typhoon Haiyan*. University of the Philippines Center for Integrative and Development Studies.

Cole, S. (2012) 'A political ecology of water equity and tourism: a case study from Bali'. *Annals of Tourism Research*, 39(2). 1221–41. doi:10.1016/j.annals.2012.01.003.

Cullen-Unsworth, L. and Unsworth, R. (2013) 'Seagrass meadows, ecosystem services, and sustainability'. *Environment: Science and Policy for Sustainable Development*, 55(3). 14–28.

Cullis-Suzuki, S. and Pauly, D. (2010) 'Failing the high seas: A global evaluation of regional fisheries management organizations'. *Marine Policy*, 34(5). 1036–42. doi:10.1016/j.marpol.2010.03.002.

Decker, C. S. and Reuveny, R. (2005) 'Endogenous Technological Progress and the Malthusian Trap: Could Simon and Boserup Have Saved Easter Island?' *Human Ecology*, 33(1). 119–40. doi:10.1007/s10745-005-1657-z.

de Sherbinin, A., Levy, M., Adamo, S., MacManus, K., Yetman, G., Mara, V., Razafindrazay, L., Goodrich, B., Srebotnjak, T., Aichele, C. and Pistolesi, L. (2012) 'Migration and risk: net migration in marginal ecosystems and hazardous areas'. *Environmental Research Letters*, 7(4). 045602. doi:10.1088/1748-9326/7/4/045602.

Dirhamsyah (2012) 'IUU fishing in Indonesia's live reef fisheries'. *Australian Journal of Maritime & Ocean Affairs*, 4(2). 44–52.

Dolezal, C. and Trupp, A. (2015) 'Tourism and Development in Southeast Asia'. *Austrian Journal of South-East Asian Studies*, 8(2). 117–24.

Doshi, A., Pascoe, S., Thébaud, O., Thomas, C. R., Setiasih, N., Hong, J. T. C., True, J., Schuttenberg, H. Z. and Heron, S. F. (2012) 'Loss of economic value from coral bleaching in SE Asia'.

Duarte, C. M., Borum, J., Short, F. T., Walker, D. and Polunin, N. (2008) 'Seagrass ecosystems: their global status and prospects'. Aq*uatic ecosystems: trends and global prospects* Cambridge University Press, Cambridge.

Editorial Board (2017) 'The Great Barrier Reef is dying'. *The Washington Post*, 19 March. https://www.washingtonpost.com/opinions/the-great-barrier-reef-is-dying/2017/03/19/a1e1277a-0b37-11e7-93dc-00f9bdd74ed1_story.html?utm_term=.3374fa4ff074.

Erban, L. E., Gorelick, S. M. and Zebker, H. A. (2014) 'Groundwater extraction, land subsidence, and sea-level rise in the Mekong Delta, Viet Nam'. *Environmental Research Letters*, 9(8). 084010.

Eriksen, M., Lebreton, L. C., Carson, H. S., Thiel, M., Moore, C. J., Borerro, J. C., Galgani, F., Ryan, P. G. and Reisser, J. (2014) 'Plastic pollution in the world's oceans: more than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea'. *PloS one*, 9(12). e111913.

Erkens, G., Bucx, T., Dam, R., De Lange, G. and Lambert, J. (2015) 'Sinking coastal cities'. *Proceedings of the International Association of Hydrological Sciences*, 372. 189–98.

Estoque, R. C., Murayama, Y. and Myint, S. W. (2017) 'Effects of landscape composition and pattern on land surface temperature: An urban heat island study in the megacities of Southeast Asia.' *Science of the Total Environment*, 577. 349–59.

FAO (2016) *The State of World Fisheries and Aquaculture* - 2016. FAO, Rome. http://www.fao.org/3/a-i5555e.pdf.

Field, J. (2017) 'What is appropriate and relevant assistance after a disaster? Accounting for culture (s) in the response to Typhoon Haiyan/Yolanda'. *International Journal of Disaster Risk Reduction*, . doi:https://doi.org/10.1016/j.ijdrr.2017.02.010.

Fragkias, M., Güneralp, B., Seto, K. and Goodness, J. (2013) 'A Synthesis of Global Urbanization Projections'. *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities A Global Assessment*, T. Elmqvist, M. Fragkias, J. Goodness, B. Güneralp, P. J. Marcotullio, R. I. McDonald, S. Parnell, M. Schewenius, M. Sendstad, K. C. Seto, and C. Wilkinson (eds.). Springer Netherlands, Dordrecht. 409–35.

Franke, M. (2014) *When One Country's Land Gain Is Another Country's Land Loss… The Social, Ecological and Economic Dimensions of Sand Extraction in the Context of World-Systems Analysis Exemplified by Singapore's Sand Imports*. HWR Berlin, Berlin.

Froese, R. and Pauly, D. (2017) 'Fishbase'. www.fishbase.org.

Galloway, T. S. and Lewis, C. N. (2016) 'Marine microplastics spell big problems for future generations.' *Proc Natl Acad Sci U S A*, 113(9). 2331–33.

Grech, A., Chartrand-Miller, K., Erftemeijer, P., Fonseca, M., McKenzie, L., Rasheed, M., Taylor, H. and Coles, R. (2012) 'A comparison of threats, vulnerabilities and management approaches in global seagrass bioregions'. *Environmental Research Letters*, 7(2). 024006.

Green, T. and Short, F. (2003) *World Atlas of Seagrasses*. University of California Press, Berkeley.

Grimm, N. B., Faeth, S. H., Golubiewski, N. E., Redman, C. L., Wu, J., Bai, X. and Briggs, J. M. (2008) 'Global change and the ecology of cities'. *science*, 319(5864). 756–60.

Gross, M. (2013) 'Plastic waste is all at sea'. *Current Biology*, 23(4). R135–37.

Group of Experts and the Pool of Experts (2016a) 'Chapter 25. Marine Debris'. *The First Global Integrated Marine Assessment*. *World Ocean Assessment I* United Nations.

Group of Experts and the Pool of Experts (2016b) *The First Global Integrated Marine Assessment. World Ocean Assessment I*. United Nations.

Hallegatte, S., Green, C., Nicholls, R. J. and Corfee-Morlot, J. (2013) 'Future flood losses in major coastal cities (Supplementary Information)'. *Nature Climate Change*, 3(9). 802–6. doi:10.1038/nclimate1979.

Hamilton, S. E. and Casey, D. (2016) 'Creation of a high spatio-temporal resolution global database of continuous mangrove forest cover for the 21st century (CGMFC-21)'. *Global Ecology and Biogeography*, 25(6). 729–38.

Hand, M. (2015) 'Malacca Strait traffic hits an all time high in 2014, VLCCs and dry bulk lead growth'. http://www.seatrade-maritime.com/news/asia/malacca-strait-traffic-hits-an-all-time-high-in-2014-vlccs-and-dry-bulk-lead-growth.html.

Harkes, I. and Novaczek, I. (2002) 'Presence, performance, and institutional resilience of sasi, a traditional management institution in Central Maluku, Indonesia'. *Ocean & coastal management*, 45(4). 237–60.

Heron, S. F., Maynard, J. A., Hooidonk, R. van and Eakin, C. M. (2016) 'Warming Trends and Bleaching Stress of the World's Coral Reefs 1985-2012.' *Sci Rep*, 6. 38402.

Hijioka, Y., Lin, E., Pereira, J. J., Corlett, R. T., Cui, X., Insarov, G., Lasco, R., Lindgren, E. and Surjan, A. (2014) 'Asia'. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastandrea, and L. L. White (eds.). Cambridge University Press, Cambridge, UK, and New York. 1327–70.

Hogarth, P. J. (2015) *The Biology of Mangroves and Seagrasses*. Oxford University Press.

Huang, D., Tun, K. P., Chou, L. M. and Todd, P. A. (2009) 'An inventory of zooxanthellate scleractinian corals in Singapore, including 33 new records'. *Raffles Bulletin of Zoology*, 22. 69–80.

Hüffer, T., Praetorius, A., Wagner, S., Kammer, F. von der and Hofmann, T. (2017) 'Microplastic Exposure Assessment in Aquatic Environments: Learning from Similarities and Differences to Engineered Nanoparticles.' *Environmental Science & Technology*, 51(5). 2499–2507.

Hugo, G. J. (2015) 'Internal and International Migration in East and Southeast Asia: Exploring the Linkages'. *Population, Space and Place*, . doi:10.1002/psp.1930.

IAPH Secretariat (2015) 'World Container Traffic Data 2015'. *Statistics*. http://www.iaphworldports.org/iaph/wp-content/uploads/WorldPortTraffic-Data-for-IAPH-using-LL-data2015.pdf.

Ingebritsen, S. E. and Galloway, D. L. (2014) 'Coastal subsidence and relative sea level rise'. *Environmental Research Letters*, 9(9). 091002.

IPCC (2014) *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Core Writing Team, R. K. Pachauri, and L. A. Meyer (eds.). Intergovernmental Panel on Climate Change, Geneva.

IUCN and UNEP-WCMC (2017) *The World Database on Protected Areas (WDPA) [On-Line]*. UNEP-WCMC, Cambridge, UK.

Jabeen, K., Su, L., Li, J., Yang, D., Tong, C., Mu, J. and Shi, H. (2017) 'Microplastics and mesoplastics in fish from coastal and fresh waters of China'. *Environmental Pollution*, 221. 141–49.

Jago-on, K. A. B., Kaneko, S., Fujikura, R., Fujiwara, A., Imai, T., Matsumoto, T., Zhang, J., Tanikawa, H., Tanaka, K., Lee, B. and Taniguchi, M. (2009) 'Urbanization and subsurface environmental issues: an attempt at DPSIR model application in Asian cities.' *Sci Total Environ*, 407(9). 3089–3104. doi:10.1016/j.scitotenv.2008.08.004.

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Narayan, R. and Law, K. L. (2015) 'Plastic waste inputs from land into the ocean'. *Science*, 347(6223). 768–71. doi:10.1126/science.1260352.

Jevrejeva, S., Jackson, L. P., Riva, R. E., Grinsted, A. and Moore, J. C. (2016) 'Coastal sea level rise with warming above 2°C'. *Proceedings of the National Academy of Sciences*, 113(47). 1–8.

Johns, M. (2013) 'Enhancing responsible fishing practices in South East Asia to combat Illegal, Unreported and Unregulated (IUU) fishing'. *Australian Journal of Maritime & Ocean Affairs*, 5(3). 112–19.

Karim, A. H. M. Z. (2016) *Tourism in Malaysia: An Empirical Study on Socio-Economic and Environmental Impacts*. Partridge Publishing, Singapore.

Katsnelson, A. (2015) 'News Feature: Microplastics present pollution puzzle'. *Proceedings of the National Academy of Sciences*, 112(24). E3150.

Krishnan, P., Grinson-George, G., Vikas, N., Titus-Immanuel, T., Goutham-Bharathi, M. P., Anand, A., Kumar, K. V. and Kumar, S. S. (2013) 'Tropical storm off Myanmar coast sweeps reefs in Ritchie's Archipelago, Andaman'. *Environmental monitoring and assessment*, 185(6). 5327–38.

Kron, W. (2012) 'Coasts: the high-risk areas of the world'. *Natural Hazards*, 66(3). 1363–82. doi:10.1007/s11069-012-0215-4.

Kühn, S., Rebolledo, E. L. B., Franeker, J. A. van, Bergman, M., Gutow, L. and Klages, M. (2015) 'Deleterious effects of litter on marine life'. *Marine anthropogenic litter* Springer, Dordrecht.

Kummu, M., De Moel, H., Salvucci, G., Viviroli, D., Ward, P. J. and Varis, O. (2016) 'Over the hills and further away from coast: global geospatial patterns of human and environment over the 20th–21st centuries'. *Environmental Research Letters*, 11(3). 034010.

Lane, D. J. and Limbong, D. (2015) 'Catastrophic depletion of reef-associated sea cucumbers: resource management/reef resilience issues for an Indonesian marine park and the wider Indo-Pacific'. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 25(4). 505–17.

Lavides, M. N., Molina, E. P. V., Gregorio Jr, E., Mill, A. C., Rushton, S. P., Stead, S. M. and Polunin, N. V. (2016) 'Patterns of Coral-Reef Finfish Species Disappearances Inferred from Fishers?' Knowledge in Global Epicentre of Marine Shorefish Diversity'. *PloS one*, 11(5). e0155752.

Lebel, L., Manuta, J. B. and Garden, P. (2010) 'Institutional traps and vulnerability to changes in climate and flood regimes in Thailand'. *Regional Environmental Change*, 11(1). 45–58. doi:10.1007/s10113-010-0118-4.

Lichter, M., Vafeidis, A. T., Nicholls, R. J. and Kaiser, G. (2010) 'Exploring data-related uncertainties in analyses of land area and population in the Low-Elevation Coastal Zone(LECZ)'. *Journal of Coastal Research*, 27(4). 757–68.

Li, J., Qu, X., Su, L., Zhang, W., Yang, D., Kolandhasamy, P., Li, D. and Shi, H. (2016) 'Microplastics in mussels along the coastal waters of China'. *Environmental Pollution*, 214. 177–84.

Li, W., Cao, Q., Lang, K. and Wu, J. (2017) 'Linking potential heat source and sink to urban heat island: Heterogeneous effects of landscape pattern on land surface temperature.' *Science of the Total Environment*, 586. 457–65.

Li, W. C., Tse, H. F. and Fok, L. (2016) 'Plastic waste in the marine environment: A review of sources, occurrence and effects.' *Science of the Total Environment*, 566-567. 333–49.

Mackelworth, P. (2012) 'Peace parks and transboundary initiatives: implications for marine conservation and spatial planning'. *Conservation Letters*, 5(2). 90–98.

Maire, E., Cinner, J., Velez, L., Huchery, C., Mora, C., Dagata, S., Vigliola, L., Wantiez, L., Kulbicki, M. and Mouillot, D. (2016) 'How accessible are coral reefs to people? A global assessment based on travel time'. *Ecology letters*, 19(4). 351–60.

Marschke, M. (2012) *Life, Fish and Mangroves: Resource Governance in Coastal Cambodia*. University of Ottawa Press.

McGranahan, G., Balk, D. and Anderson, B. (2007) 'The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones'. *Environment and Urbanization*, 19(1). 17–37. doi:10.1177/0956247807076960.

McManus, J. W. (1994) 'Spratly islands: a marine park?' *Ambio*, 23(3). 181–86.

McManus, J. W., Shao, K.-T. and Lin, S.-Y. (2010) 'Toward establishing a Spratly Islands International Marine Peace Park: ecological importance and supportive collaborative activities with an emphasis on the role of Taiwan'. *Ocean Development & International Law*, 41(3). 270–80.

Merkens, J.-L.-. L., Reimann, L., Hinkel, J. and Vafeidis, A. T. (2016) 'Gridded population projections for the coastal zone under the Shared Socioeconomic Pathways'. *Global and Planetary Change*, 145. 57–66.

Metuzals, K., Baird, R., Pitcher, T., Sumaila, U. R. and Ganapathiraju, P. (2010) 'One fish, two fish, IUU, and no fish: unreported fishing worldwide'. *Handbook of marine fisheries conservation and management. Oxford University Press, New York*, . 165–81.

Ministry of Environment, Indonesia (2013a) *State of the Environment Report of Indonesia 2013: Environmental Security of Indonesia*. Ministry of Environment, Republic of Indonesia., Jakarta.

Nakaoka, M., Lee, K.-S., Huang, X., Almonte, T., Bujang, J. S., Kiswara, W., Ambo-Rappe, R., Yaakub, S. M., Prabhakaran, M. P. and Hena, M. K. A. (2014) R*egional Comparison of the Ecosystem Services from Seagrass Beds in Asia. Springer*.

Neumann, B., Vafeidis, A. T., Zimmermann, J. and Nicholls, R. J. (2015) 'Future coastal population growth and exposure to sea-level rise and coastal flooding-a global assessment'. *PloS one*, 10(3). e0118571.

Novaczek, I. (2001) A*n Institutional Analysis of Sasi Laut in Maluku, Indonesia*. WorldFish, Manila.

Nurasa, T., Naamin, N. and Basuki, R. (1993) *The Role of Panglima Laot 'Sea Commander' System in Coastal Fisheries Management in Aceh, Indonesia*. APFIC, IPFC Fisheries Symposium.

Nurse, L. A., McLean, R. F., Agard, J., Briguglio, L. P., Duvat-Magnan, V., Pelesikoti, N., Tompkins, E. and Webb, A. (2014) 'Small islands'. *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. *Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change*, V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White (eds.). Cambridge University Press, Cambridge, UK, and New York. 1613–54.

Ooi, J. L. S., Kendrick, G. A., Niel, K. P. V. and Affendi, Y. A. (2011) '*Knowledge gaps in tropical Southeast Asian seagrass systems*'. Estuarine, Coastal and Shelf Science, 92(1). 118–31.

Pauly, D. (1994) 'From growth to Malthusian overfishing: stages of fisheries resources misuse'. *Traditional marine resource management and knowledge Information Bulletin*, 3. 7–14.

Pauly, D. (1988) 'Some definitions of overfishing relevant to coastal zone management in Southeast Asia'. *Tropical Coastal Area Management*, 3(1). 14–15.

Pauly, D. (1987) 'Theory and practice of overfishing: a Southeast Asian perspective'. *Papers Presented at the Symposium on the Exploitation and Management of Marine Fishery Resources in Southeast Asia, 22nd Session, Indo-Pacific Fishery Commission, Darwin, Australia* 16–17.

Pauly, D. and Zeller, D. (2015) 'Sea Around Us Concepts, Design and Data'. http://www.seaaroundus.org/data/#/eez.

Peters, G. P., Andrew, R. M., Boden, T., Canadell, J. G., Ciais, P., Quéré, C. L., Marland, G., Raupach, M. R. and Wilson, C. (2012) 'The challenge to keep global warming below 2C'. *Nature Climate Change*, 3(1). 4. doi:10.1038/nclimate1783.

Pham, C. K., Ramirez-Llodra, E., Alt, C. H., Amaro, T., Bergmann, M., Canals, M., Davies, J., Duineveld, G., Galgani, F. and Howell, K. L. (2014) 'Marine litter distribution and density in European seas, from the shelves to deep basins'. *PLoS One*, 9(4). e95839.

Phongsuwan, N., Chankong, A., Yamarunpatthana, C., Chansang, H., Boonprakob, R., Petchkumnerd, P., Thongtham, N., Paokantha, S., Chanmethakul, T. and Panchaiyapoom, P. (2013) 'Status and changing patterns on coral reefs in Thailand during the last two decades'. *Deep Sea Research Part II: Topical Studies in Oceanography*, 96. 19–24.

Polidoro, B. A., Livingstone, S. R., Carpenter, K. E., Hutchinson, B., Mast, R. B., Pilcher, N. J., de Mitcheson, Y. S. and Valenti, S. V. (2009) *Status of the World's Marine Species*. IUCN, Gland, Switzerland.

Raucoules, D., Le Cozannet, G., Wöppelmann, G., De Michele, M., Gravelle, M., Daag, A. and Marcos, M. (2013) 'High nonlinear urban ground motion in Manila (Philippines) from 1993 to 2010 observed by DInSAR: implications for sea-level measurement'. *Remote Sensing of Environment*, 139. 386–97.

Reef Check Malaysia (2015) *Status of Coral Reefs in Malaysia*, 2015. Reef Check Malaysia, Kuala Lumpur.

Richards, D. R. and Friess, D. A. (2016) 'Rates and drivers of mangrove deforestation in Southeast Asia, 2000–2012'. *Proceedings of the National Academy of Sciences*, 113(2). 344–49.

Rijnsdorp, A. D., Peck, M. A., Engelhard, G. H., Möllmann, C. and Pinnegar, J. K. (2009) 'Resolving the effect of climate change on fish populations'. *ICES* Jour*nal of Marine Science: Journal du Conseil*, 66(7). 1570–83. doi:10.1093/icesjms/fsp056.

Rodolfo, K. S. (2014) 'On the geological hazards that threaten existing and proposed reclamations of Manila Bay'. *Philippine Science Letters*, 7(1). 228–40.

Rodolfo, K. S. and Siringan, F. P. (2006) 'Global sea-level rise is recognised, but flooding from anthropogenic land subsidence is ignored around northern Manila Bay, Philippines'. *Disasters*, 30(1). 118–39.

Ruddle, K. and Hickey, F. R. (2008) 'Accounting for the mismanagement of tropical nearshore fisheries'. *Environment, Development and Sustainability*, 10(5). 565–89.

Rujivanarom, P. (2017) 'Kilometres-long piles of garbage floating offshore'. *The Nation*. http://www.nationmultimedia.com/news/national/30306067.

Russell, B. D., Connell, S. D., Uthicke, S., Muehllehner, N., Fabricius, K. E. and Hall-Spencer, J. M. (2013) 'Future seagrass beds: can increased productivity lead to increased carbon storage?' *Marine Pollution Bulletin*, 73(2). 463–69.

Sadovy, Y. (2010) 'Humphead wrasse and illegal, unreported and unregulated fishing'. *SPC Live Reef Fish Information Bulletin*, 19. 19–21.

Sandilyan, S. and Kathiresan, K. (2015) 'Mangroves as bioshield: An undisputable fact'. *Ocean & Coastal Managemen*t, 103. 94–96.

Santos, C. T., Toda, L., Orduña, J. R., Santos, F. D. and Ferrão, J. (2016) 'The impacts of Typhoon Haiyan in the Philippines: Implications to land use planning'. *Climate, Disaster and Development Journal*, 1. 57–66.

Schmidt, C. W. (2015) 'Delta Subsidence: an imminent threat to coastal populations'. *Environmental Health Perspectives*, 123(8). A204–9. doi:10.1289/ehp.123-A204.

SEAFDEC (2017) *Fishery Statistical Bulletin of Southeast Asia 2014*. SEAFDEC, Bangkok.

SEAFDEC (2016) *Proceedings of the High-Level Consultation on Regional Cooperation in Sustainable Fisheries Development towards the ASEAN Economic Community: Combating IUU Fishing and Enhancing the Competitiveness of ASEAN Fish and Fishery Products*. SEAFDEC.

Secretariat of the International Human Dimensions Programme on Global Environmental Change (UNU-IHDP) (2015) *Coastal Zones and Urbanization*: *Summary for Decision-Makers*. Secretariat of the International Human Dimensions Programme on Global Environmental Change (UNU-IHDP).

Seto, K. C., Fragkias, M., Güneralp, B. and Reilly, M. K. (2011) 'A meta-analysis of global urban land expansion'. *PloS one*, 6(8). e23777.

Seto, K, Parnell, S. and Elmqvist, T. (2013) 'Introduction'. *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities A Global Assessment*, T. Elmqvist, M. Fragkias, J. Goodness, B. Güneralp, P. J. Marcotullio, R. I. McDonald, S. Parnell, M. Schewenius, M. Sendstad, K. C. Seto, and C. Wilkinson (eds.). Springer Netherlands, Dordrecht. 1–12.

Short, F. T., Coles, R. and Pergent-Martini, C. (2001) 'Global seagrass distribution'. *Global seagrass research methods*, F. T. Short and R. G. Coles (eds.). Elsevier, London.

Short, F. T., Polidoro, B., Livingstone, S. R., Carpenter, K. E., Bandeira, S., Bujang, J. S., Calumpong, H. P., Carruthers, T. J., Coles, R. G. and Dennison, W. C. (2011) 'Extinction risk assessment of the world's seagrass species'. *Biological Conservation*, 144(7). 1961–71.

Siry, H. Y. (2011) 'In search of appropriate approaches to coastal zone management in Indonesia'. *Ocean & Coastal Management*, 54(6). 469–77. doi:10.1016/j.ocecoaman.2011.03.009.

Smajgl, A., Toan, T. Q., Nhan, D. K., Ward, J., Trung, N. H., Tri, L. Q., Tri, V. P. D. and Vu, P. T. (2015) 'Responding to rising sea levels in the Mekong Delta'. *Nature Climate change*, 5(2). 167–74. doi:10.1038/nclimate2469.

Small, C. and Cohen, J. (2004) 'Continental physiography, climate, and the global distribution of human population 1'. *Current Anthropology*, 45(2). 269–77.

Small, C. and Nicholls, R. J. (2003) 'A global analysis of human settlement in coastal zones'. *Journal of Coastal Research*, 19(3). 584–99.

Spalding, M. (2010) *World Atlas of Mangroves*. Routledge.

Stobutzki, I. C., Silvestre, G. T. and Garces, L. R. (2006) 'Key issues in coastal fisheries in South and Southeast Asia, outcomes of a regional initiative'. *Fisheries Research*, 78(2). 109–18.

Stokke, O. S. (2001) *Governing High Seas Fisheries: The Interplay of Global and Regional Regimes*. Oxford University Press, Oxford.

Sumaila, U. R., Khan, A., Teh, L., Watson, R., Tyedmers, P. and Pauly, D. (2010) 'Subsidies to high seas bottom trawl fleets and the sustainability of deep-sea demersal fish stocks'. *Marine Policy*, 34(3). 495–97. doi:10.1016/j.marpol.2009.10.004.

Sussarellu, R., Suquet, M., Thomas, Y., Lambert, C., Fabioux, C., Pernet, M. E. J., Goïc, N. L., Quillien, V., Mingant, C., Epelboin, Y., Corporeau, C., Guyomarch, J., Robbens, J., Paul-Pont, I., Soudant, P. and Huvet, A. (2016) '*Oyster reproduction is affected by exposure to polystyrene microplastics*.' PNAS, 113(9). 2430–35.

Swartz, W., Sala, E., Tracey, S., Watson, R. and Pauly, D. (2010) 'The spatial expansion and ecological footprint of fisheries (1950 to present)'. *PloS one*, 5(12). e15143.

Takagi, H., Thao, N. D. and Anh, L. T. (2016) 'Sea-Level Rise and Land Subsidence: Impacts on Flood Projections for the Mekong Delta?'s Largest City'. *Sustainability*, 8(9). 959.

Taniguchi, M. ed. (2011) 'Groundwater and subsurface environments : human impacts in Asian coastal cities'. Springer, Tokyo.

Teh, L. S. L., Witter, A., Cheung, W. W. L., Sumaila, U. R. and Yin, X. (2016) 'What is at stake? Status and threats to South China Sea marine fisheries.' *Ambio*, . doi:10.1007/s13280-016-0819-0.

Teh, L. S., Teh, L. C. and Sumaila, U. R. (2013) 'A global estimate of the number of coral reef fishers'. *PLoS One*, 8(6). e65397.

Teh, L. and Sumaila, U. R. (2007) 'Malthusian overfishing in Pulau Banggi?' *Marine Policy*, 31(4). 451–57.

The Nation (2017) 'The Gulf of Thailand as communal trash bin'. *The Nation*. http://www.nationmultimedia.com/news/opinion/today_editorial/30306957.

Thirumaran, K. and Arumynathan, P. (2016) 'Destination ASEAN, Beyond 2015'. *Development of Tourism and the Hospitality Industry in Southeast Asia*, P. Mandal and J. Vong (eds.). Springer Singapore. 1–11.

Tkachenko, K. S., Britayev, T. A., Huan, N. H., Pereladov, M. V. and Latypov, Y. Y. (2016) 'Influence of anthropogenic pressure and seasonal upwelling on coral reefs in Nha Trang Bay (Central Viet Nam)'. *Marine Ecology*, 37(5). 1131–46.

Tun, T. and Bendell, B. (2011) 'Preliminary observations on the seagrasses of Lampi and neighbouring islands of The Myeik Archipelago, Myanmar'. *Proceedings of the 6th International Symposium on SEASTAR2000 and Asian Bio-logging Science (The 10th SEASTAR2000 workshop)* , Kyoto, Japan. Graduate school of Informatics, Kyoto University.

UNEP (2009) Marine *Litter: A Global Challenge*. United Nations Environment Programme (UNEP), Nairobi.

United States Central Intelligence Agency (2017) 'Field Listing: Coastline.The World Factbook'. https://www.cia.gov/library/publications/the-world-factbook/fields/2060.html.

Unsworth, R. K. and Cullen, L. C. (2010) 'Recognising the necessity for Indo-Pacific seagrass conservation'. *Conservation Letters*, 3(2). 63–73.

Unsworth, R. K. F., Collier, C. J., Waycott, M., Mckenzie, L. J. and Cullen-Unsworth, L. C. (2015) 'A framework for the resilience of seagrass ecosystems.' *Marine Pollution Bulletin*, 100(1). 34–46.

Unsworth, R. K. F., Hinder, S. L., Bodger, O. G. and Cullen-Unsworth, L. C. (2014) 'Food supply depends on seagrass meadows in the coral triangle'. *Environmental Research Letters*, 9(9). 094005.

Unsworth, R. K. F., Keulen, M. van and Coles, R. G. (2014) *Seagrass Meadows in a Globally Changing Environment*.

USAID (2015) *First ASEAN-US Trade and Environment Dialogue: Workshop on Combatting Illegal, Unreported and Unregulated (IUU) Fishing*. ASEAN, Kuala Lumpur, Malaysia.

Utomo, P. B. (2010) *The Role of Traditional Knowledge in Fisheries Management: A Study of Panglima Laot (Sea Commander) in the Aceh Province of Indonesia*. World Maritime University.

Ventura, V. A. M. F. (2015) 'Tackling Illegal, Unregulated and Unreported Fishing: The ITLOS Advisory Opinion on Flag State Responsibility for IUU Fishing and the Principle of Due Diligence'. *Braz. J. Int'l L.*, 12. 50.

Veron, J. E. N., Devantier, L. M., Turak, E., Green, A. L., Kininmonth, S., Stafford-Smith, M. and Peterson, N. (2009) 'Delineating the coral triangle'. *Galaxea, Journal of Coral Reef Studies*, 11(2). 91–100.

Vo, S. T., DeVantier, L. M., Tuyen, H. T. and Hoang, P. K. (2014) 'Ninh Hai waters (south Viet Nam): a hotspot of reef corals in the western South China Sea'. *Raffles Bull Zool*, 62. 513–20.

Wada, Y., van Beek, L. P. H., Sperna Weiland, F. C., Chao, B. F., Wu, Y.-H. and Bierkens, M. F. P. (2012) 'Past and future contribution of global groundwater depletion to sea-level rise'. *Geophysical Research Letters*, 39(9). n/a – n/a. doi:10.1029/2012gl051230.

Warren-Rhodes, K., Sadovy, Y. and Cesar, H. (2003) 'Marine ecosystem appropriation in the Indo-Pacific: A case study of the live reef fish food trade'. *Ambio: A Journal of the Human Environment*, 32(7). 481–88.

Watts, A. J. R., Urbina, M. A., Corr, S., Lewis, C. and Galloway, T. S. (2015) 'Ingestion of Plastic Microfibers by the Crab Carcinus maenas and Its Effect on Food Consumption and Energy Balance.' *Environmental Science & Technology*, 49(24). 14597–604.

Waycott, M., Duarte, C. M., Carruthers, T. J., Orth, R. J., Dennison, W. C., Olyarnik, S., Calladine, A., Fourqurean, J. W., Heck, K. L. and Hughes, A. R. (2009) 'Accelerating loss of seagrasses across the globe threatens coastal ecosystems'. *Proceedings of the National Academy of Sciences*, 106(30). 12377–81.

Wear, S. L. (2016) 'Missing the boat: Critical threats to coral reefs are neglected at global scale'. *Marine Policy*, 74. 153–57.

Wedding, L. M., Friedlander, A. M., McGranaghan, M., Yost, R. S. and Monaco, M. E. (2008) 'Using bathymetric lidar to define nearshore benthic habitat complexity: Implications for management of reef fish assemblages in Hawaii'. *Remote Sensing of Environment*, 112(11). 4159–65.

Wilcox, C., Sebille, E. V. and Hardesty, B. D. (2015) 'Threat of plastic pollution to seabirds is global, pervasive, and increasing.' *PNAS*, 112(38). 11899–904.

Wilkinson, C. (2008) *Status of Coral Reefs of the World: 2008*. Global Coral Reef Monitoring Network Townsville.

Williams, I. D., Baum, J. K., Heenan, A., Hanson, K. M., Nadon, M. O. and Brainard, R. E. (2015) 'Human, oceanographic and habitat drivers of central and western Pacific coral reef fish assemblages'. *PLoS One*, 10(4). e0120516.

Wilson, C. and Linkie, M. (2012) 'The Panglima Laot of Aceh: a case study in large-scale community-based marine management after the 2004 Indian Ocean tsunami'. *Oryx*, 46(04). 495–500. doi:10.1017/S0030605312000191.

Wongthong, P. and Harvey, N. (2014) 'Integrated coastal management and sustainable tourism: A case study of the reef-based SCUBA dive industry from Thailand'. *Ocean & Coastal Management*, 95. 138–46.

Woodruff, J. D., Irish, J. L. and Camargo, S. J. (2013) 'Coastal flooding by tropical cyclones and sea-level rise.' *Nature*, 504(7478). 44–52. doi:10.1038/nature12855.

World Bank (2010) *Climate Risks and Adaptation in Asian Coastal Megacities: A Synthesis Report*. World Bank, Washington, D.C.

Yang, D., Shi, H., Li, L., Li, J., Jabeen, K. and Kolandhasamy, P. (2015) 'Microplastic Pollution in Table Salts from China.' *Environmental Science & Technology*, 49(22). 13622–27.

Zeitoun, D. G. and Wakshal, E. (2013) *Land Subsidence Analysis in Urban Areas the Bangkok Metropolitan Area Case Study*. Springer, Dordrecht.

2.6. Production and consumption

The patterns of production and consumption show an increasingly unsustainable trend across member states of the ASEAN. Although efficiency and productivity are increasing, improved waste and chemicals management is needed across the ASEAN region. Resource use continues to rise upwards in line with rapid urbanization and industrialization.

2.6. Production and Consumption

Key Messages

- The patterns of production and consumption show an increasingly unsustainable trend across the ASEAN region. Although efficiency and productivity are increasing, improved waste and chemicals management is needed across the ASEAN region.
- Resource use continues to rise upwards in line with rapid urbanization and industrialization. The increase of resource use per capita also indicates an improvement in living standards.
- Productivity in most ASEAN Member States (AMS) remains at a relatively low level, showing slow economic growth. A shift from demographic-change based growth to more sustainable technology and productivity-driven growth is key to framing successful new development strategies across AMS.
- The rising amounts of waste and its management pose a serious challenge for most AMS, especially plastic bags, e-waste and food waste. Landfill is still the main way to dispose of solid waste, however 3Rs and waste-to-energy have become popular in the region. Plastic bags, e-waste and food waste need special attention and customized actions.
- The use of pesticides continues to rise in the agricultural sector and is one of the biggest chemicals management challenges in the ASEAN region. Some banned chemicals are still being used. It is recommended that all the AMS ratify the four international conventions on chemicals issues (Basel, Rotterdam, Stockholm and Minamata) to achieve Sustainable Development Goal (SDG) 12, Target 12.4.1.
- Green finance enables the region, in terms of production, to invest in more resource and process efficient technologies and activities, while green/sustainable public procurement (GPP/SPP) and ecolabelling, green building rating systems and energy labelling schemes come from the consumption/demand side to encourage more sustainable/green production.
- Relevant policies, regulations, infrastructure and facilities are needed to lead greater improvements in resource and production sustainability, and waste and chemicals management.
- Sustainable production and consumption is a cross-cutting issue highly relevant to other themes, such as economic growth, wellbeing, agriculture, cities, climate change and energy, biodiversity and natural resources, governance and technologies.

1. Introduction

This chapter analyzes the state and trends of production and consumption from the following four perspectives.

- Resource efficiency. Natural resources are categorized into three areas – material, water and energy (UNEP 2013). The efficiency is analyzed from parameters of total consumption, consumption per capita and intensity.
- Process efficiency. The evaluation on process is based on parameters such as gross domestic product (GDP) per capita, national income per capita, labour productivity, capital productivity and national productivity (Kao 2013).
- Waste management. This section discusses different kinds of waste generation and management: municipal solid waste, food waste, e-waste and disaster waste.
- Chemicals management. This section identifies the key chemical management issues in the ASEAN region.

2. Drivers

The ASEAN region's population growth rate of 1.3% is faster than the global rate of 1.18%. It has almost three times higher population density than the world average (see Section 1).

Cities in ASEAN Member States (AMS) are growing and expanding at a rate of 2.65%, that is much faster than cities in other parts of the world. Moreover, the rate of urbanization is much faster than the overall population growth rate. According to World Bank data, three out of 37 megacities in the world – Jakarta, Manila and Bangkok – are in the ASEAN region.

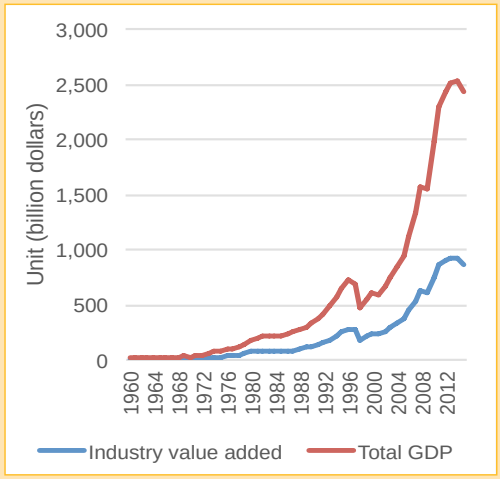


Figure 43. Industry value added to GDP in ASEAN

The ASEAN region's annual economic growth rate has remained at about 5% for the last five years. However, some AMS are growing faster than others: the countries referred to as CLMV (Cambodia, Lao PDR, Myanmar and Viet Nam) reached a higher rate of 7%. The middle-class population is also growing: in 2012, it was over 125 million, about the same as the total population of Japan. This is further projected to grow by another 70 million by 2020, of which Indonesia alone will account for 35 million (Liang 2015).

The ASEAN region is transitioning from an agrarian society to an industrialized society; employment has shifted from the agriculture sector more towards the industry and services sectors over the past 25 years (see Section 1.1). Annual industry value added is in line with annual total GDP growth (see Figure 43). The value added from industry in the ASEAN region accounts for about 35% of its total GDP, which is about 7% higher than the global average in 2015 (see Figure 45).

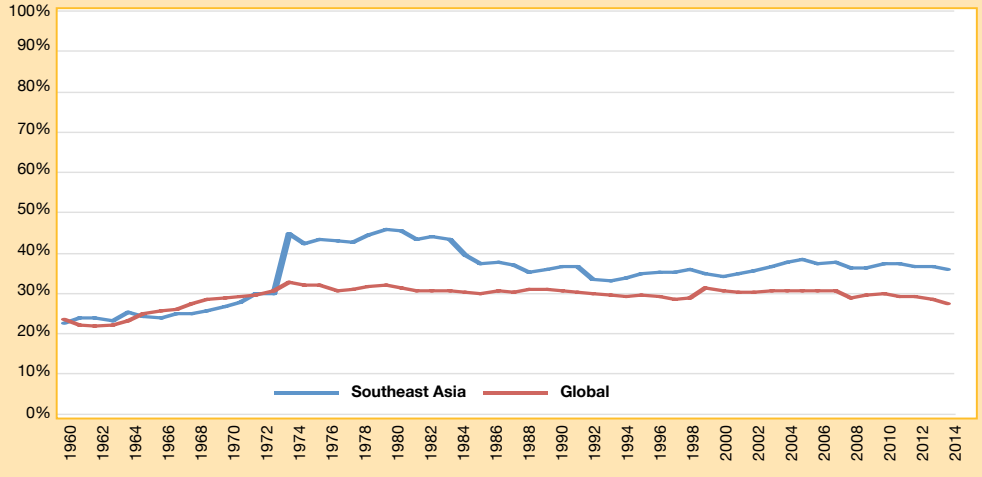


Figure 44. Percentage of industry value added to GDP in ASEAN

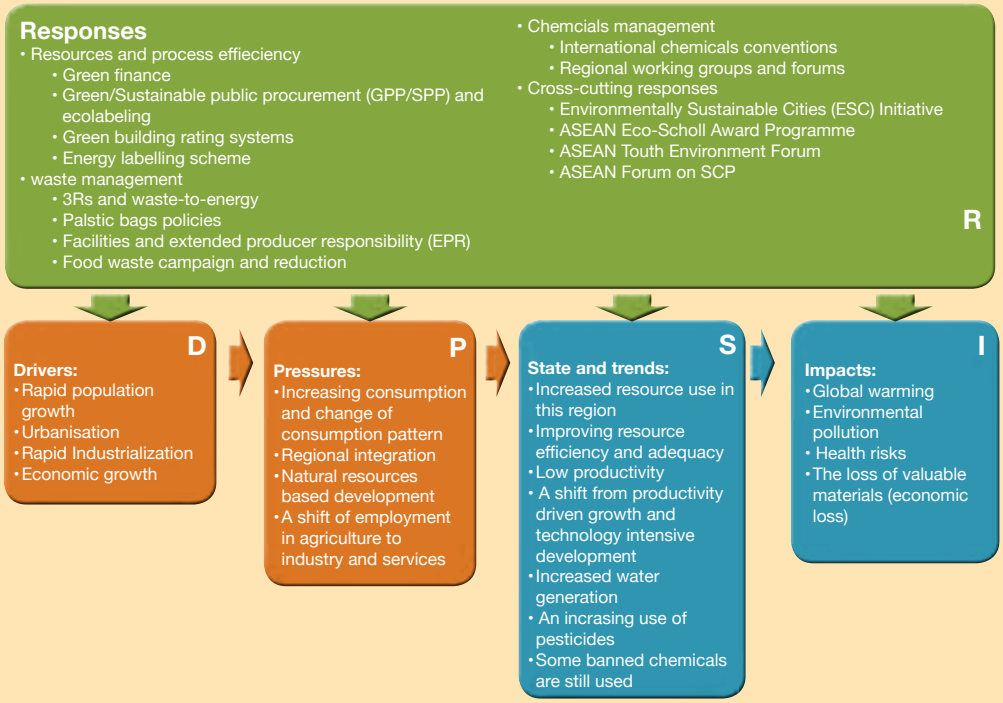


Figure 45. DPSIR framework for Production and Consumption

3. Pressures

The need for using more natural resources stems from the ASEAN region's economic development and urbanization as well as the growing population, increase in domestic consumption, infrastructure, transportation, and the expanding middle-class (OECD 2013b).

Emerging AMS alongside India and China have the fastest middle-class growth rates in the world (OECD 2013b), an increase from 21% in 1990 to 56% in 2008 (Chun 2010). The growing middle class has not only encouraged strong consumption growth rates, but also changed the consumption patterns or lifestyles, demanding a shift in emphasis from development of export industries to industries and services to meet the needs of own nation's needs (OECD 2013b).

Since the signing of the ASEAN Declaration in 1976, regional integration is progressing within three main frameworks: ASEAN, ASEAN+3, and ASEAN+6 (OECD 2015) (see Chapter 1.1). The ASEAN region has enjoyed strong economic growth through unsustainable natural resource exploitation (OECD 2014).

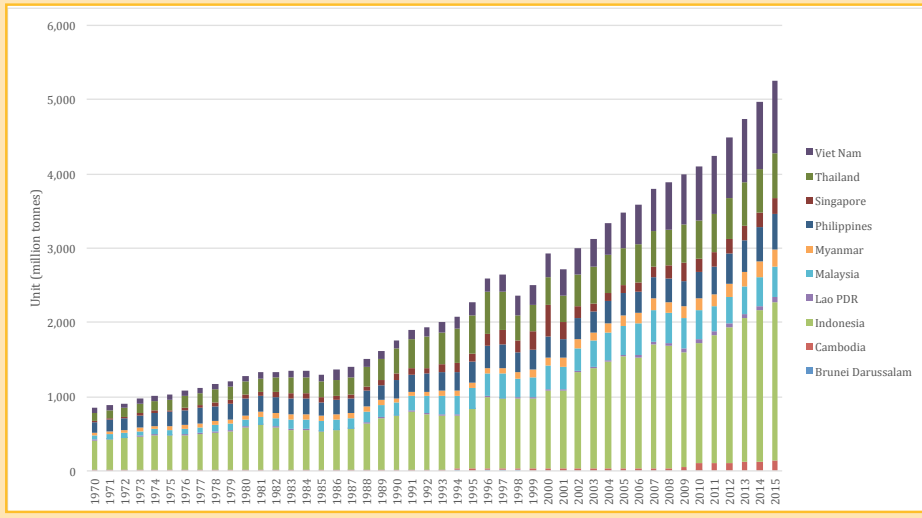
As discussed in Section 1, employment in the ASEAN region has shown a trend towards transitioning from agriculture to other sectors, including industry and services during the past 25 years.

4. State and trends

Resource efficiency

Material

The material consumption in ASEAN has increased from less than 1 billion tonnes per year to more than 5 billion, between 1970 and 2010 (Figure 45). The region consumed over 5 out of the global average annual consumption of 70 billion tonnes of material from 1970 to 2010. ASEAN's annual consumption growth rate is in line with the global growth rate of 5 percent (UNEP 2013).



Source: Shandl et. al., 2016

Figure 46. Domestic material consumption in Southeast Asia

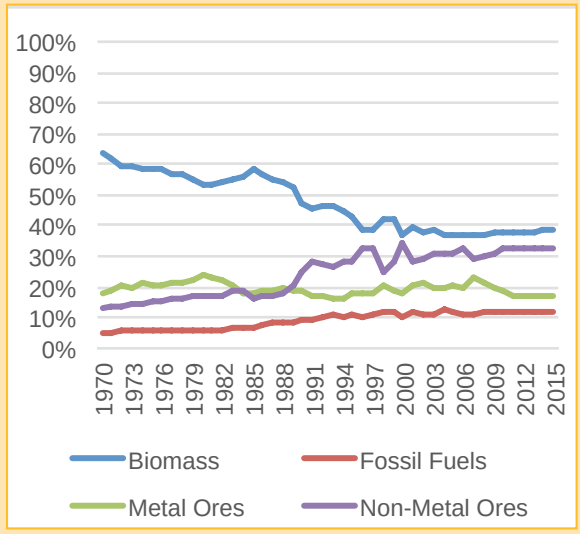


Figure 47. Domestic material consumption by material category in Southeast Asia

The consumption growth rates of different categories of materials vary greatly, with non-metallic minerals, including industrial and construction minerals, showing the highest growth rate (Figure 47). In line with its rapid urbanization and industrialization, a move away from biomass to fossil fuel, metal ores and non-metallic minerals was noticed. However, this shift did not lead to a decrease in total consumption; demand in 2015 doubled compared to the beginning of the 20th century.

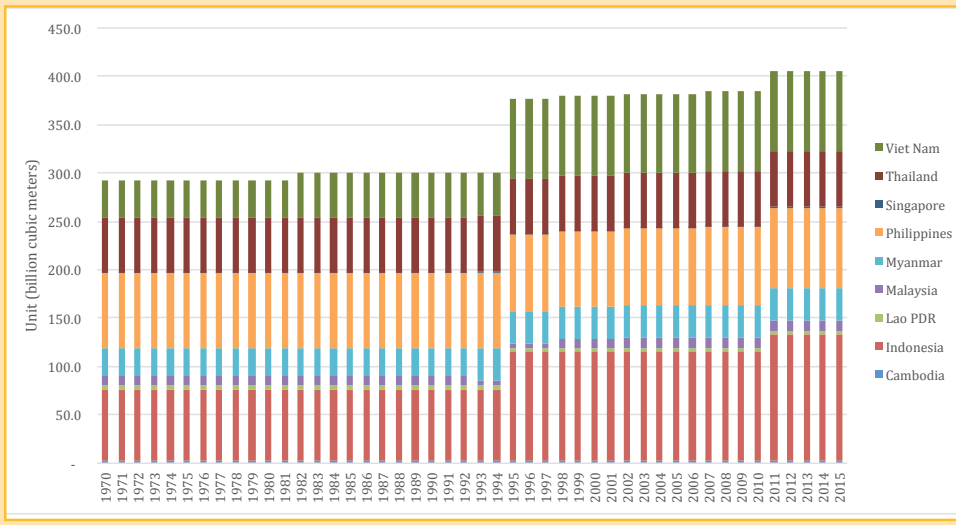
Material use per person in the ASEAN region has more than doubled, from 3 to 8 tonnes per person, since 1970, with almost

linear growth since the late-1980s (Shandl et. Al. 2016). The rate in Southeast Asia is slower than the Asia and Pacific region since the 20th century.

On average, the ASEAN region consumes 3.5 kilograms of materials to produce one dollar of GDP (Shandl et. Al. 2016). This is slightly higher than the average amount in Asia and the Pacific, while it lags far behind the rest of the world where only 1 kilogram is needed per dollar. However, as a whole, the material intensity in Southeast Asia has decreased. Lao PDR needs the most materials to produce one dollar – 12 kilograms, followed by Cambodia and Viet Nam that require 10.8 and 9.8 kilograms respectively.

Water

Total water use in Southeast Asia has experienced two stages of increase: the first in 1995, increasing to 376 billion cubic meters and the second in 2011 to 405 billion cubic meters (Figure 47). In 1995, Indonesia's consumption increased 50% and this increase greatly contributed to the first step-up of the whole region's consumption, while some countries stayed the same throughout the past 40 years such as Cambodia, Lao PDR, and Thailand at 2.2, 3.5, and 57.3 billion cubic meters respectively.



Source: Shandl et. al., 2016

Figure 48. Total water use in Southeast Asia

All three kinds of water use – agriculture, manufacturing, and residential, increased two-fold from 1970 to 2015, while the share of agriculture use decreased from 70 percent to 50 percent (Shandl et. Al. 2016). The share of both manufacturing and residential use increased before the 21th century but has stayed stable since then. On average, water use per capita has decreased from 1,043 to 641 cubic meters throughout ASEAN (Shandl et. Al. 2016).

In 2015, Southeast Asia needed 266 cubic meters of water on average to produce one US dollar, a huge decrease from 2,322 cubic meters in 1970. Myanmar still needs 1,157 cubic meters, while Singapore uses only 11.2. In general, water usage intensity in ASEAN has decreased over the past 40 years (Figure 48).

Box 16. Eight industries receive the Philippines' Department of Environment and Natural Resources (DENR) recognition for exemplary environmental performance

For exhibiting exemplary environmental performance, eight companies from the chiller and power sectors, received recognition from the Department of Environment and Natural Resources (DENR) at the Joint Awarding Ceremony of the Philippines-Chiller Energy Efficiency Project (PCEEP) and the Philippine Environment Partnership Program (PEPP) held at the H2O Hotel in Manila.

The project's beneficiaries were awarded and recognized for their initiatives in implementing energy-efficient operations, particularly the chiller sector's move to replace their ozone depleting substances (ODS)-based inefficient chillers to new technologies.

The PCEEP, a World Bank-Global Environment Facility (WB-GEF)-initiated project, provides technical and financial assistance to replace old chillers with energy-efficient and Non-ODS-based chillers, in order to protect the ozone layer and reduce greenhouse gas emissions.

The PCEEP provides an opportunity for chiller owners to select new chiller technologies that are not only more energy efficient, but also operating with non-ODS-based refrigerant and with lower leakage rate. Such a move will bring economic as well as ecological benefits not only to chiller owners but also the country, in terms of savings in electricity and reduced greenhouse gas emissions.

Awardees were selected after passing a series of evaluation stages including documentary and site validation with the members of the PCEEP-Technical Evaluation Committee. At the end of the project life on January 1, 2017, the PCEEP was expected to have replaced 30,649 tons of refrigeration, reduced 5,700 kilograms of ozone-depleting potentials, generated at least 124.7 gigawatt-hours in electricity savings, abated 10 megawatt-demand, and reduced 62,400 tons of greenhouse gases.

On the other hand, the Philippine Environment Partnership Program, PEPP, pursuant to DENR Administrative Order No. 14 (Series of 2003), is a DENR partnership program that aims to support industry self-regulation towards improved environmental performance.

Under Track 1, industries are recognized for their initiatives that go beyond compliance which means they should have had no cases filed with the Pollution Adjudication Board for three years prior to the date of application. They are in full compliance with all applicable environmental laws, and should have been proven to show superior environmental performance, such as implementing successful environmental management system, pollution prevention or waste minimization initiatives and community or social responsibility programs.

Source: Government of the Philippines

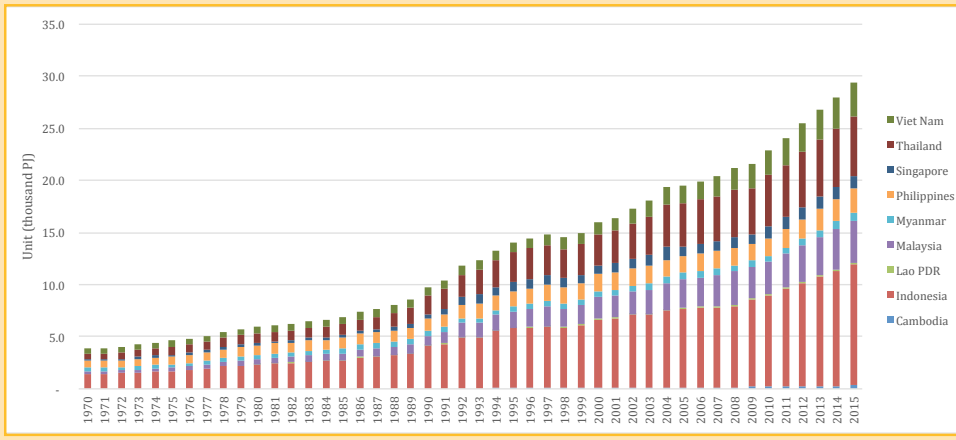
Energy

The energy demands in Southeast Asia increased seven-fold in 2015 when compared to 1970, mostly to meet the demands of modern lifestyles including shopping malls and other urban infrastructure. Indonesia's energy demand has increased more than nine-fold.

The demand for petroleum, natural gas and coal also grew remarkably. The share of coal increased from 2 percent in 1970 to 14.4 percent in 2015, with natural gas growing from 0.4 percent to 22 percent. Petroleum's share remained stable at 35 percent.

Although non-hydro renewables increased threefold to 7.9 thousand PJ in 2015, which is double the amount of coal, its percentage share dropped by half. The use of solar, wind

and geothermal energy gained ground in the 1990s and their share of the total primary energy supply has been consistent around 6 percent over the past 20 years (Shandl et. Al. 2016). The use of hydropower emerged since the 1970s and since then, both its actual consumption and share had increased more than five-fold in 2010. Indonesia is the leading ASEAN country utilising biofuel and geothermal energy, accounting for 25.7 percent and 7.6 percent of its energy supply (IEA 2015). This shows that renewable energy production can complement traditional energy to meet the region's growing demands.



Source: Shandl et. al., 2016

Figure 49. Total primary energy supply in Southeast Asia

In general, the total primary energy supply per capita in ASEAN, has greatly increased. The growing energy needs in Singapore, Malaysia and Thailand are faster than the average of Southeast Asia, however, it remains only about 70 percent of the average of the Asia and the Pacific region as a whole (UNEP 2013).

The energy needed to produce one dollar decreased from 29.2 MJ in 1970 to 19.4 MJ in 2015 (Shandl et. Al. 2016). Although Myanmar still needs 28.8 MJ in 2015 to produce one dollar, it reduced dramatically from a high level of 166.7 MJ in 1970. The same is true for Viet Nam that consumed 71.3 MJ back in 1970 but less than half (33.2 MJ) in 2015. Singapore has consistently required the least energy since 1970, at 1.3 MJ.

Process efficiency

Productivity in most ASEAN Member States remains at a relatively low level, with a slowing growth rate (OECD 2015).

The National Cheng Kung University conducted a study on the national productivity of the Southeast Asia countries during 2001-2004 (Kao 2013). The labour productivity, capital productivity, and national productivity of all ten countries are shown in Table 48.

The study classified the ten countries into four categories – high-productivity, labour-intensive, capital-intensive, and low productivity, based on both labour productivity and capital productivity. Of the ten countries, Malaysia, Indonesia, and the Philippines have relatively higher productivity; Myanmar and Cambodia are considered labour-intensive; Singapore and Brunei are capital-intensive; while Thailand, Lao PDR, and Viet Nam have low-productivity.

Table 49. National productivity in Southeast Asia

Country	GDP p.c.	NI p.c.	Labor P.	Capital P.	National P.
Malaysia (My)	3715	3390	2.0485	7.5788	1.6126
Indonesia (I)	701	613	1.9635	6.8356	1.5253
Philippines (P)	971	1033	2.0608	5.5311	1.5014
Singapore (S)	22530	22180	2.1368	3.3499	1.3046
Brunei (B)	12555	14094	2.0443	3.3213	1.2654
Myanmar (Mm)	279	300	1.3215	8.5372	1.1444
Cambodia (C)	261	293	1.3228	6.5391	1.1002
Thailand (T)	1985	1997	1.4465	4.5450	1.0973
Laos (L)	312	258	1.3255	4.5096	1.0244
Viet Nam (V)	401	383	1.2152	3.5660	0.9063
Average			**1.6885**	**5.4315**	**1.2482**

*Source: Kao, 2013. Note: *NI: National Income*

Using criteria for national productivity and GDP per capita, Kao (2013) classified living standards into another four groups: fast growing-moderate living standards group, represented by Malaysia only; fast growing-low living standards group, including Indonesia and the Philippines; Singapore and Brunei comprised of the third group – stable growing-high living standards group; and the remaining five countries, Myanmar, Cambodia, Thailand, Laos, and Viet Nam belonging to the fourth group of slow growing-low living standards group.

Although productivity in ASEAN has been rising in recent decades, it's still at a relatively low level in most countries. This low productivity is considered as the biggest pitfall towards economic growth, because previous progress was derived from a broad labor shift from agriculture to more efficient sectors, rather than improvements within sectors (McKinsey Global Institute 2014). A study from World Bank confirmed that urbanization with its rising density of population is a critical contributor towards productivity increase (Rosenthal and Strange 2003). It is estimated that a city of 200,000 people could be 3 - 8 percent more productive than a city with half this population.

Since the global financial crisis, most developing countries have experienced a slowing in productivity, however, it has not been spread evenly across all sectors, with some areas more seriously affected than others (OECD 2015). It is said that "while demographics are still favourable, the boost to economic growth from an expanding workforce will eventually begin to taper" (McKinsey Global Institute 2014).

Like many other emerging economies in the world, ASEAN countries with high GDP growth rates, have been slowing or reached zero growth as they approach high-income country level status (OECD 2013a). This phenomenon is known as "middle-income trap", faced by economies that grew based on structural transformation, demographic change and factor accumulation (which means an increase in the quantity of a factor). Improvement in the quality of human and other capital is needed to transition towards more sustainable productivity-driven growth and technology-intensive development (OECD 2013a).

The slowing of productivity hampers GDP growth as well as the ability to continue to raise living standards (OECD 2015). The key to the success of new development strategies in Southeast Asia is to enhance productivity through structural policy reforms (OECD 2013b). McKinsey Global Institute (McKinsey Global Institute 2014) suggested that ASEAN Member States build a more competitive manufacturing sector through securing more production efficiency from multinational corporations.

Waste management

The rising amounts of waste and its management poses a serious challenge for most Southeast Asia countries, especially plastic bags, e-waste and food waste. Different types of wastes are mixed together leading to unsustainable end-of-pipe management.

Municipal solid waste

In 2012, Southeast Asia produced 202,000 tonnes of municipal solid waste (MSW) per day and this is predicted to double by 2025 (Table 51). The biggest contributer now and expected in the future is Indonesia, while Lao PDR is expected to experience the greatest increase.

Table 50. Municipal solid waste generation in Southeast Asia

ASEAN Member State	2012		2025 (projected)	
	MSW Generation per capita (kg/kapita/day)	Total MSW Generation per capita (kg/kapita/day)	MSW Generation per capita (kg/kapita/day)	MSW Generation per capita (kg/kapita/day)
Brunei Darussalam	N/A	N/A	N/A	N/A
Cambodia	N/A	N/A	N/A	N/A
Indonesia	0.52	61.644	0.85	151.921
Lao PDR	0.7	1.342	1.1	4.154
Malaysia	1.52	.21.918	1.9	51.655
Myanmar	0.44	5.616	0.85	21.012
Philippines	0.5	29.315	0.9	77.776
Singapore	N/A	N/A	N/A	N/A
Thailand	1.76	39.452	1.95	56.673
Viet Nam	1.46	35.068	1.8	72.909
Southeast Asia	1.03	901.807	**1.38**	**445.841**

The average municipal solid waste generation in 2012 was 1.03 kg per person, per day. Thailand and Malaysia made a significant contribution to this amount with 1.76 and 1.52 kg respectively. Myanmar produced the least MSW per person per day at just 0.44 kg. The ASEAN regional average is expected to increase to 1.38 by 2025, with the increase expected to come mainly from Thailand.

Indonesian Olefin, Aromatic and Plastic Association (Inaplas) found that, on average, Indonesia consumes 17 kg per capita of plastics, while Malaysia consumes 35 kg and Thailand 40 kg. In particular, 70% of the total consumption in Indonesia is from food packaging while packaging accounts for 48% in Thailand and 45% in Malaysia (Düsseldorf 2016).

Hazardous waste

Most of the time, industrial solid waste and hazardous waste are mixed with municipal solid waste (UNEP 2004). Table 52 shows the estimation of hazardous waste generation in several ASEAN countries.

Table 51. Estimated Annual Production of Hazardous Waste in Selected Countries (unit: thousand tons)

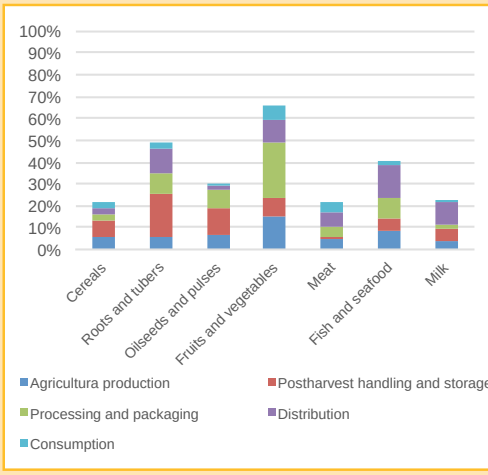
ASEAN Member State	1993	2000	2010
Indonesia	5,000	12,000	23,000
Malaysia	377	400	1,750
Philppines	115	285	530
Singapore	28	72	135
Viet Nam	460	910	1,560
Thailand	882	2,215	4,120

Source: UNEP, 2004

Food waste

Food loss per capita in Southeast Asia is 120-170 kg/year, accounting for 26-36 percent of the total per capita production of edible parts of food for human consumption – 460 kg/year. Per capita food waste by consumers is 6-11 kg/year (FAO 2011a).

Most food waste comprises fruits and vegetables with 66% being wasted between production and consumption. This is followed by roots and tubers (49%) and fish and seafood (40.2%). The least wasted commodities were meat and cereal with 21%. Food waste during consumption is generally a lot less than during the production and distribution stages (Figure 50).



Source: FAO

Figure 50. Estimated/assumed waste percentage for each commodity group in each step in Southeast Asia

E-waste management

The rates of development and abandonment of technologies such as laptops, tablets, and smart phones in Asia are equal. The rapid update in new technological models even with minimal improvements leads to an acceleration in the generation of e-waste (GBI Research 2012).

A recent study (United Nations University 2017) showed a 63 percent increase in e-waste. The average domestic e-waste generation in ASEAN in 2014 was 4.64 kg/inhabitant (inh), which is higher than the whole of Asia (3.7 kg/inh) and Africa (1.7 kh/inh) but is much lower compared to the other continents: Americas (12.2 kg/inh), Europe (15.6 kg/inh) and Oceania (15.2 kg/inh) (C.P. et al. 2015). Singapore produced the most e-waste domestically per inhabitant, while Myanmar the least (Table 53)

The Thailand State of the Environment Report 2016 (Government of Thailand 2017) shows that electronic waste from electrical appliances and electronic products continued to increase from 357,000 tons in 2012 to 384,233 tons in 2015.

This waste includes: Televisions: 106,335 tons (27 percent); air conditioning units: 74,799 tons (19 percent); refrigerators: 65,765 tons (17 percent); washing machines: 60,492 tons

(16 percent); and, computers, VCD/DVD players, telephones and digital cameras: 57,058 tons (15 percent).

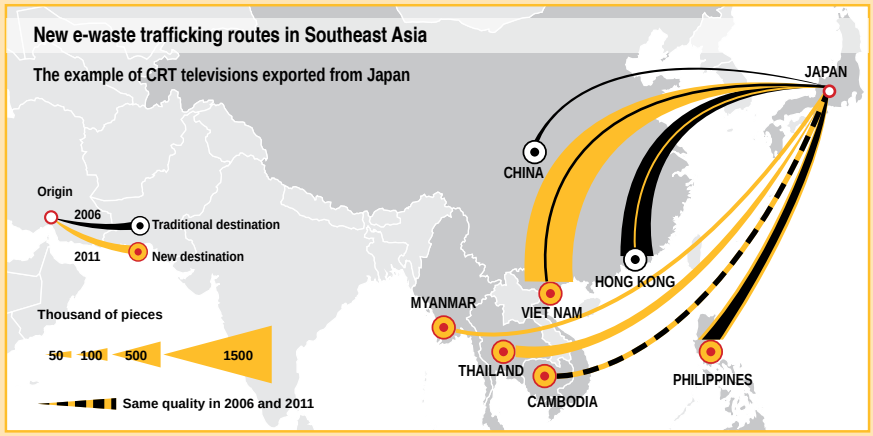
With increasing demand for recycled materials in Asia, both the export volumes and prices of recycled materials are increasing (EEA 2012). For example, the value of scrap iron and steel exports increased eight-fold between 1990 and 2011. The export of recycled materials to Asia has grown at an even greater rate. The amount has increased 1-10% while the value increased more than 10% during 1999-2011. However, a large amount of used electronical products imported in Asia are no longer functional (EEA 2012).

Table 52. Domestic e-waste generation in ASEAN in 2014

ASEAN Member State	Kg/inhabitant	Volume (Kilotonnes)
Brunei Darussalam	N/A	N/A
Cambodia	1	16
Indonesia	3	745
Lao PDR	1.2	8
Malaysia	7.6	232
Myanmar	0.4	29
Philppines	1.3	127
Singapore	19.6	110
Thailand	6.4	419
Viet Nam	1.3	116

Source: C.P. et.al., 2015

Despite the Basel Convention – an international treaty to prevent hazardous waste transfers from developed countries to developing countries, countries in Southeast Asia including Cambodia, Myanmar, Philippines, Thailand and Viet Nam have recently been identified by GRID-Arendal as new e-waste destinations (Figure 51). Indonesia recycles electronic products discarded in the USA into raw materials and then exports them to China (UNEP 2015).

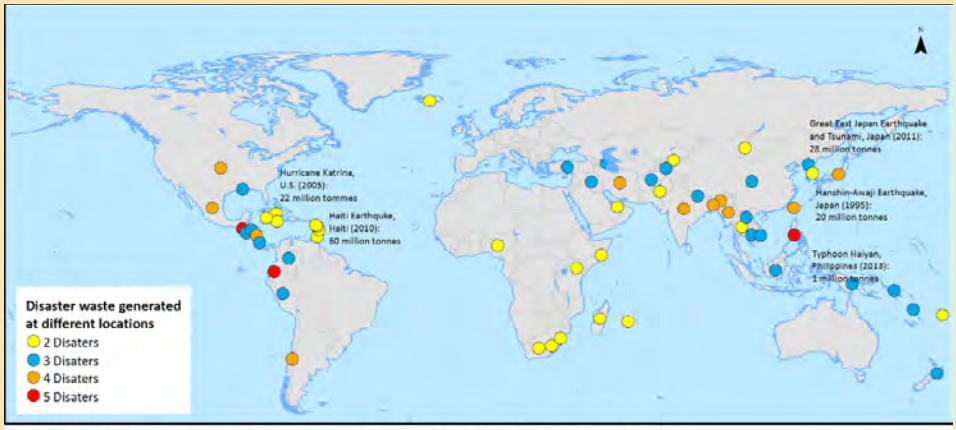


Source: Van Lynden and Oldeman 1997

Figure 51. New e-waste trafficking routes in Southeast Asia

Disaster waste

Southeast Asia is one of the most vulnerable regions to climate change and environmental disasters (Figure 52). Waste, resulting from environmental disasters including destroyed properties and infrastructure has become a significant concern in the Philippines, Myanmar, Indonesia, Thailand, Viet Nam and Cambodia. For example, Typhoon Haiyan, which made landfall in the Philippines in 2013, created over 1 million tonnes of waste (UNEP 2016).



Source: United Nations Environment Programme (UNEP)/International Solid Waste Association (ISWA), 2015

Figure 52. Different locations of disaster waste generation

Chemicals management

The use of pesticides continues to rise in the agricultural sector and is one of the biggest chemicals management challenges in Southeast Asia. Some banned chemicals are still being used. In general, there is fundamental lack of information on chemical use and distribution in Southeast Asia and chemicals are being dumped with little information or awareness of when and how to dispose of them (FAO 2011b).

One of the biggest challenge in Southeast Asia' chemicals management is the intensive use of, along with insufficiently control over, pesticides in the agricultural sector (Swedish Chemicals Agency 2016). Thailand uses the most pesticides – 6,838 tonnes per year, which is twice as much as the second ranked country – Malaysia (Table 54).

The most commonly used pesticides are more often than not the most toxic products (Swedish Chemicals Agency 2016). Pesticides are over-used and their residues have affected trade through the rejection of cross-border shipments (Dao 2016). Under the restricted control of chemical use in Europe and the US, the identification of unacceptably high levels of chemical residues from imported produce can lead to the rejection of entire shipments, causing considerable economic losses to the importing countries. During January to April 2016, the US alone rejected 95 containers of rice weighing 1,700 tons from Viet Nam, because of the high rates of pesticide residues. As a result, rice exports to the U.S. for the first eight months of 2016 was only 22,084 tons, 33 percent less when compared to the same period of the previous year (Dao 2016).

Table 53. Pesticides use in Southeast Asia

ASEAN Member State	Use of Pesticides (tonnes per year)					
	2009	2010	2011	2012	2013	2014
Brunei Darussalam	3.74	6.16	0.54	0.57	0.26	1.2
Lao PDR	0.49	0.05	-	19.53	54.07	0.2
Malaysia	16,607	21,636	3,532	4,098	4,902	4,053
Myanmar	591.84	1,812	2,369	1,677	1,245	2,220
Thailand	8,112	9,995	10,671	4,770	1,675	6,838

Source: FAO STAT, acessed 9 January, 2017

Chemicals like asbestos, banned in other regions, are still used in Southeast Asia (FAO 2011b). According to the WHO, asbestos is one of the 10 priority chemicals of high concern. Canada has banned the domestic use of asbestos and created a major education programme for its government sector, yet still mines and exports it to ASEAN, in particular to Indonesia (FAO 2011b).

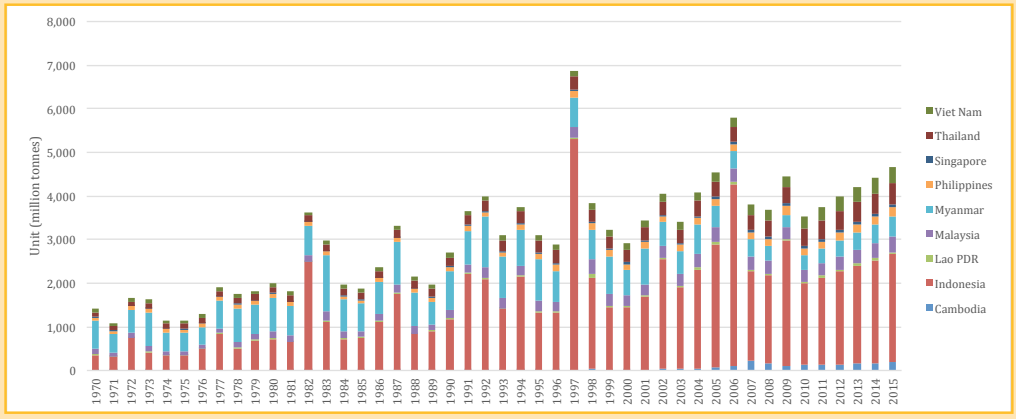
The legislative and institutional infrastructure and capacity in some Southeast Asia's developing countries to manage chemicals are not sufficient (WHO 2009).

5. Impacts

Contributions of GHG emissions to global warming

The greenhouse gas (GHG) emissions in Southeast Asia increased from 1.4 million tonnes in 1970 to 4.7 million tonnes in 2015. The two peaks in 1997 and 2006 resulted from particularly high contributions from Indonesia (Figure 53). Indonesia contributed half of all emissions in the region over the past 40 years, followed by Thailand and Viet Nam. Singapore and Lao PDR had the smallest GHG emissions in the region with approximately 51.4 and 55.2 million tonnes respectively in 2015.

More than half of the emissions resulted from land-use change; emissions decreased by about 10 percent between 1970 and 2015 (Shandl et. Al. 2016). Both energy and agriculture contributed 10-15 percent GHG emissions individually in 2015; while the share of emissions from agriculture decreased while that of energy increased. Emissions from industry and energy increased thirteen-fold during this time.



Source: Shandl et. al., 2016

Figure 53. Greenhouse gas emission in Southeast Asia

Increasing environmental pollution

A widening gap between the demands for services and the capacity of cities to meet the demands of rapid urbanization and industrialization is resulting in significant environmental and health impacts especially related to the huge amounts of waste generated and lack of systematic waste management (UNEP 2004). For example, solid and liquid waste causes water and soil contamination and wastewater pollutes rivers, lakes, and seas, which further affects the availability of clean water supplies whether from surface water

or ground water (UNEP 2004). Uncontrolled dumping leads to leachate run off, methane emission, spontaneous combustion and other environmental problems (UNEP 2016). Four of the top five countries that contribute the most plastic waste in the world's seas are from ASEAN – Indonesia, Philippines, Thailand and Viet Nam (Winn 2016).

Increasing health risks

The burning of polyvinyl chloride (PVC) cladding 2002 and ASEAN Trade in Goods Agreement to recover copper cables during e-waste recycling process, not only results in environmental pollution, but poisons the recycling operators and their neighbours (UNEP and ISWA 2015).

People are exposed to various chemicals daily and through multiple routes such as through ingestion, inhalation, skin contact and via the umbilical cord to the unborn child (WHO 2016). Exposure to chemicals poses a number of concerns for public health such as diseases, food safety, chemical safety, radio nuclear safety, accidental or deliberate release, product safety, environmental hazards and as effects from natural disasters (FAO 2011b).

Stocks of hazardous pesticides without facilities for safe hazardous waste disposal, often deteriorate and contaminate the environment and put people at risk (UNEP 2015). Poor people from the rural areas are considered as the most affected group who might not even be aware of the toxic nature of the chemicals in their environment (UNEP 2015).

Environmental crime

Recently, UNEP (2015) published a report discussing the criminal trade behind e-waste trade across continents.

E-waste contains toxic chemicals such as mercury, lead and brominated flame retardants, that categorize e-waste as hazardous and requires proper management (UNEP 2015). At the same time, it also includes precious metals including gold, copper, nickel, and rare materials of value such as indium and palladium, making e-waste an appealing trade. For this reason, e-waste is often shipped disguised as second-hand goods (UNEP 2015).

Some people benefit from illegal waste shipments to destination countries through payments for the safe disposal of waste and/or recycling certain valuable components (UNEP 2015). However, e-waste is frequently dumped or recycled in an unsafe manner. Even if some is recycled, the majority of the waste is dumped and is harmful to human health. Driven by profit, illegal shipments may include exporters, middlemen and informal recyclers who conduct their illegal activities along the legal operation chain (UNEP 2015).

At a larger scale, serious crimes such as tax fraud or money laundering can also be involved in the transport sector; however, monitoring, statistics and reporting are almost non-existent (UNEP 2015).

There are four global agreements that address this major problem: the Basel Convention on hazardous waste, Rotterdam on hazardous chemicals, Stockholm Conventions on persistent organic pollutants (POPs), Minamata Convention on mercury and also the UN Solving the E-waste Problem (StEP) Initiative on tracking and managing hazardous waste and chemicals. However, due to the lack of legal clarity, grey zones of these international conventions and the different national legislations, the management of hazardous waste shipments remains a serious challenge (UNEP 2015).

6. Responses

Resource and process efficiency

In a recent UNEP report, resource efficiency has been defined as "the ways in which resources are used to deliver value to society and aims to reduce the amount of resources needed, and emissions and waste generated, per unit of product or service" (Schandl et al. 2015). To address resource efficiency and process efficiency, ASEAN Member States have taken the following initiatives: Green finance to enable the region to invest in more resource- and process-efficient technologies and activities for production. On the consumption/demand side, efforts have focused on green/sustainable public procurement (GPP/SPP) and ecolabelling, green building rating system, and energy labelling schemes.

Green finance

The financial sector in ASEAN plays a crucial role in encouraging investment shifts from traditional industries that are based on fossil fuel and natural resources towards more resource-efficient technologies and business models (Volz 2016). Green investment in Southeast Asia increased from US$ 13.5 billion in 2011 to US$ 22 billion in 2013 (Table 55), which accounts for half of the whole Asia region (Volz 2016). At the same time, it was estimated that in 2012, ASEAN invested US$ 51 billion in fossil fuel subsidies (IEA 2013). Subsidies remain a significant factor of energy market distortion, even if Indonesia, Malaysia and Thailand have made notable reform efforts, through increasing electricity tariffs and reduced subsidies for liquefied petroleum gas (LPG) and oil use. Government actions will be continually needed to address the barriers to facilitate energy efficiency mainstreaming in ASEAN (IEA 2013).

Table 54. Financial institutions in Southeast Asia signed up to global sustainable finance initiatives

ASEAN Member States	Name of the company	Industry
Indonesia	Bank bjb	Banking
	PT Bank Negara Indonesia (Persero) Tbk	Banking
Malaysia	Amgeneral Insurance Berhad	Insurance
Philippines	Development Bank of the Philippines	Banking
	Land Bank of the Philippines	Banking
	National Reinsurance Corporation of the Philippines	Insurance
Singapore	City Development Limited	Investment
Thailand	Bangkok Insurance Public Company, Ltd	Insurance
	TISCO Financial Group Public Company Limited	Banking
Viet Nam	ABBANK	Banking

Source: Association for Sustainable & Responsible Investement in Asia (ASRA) 2014

Volz (2016) notes that Environmental, Social and Governance (ESG) standards have been incorporated in very few financial institutions in Asia (Table 56). With increased recognition of the benefits of green finance and the global trend in green investment, ASEAN Capital Markets Forum (ACMF) took on the leadership role in identifying green finance standards for ASEAN at its 25th Forum in Jakarta (San and Nordin 2016).

At the national level, only Indonesia and Viet Nam have taken the initiative to align their financial systems with sustainable development (Volz 2016). In 2014, Otoritas Jasa

Keuangan (OJK), the financial regulatory authority in Indonesia, developed a roadmap for Sustainable Finances in Indonesia (2015-2019). In 2015, the state Bank of Viet Nam established its Directive on Promoting Green Credit and Managing Environmental and Social Risks and a 10-sector checklist (Volz 2016).

Table 55. Sustainable investment assets under management by market (in US$ millions)

ASEAN Member State	2011	2013
Indonesia	595	1,142
Malaysia	9,956	15,087
Singapore	2,967	5,660
Thailand	14	20
Viet Nam	-	195
Total	13,532	22.104

Source: FAO-AquaStat (2017)

Green/Sustainable public procurement (GPP/SPP) and ecolabelling

Since the Rio Earth Summit in 1992, Green Public Procurement (GPP) / Sustainable Public Procurement (SPP) has been considered as one of the most effective tools for promoting sustainable goods and services (AIT 2016). On April 1st, 2014, the Sustainable Public Procurement Initiative (SPPI) officially became UNEP's 10-year framework of programmes on sustainable consumption and production patterns (10YFP) Programme at an event in New York, at the margins of the 10th Session of the Open Working Groups on Sustainable Development Goals (SDGs) (Yaker 2014). UNEP launched a project "Stimulating the demand and supply of sustainable products through green/sustainable public procurement and ecolabelling" (GPPEL/SPPEL) amongst ASEAN+3 countries in 2013 (AIT 2016).

Table 56. Status of Type I ecolabelling schemes in 2014

ASEAN Member State	Name of environmental lable scheme	Ecolable since	Legal basis of ecolabeling	Logo	Global Ecolabeling Network	No. of standards	No. of certified product categories	No. of certified products
Brunei Darussalam	N/A	N/A	N/A	N/A	No	-	N/A	-
Cambodia	N/A	-	Draft law in 2012, not implemented	N/A	Yes	-	N/A	-
Indonesia	Ramah Lingkungan	2004	No laws yet		Yes	12	12	19
Lao PDR	N/A	-	No laws yet	N/A	No	-	N/A	-
Malaysia	SIRIM E-L scheme	2004	Green Directory, but not mandatory		Yes	37	37	72
Myanmar	N/A	-	No laws yet	N/A	No	-	N/A	-
Philippines	Green Choice	2002	Executive order 301 since 2005		Yes	38	38	41
Singapore	Green Label	1992	No specific laws		Yes	45	16	2150
Thailand	Green Label	1994	Cabinet Resolution of 2008		Yes	73	23	512
Viet Nam	Viet Nam Green Label	2009	Law on Environmental Protection since 2014		No	14	14	54

Source: AIT, (2016)

In 1992, Agenda 21 recommended governments to promote environmental labelling, aiming at consumption pattern changes (AIT 2016). The international organization for standardization (ISO) has classified environmental labels into three categories: Type I (ISO 14042) – "a voluntary, multiple-criteria based third party program"; Type II (ISO 14021) – "informative environmental self-declaration claims"; and Type III (ISO/TR 14025) – "voluntary programs that provide quantified environmental data" (AIT 2016). Table 57 showed the status of Type I ecolabelling schemes in each ASEAN Member States.

Opportunities of SPP implementation exist under relevant agreements at various levels: 1) regional agreements within ASEAN, such as ASEAN Sectoral Mutual Recognition Arrangement for Electrical and Electronic Equipment (ASEAN EE MRA) signed in 2002 and ASEAN Trade in Goods Agreement (ATIGA) in 2003, 2) multilateral agreements between ASEAN and other countries including China and Japan, 3) bilateral agreements between countries, like Korea and Thailand, Singapore and Australia, as well as 4) the international WTO Agreements - General Agreement on Tariffs and Trade (GATT) and Technical Barriers to Trade (TBT) Agreement where all 10 countries are involved (AIT 2016).

Green building rating systems

Since the end of last century, green building rating scheme has attracted people's attention on its potential to address sustainability in building construction through encouraging energy efficiency, water efficiency, material efficiency, indoor environmental quality, transportation, innovations, and construction and waste management (Cadorna et al. 2014).

Starting from Singapore in 2005, most ASEAN Member States developed their own green building rating systems to drive more sustainable building construction in their countries. Table 58 shows the existing green building rating systems in ASEAN Member States.

Table 57. Type and cost of existing green building rating systems in ASEAN Member States

ASEAN Member State	Green Building Rating System	Establishment	Cost	Mandatory/ Voluntary
Brunei Darussalam	None	-	-	-
Cambodia	None	-	-	-
Indonesia	GREENSHIP	2009	-	Voluntary
Lao PDR	None	-	-	-
Malaysia	GBI (Green Building Index)	2009	MYR 5,000 - 45,000	Voluntary
Myanmar	None	-	-	-
Philippines	BERDE (Building for Ecological Rsponsive DEsign Excellence) QCGBC (Quezon City Green Building Council)	BERDE (2007) QCGBC (2009)	BERDE (PHP 50,000)	Voluntary
Singapore*	GREEN MARK	2005	SGD 15,390 - 35,790	Mandatory
Thailand	TREES (Thai's Rating of Energy and Environmental Sustainability)	2009	THB 30,000 - 300,000	Voluntary
Viet Nam	LOTUS	2007	VND 84,500,000 - 210,000,000	Voluntary

*Source: Cadoma et al., 2014, *Building & Construction Authority, Singapore 2016*

ASEAN Centre for Energy has further established a Green Building Award in 2014 for two categories – small & medium green building and large green building. Table 59 included all the winners since 2014.

Table 58. Winners of ASEAN Green Building Award

Category		2014	2015	2016
Small & Medium Green Building Category	Winner	Pluit Residential House, Indonesia Samwoh Eco Green Building, Singapore	Mat Jambol House, Singapore	Tsao Residence, Singapore
	1st Runner-up	-	-	Komplek Hijau Solar, Malaysia
Large Green Building Category	Winner	Green Building of Sinarmas Land Plaza, Indonesia	Ocean Financial Centre, Singapore	Main Building of Ministry of Public Works and Housing (PWH), Indonesia Insead Leadership Development Centre (Phase 3), Singapore
	1st Runner-up	Treetops Executive Residences, Singapore	SCG 100th Year Building: The Siam Cement Public Co. Ltd., Thailand	Menara Kerja Raya High Rice Office Tower, Malaysia Minitry of Manpower Service Centre, Singapore
	2nd Runner-up	King Power Pattaya Complex, Thailand	United World College of South East Asia (East Campus), Singapore	Thanya Park, Thailand

Source: ASEAN Centre for Energy, 2017

Energy labelling scheme

As a result of rapid economic development and urbanization, demand for energy in Southeast Asia has grown for buildings, appliances and equipment, lighting, transportation, and industry (IEA 2014). The International Energy Agency (IEA) has recommended the implementation of energy labels as one of the ways to address energy efficiency in this region (IEA 2014).

Many countries in ASEAN have developed their own energy labelling schemes; the Philippines, Singapore and Thailand have applied mandatory labels. Cambodia, Lao PDR, and Myanmar have received support from the ASEAN-Japan Energy Efficiency Partnership on better energy management system including energy labelling (ASEAN Centre for Energy 2016), Table 60 shows the energy labelling scheme in ASEAN Member States.

Box 17. Trash Trail in Singapore

To find out where the trash goes, Jason Godfrey, Host of Channel News Asia tracked disposed household appliances, coffee cups, textile waste, mobile phones, and data in Singapore for the first time.

Results indicated dramatic amounts of waste was generated, with only a limited amount being recycled or upcycled, even though Singapore is supposedly the most advanced country in ASEAN managing its waste. For example, , GPS trackers that some disposed refrigerators were sold in Malaysia as a second-hand appliances. Similar to mobile phones, only 7 percent of Singaporeans recycled their unwanted phones, while some phones went into the wrong trash bins that led them to the incinerators. Data shows that about 35,000 phones, if recycled, could contribute to a 1-kg gold bar, worth US$ 45,000, in addition to other metals such as silver, copper or rare earth materials.

Source: Channel News Asia, 2017

Waste management

An integrated waste management system includes waste avoidance and reduction, reuse, recycling and disposal in that order (ZHAO and Hathaway 2011). However, most Southeast Asian countries do not pay enough attention to the first priority – waste avoidance and reduction. Furthermore, there is little separation or pre-treatment at source or during the collection processes (UNEP 2004). While landfill still remains the main way to dispose of solid waste, 3Rs (Reduce, Reuse, Recycle) and waste-to-energy have become popular in the region. Plastic bags, e-waste and food waste are among the new emerging waste items that have attracted special attention where customized actions are needed.

National effort on solid waste management

In Brunei, the Department of Environment, Parks and Recreation (DEPR) Ministry of Development, is responsible for collecting and disposing of solid waste for the whole Brunei Darussalam, while Department of Municipal Boards under Ministry of Home Affairs is responsible for collecting and disposing of municipal waste from municipal area of Bandar Seri Begawan, Tutong and Belait–Seria (UNEP 2004). DEPR has taken the following initiatives to improve waste management: 1) promote 3R in its new integrated waste management system, through talks/lectures in schools and communities, through public-private partnerships (PPP) with universities and primary schools; 2) promote eco/environmental clubs and set up waste separation activities in secondary school; 3) promote reusable bags to reduce plastic bag consumption through cooperation with supermarket operators; and 4) provide recycling bins with recycling companies (Yunos et al. 2010).

Cambodia has two private municipal waste collection and transportation companies for its main cities with market fee collectors for the others (Phalla 2016). The main disposal includes open pits and burning at its 76 landfills, before which recycling is carried out through waste buyers during the waste generation stage or through scavengers before transportation to the dumping-sites (Phalla 2016). The government allocated US$ 1.25 million to sub-national administration to support urban solid waste management in 2015 and another US$ 2 million in 2016. The country is also developing a waste-to-energy scheme (Phalla 2016).

Indonesia has enacted three laws for solid waste management for solid waste, environmental protection and management, and industry, and a further four regulations on the implementation of 3R through waste bank, household and household-like solid waste management, hazardous waste management, and water supply and sanitation (Ministry of Environment & Forestry and Ministry of Industry 2016).

National and local government received capacity development on 3R and solid waste management system provided by Japan International Cooperation Agency (JICA). In 2014, the Government of Indonesia also provided communities with 570 units of 3R facility, 3 units of intermediate treatment facility, and 247 units of developed and rehabilitated local and regional solid waste landfill (Ministry of Environment & Forestry and Ministry of Industry 2016). Indonesia has also promoted and implemented green industry schemes through resource efficiency and cleaner production programmes. It has aimed to reduce solid waste by 30% or equivalent to 20.9 million tons by 2025, and manage all industrial waste through the 3R principle (Ministry of Environment & Forestry and Ministry of Industry 2016).

Malaysia has developed the Action Plan for "A Beautiful and Clean Malaysia (ABC)" to implement procedures in solid waste management. It has established the Solid Waste and Public Cleansing Management Act 2007 and 3R programme (Sin et al. 2013). Malaysia also aims to replace the disposal sites with recycling, composting, incineration, inert landfill and sanitary landfill (Sin et al. 2013). Waste disposal by incineration is expected to account for 16.8% by 2020 (Sin et al. 2013). To improve the environmental performance of construction, Malaysia has developed the Construction Industry Development Board (CIDB), which has produced a master plan and standard specifications for building work and adopted the Industrial Building System (IBS) to control waste generation during construction activities (Sin et al. 2013).

Table 59. Energy labelling scheme in ASEAN Member States

ASEAN Member State	Energy Labeling	Application	Mandatory / Voluntary	Logo
Brunei Darussalam	Yes	Air-conditioners (focus area), refrigerators, water heaters, and other electrical rpoducts	Voluntary	
Cambodia	No	-	-	-
Indonesia	Yes	Television, refrigerators, air conditioners, ballasts, and washing machines	Voluntary	
Lao PDR	No	-	-	-
Malaysia	Yes	Air, conditioners, refrigerators, lighting, and televisions	Voluntary	 (Endorsement label for refrigerator)
Myanmar	No	-	-	-
Philippines	Yes	Non-ducted ACs, refrigerators and freezers, and lightings	Mandatory	
Singapore	Yes	All registrable goods including air-conditioner, refrigerator, clothes dryer, television, and lamp	Mandatory	
Thailand	Yes	12 appliances, a variety of equipment items, and Standby Power for televisions and monitors. For non-electric products, asuch as LPG stoves, VSD, and glazing and insulation	Voluntary (Ministry of Energy) & Mandatory (Thai Industrial Standards Institute)	Voluntary labels:  (for electric produts)  (for non-electric produts) Mandatory label: 
Viet Nam	2007	Refrigerator, ACs, lamps, ballasts, and water heaters	Voluntary	 (Energy saving | energy rating)

*Source: ZHAO and Hathaway, 2011, :(Brunei National Energy Research Institute (BNERI), 2015), **Example taken from the government website: https://www.doe.gov.ph/consumer-connect/lighting-and-appliance-labelling-standard.*

As part of its draft Green Economy Policy Framework, Myanmar aims to reduce waste and ensure sustainable consumption and production through improving its waste collection at source, providing incentives for waste generation reduction or enforcing landfill taxes, launching the pay-as-you-throw schemes, and deposit refund. Efforts have also been made at city level through public awareness raising campaigns and environmental education programmes to engage citizens in waste reduction and reuse activities (IGES 2016).

The Philippines enacted Republic Act 9003 (RA 9003) or the Ecological Solid Waste Management Act of 2000, aiming for a solid waste management (SWM) board at municipal and provincial levels and a committee at the barangay level (district). It has adopted a 10-year SWM plan, Materials Recovery Facilities (MRF) per barangay or cluster of barangays and municipally-centralized MRF. In 2004, it converted open dumpsites to controlled dumpsites and then in 2006, further banned the controlled dumpsites (Department of Environment and Natural Resources et al. 2015). The country has developed the Philippine National Solid Waste Management Strategy (NSWMS) (2012-2016) (Department of Environment and Natural Resources et al. 2015). In 1980, Metropolitan Manila started its first sewage treatment plant (STP) project with funding from the World Bank: it has built up 27 STPs in its second sewage project phase and eight in the third phase (Department of Environment and Natural Resources et al. 2015).

Singapore has the most efficient waste management programme among all the AMS with public waste collection schemes for households and general waste collection system for commercial and industrial premises. In 1979, Singapore adopted the first Waste-to-Energy (WTE) plant: now, it has four WTE plants at Tuas and Senoko which incinerated 90% of non-recyclable Municipal Solid Waste (MSW) with the remaining 10% deposited at the offshore Semakau Landfill (World Bank 2011). A weigh-bill with type and source of waste is required when waste is sent to the four WTE plants or the Tuas Marine Transfer Station. The National Environment Agency also encourages the public to report illegal dumping through a hotline (National Environment Agency 2017).

Thailand's National Policy on Waste Management covers 3Rs promotion, integrated technology, clustering management, public-private partnership, and waste-to-energy (WTE) (National Environment Agency 2017). Achievements of 3R include the establishment of Thailand Waste Recovery Center (TWRC) for 3Rs, the development of 3Rs regulation, national 3Rs strategic plan, and capacity building on 3Rs through training, awareness raising, guidelines & manuals, and waste-specific containers. Community-based recycling programmes include school recycling programs (garbage bank), community buy back centre, waste donation, household composting, and zero waste programs. The government cooperates with other stakeholders such as manufacturers, distributers and communities to take back end-of-life products including fluorescent lamp, packaging waste, batteries, and mobile phone and also promote informal sectors on waste business. Its future vision is the integrated waste management of 3Rs and WTE (Solid and Hazardous Substances Management Bureau n.d.).

Viet Nam has enacted Decree No. 59/2007/ND-CP in 2007, on solid waste management, Decision No.1440/QD-TTg in 2008 on construction of solid waste treatment facilities in three northern, central Viet Nam and Southern key economic regions up to 2020, and Decision No. 2149/2009/QD-TTg in 2009, on national strategy for integrated management of solid waste up to 2025 (Solid and Hazardous Substances Management Bureau n.d.). The government also invested projects on electricity generation from landfill gas in Phuoc Hiep and Dong Thanh landfills, following the Clean Development Mechanism

(CDM) (Lam n.d.). Supported by the local city government committees from Ho Chi Minh City and Hanoi and the Department of Natural Resources and Environment, volunteers in both cities went around by bike to collect waste and promote the "Viet Nam Recycles" program (Lam n.d.). Government workers also accompany the traveling volunteers to show support and garner greater attention (Viet Nam Recycling Platform (VRP) n.d.).

Plastic bags management

Four of the top five countries in ASEAN contribute 60% of the marine plastic waste – Indonesia, Philippines, Thailand and Viet Nam. AMS needs to have joint efforts between the national governments and multilateral institutions to prioritize ocean-plastic and waste-management agendas (Viet Nam Recycling Platform (VRP) n.d.). Many states in Malaysia have enacted laws on waste separation since 1 June 2016 (Ocean Conservancy and McKinsey Center for Business and Environment 2015). Since early 2016, the Ministry for the Environment and Forestry enforced new policies to ask the supermarkets and vendors to charge customers for using plastic bags on Sundays in 22 cities across Indonesia (Bakar 2016). With great support from the supermarkets, markets and retailers, Malaysia has started its "No Plastic Bag Day" every Saturday in Selangor since 2010. Seven years later, all retailers agreed not to provide free single-use plastic bags from January 1st, 2017 (Wirdana 2016).

E-waste

As noted before, Southeast Asia receives large quantities of used electronic items and in many cases disposal of such items is not properly handled, with sometimes, informally recycled "backyard" operations involving open-air burning of copper wire and acid baths to recover valuable metals (FMT Reporters 2016).

A recent study by Basel Convention Regional Centre for South-East Asia (BCRC-SEA) (Stephenson 2008) found that there are few full recycling and disposal facilities for e-waste . Singapore has 100 licensed facilities, Malaysia 97 partial recovery and 32 full recovery facilities, Brunei Darussalam 1 formal facility, Indonesia 1 licensed recycling facility, and Thailand 1 regional e-waste facility (Basel Convention Regional Centre for South-East Asia 2016).

To improve its e-waste collection, Viet Nam has implemented the mandatory extended producer responsibility (EPR) while Singapore and Malaysia have implemented it voluntarily.

Food waste

Thailand launched the "Save Food Campaign" in May 2015 and Malaysia in March 2016 with the support from FAO (2011a). Malaysia also launched a National Save Food Network in November 2015 with FAO Technical Cooperation Project Facility (TCPF). Indonesia, Cambodia, Viet Nam and Singapore have used brochures, posters and educational materials from FAO to raise awareness on food loss and waste issues. The educational materials were further translated into Khmer and disseminated in schools in Cambodia. During 2011-2013, capacity building activities on reducing post-harvest losses in horticultural chains have been provided to Cambodia, Lao PDR, Thailand and Viet Nam.

Regional effort

At regional level, ASEAN and UNEP International Environmental Technology Centre (UNEP-IETC) conducted joint regional studies, completed in 2016, on (i) Waste Management, (ii) Electronic Waste (E-waste) Management and (iii) Mercury Waste Inventory. The studies on

Waste Management and Mercury Waste inventory were implemented by Asian Institute of Technology (AIT), while the E-Waste study was conducted by Basel Convention Resource Centre-Southeast Asia (BCRC-SEA). The results and recommendations of the studies served as inputs for ASEAN in policy decision making.

Table 60. Ratification of international conventions on chemicals management

ASEAN Member State	Basel Convention[45]	Rotterdam Convention[46]	Stockholm Convention[47]	Minamata Convention[48]
Brunei Darussalam	Accession		Signature	
Cambodia	Accession	Accession	Ratification	Signature
Indonesia	Accession	Ratification	Ratification	Signature
Lao PDR	Accession	Accession	Ratification	
Malaysia	Accession	Accession	Signature	Signature
Myanmar	Acceptance		Accession	
Philippines	Ratification	Ratification	Ratification	Signature
Singapore	Accession	Accession	Ratification	Signature
Thailand	Ratification	Accession	Ratification	Accession
Viet Nam	Accession	Accession	Ratification	Approval

Chemicals management

Efforts on international chemicals conventions have been made at both national and regional levels within ASEAN, through UN agencies or bilateral agreement.

National efforts on international conventions

There are four international conventions addressing chemicals management and its related issues – Basel, Rotterdam, Stockholm, Minamata Conventions. SDG 12 'Ensure sustainable consumption and production patterns' has encouraged countries to ratify the first three convention for better chemicals management. It is recommended that all countries continue the process of ratification of these conventions so that Target 12.4.1 (number of parties to international multilateral environmental agreements on hazardous waste, and other chemicals that meet their commitments and obligations in transmitting information as required by each relevant agreement) will be achieved. Table 61 showed the status of ratification of each convention in all ASEAN Member States.

Currently, all member states have signed up to at least one of three international conventions; however, the ratification rate is limited.

In 2010, about 9,000 consumers and lab workers from research establishments, authorities, transport and waste management companies in Indonesia, Philippines and Thailand have attended trainings on how to handle laboratory chemicals safely, provided by Merck and German Association for International Cooperation (GIZ) through the Environmentally Sound Management of Chemical Waste in Southeast Asia project (Merck 2012).

45. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted on 22 March 1989 and entered into force on 5 May 1992.
46. Rotterdam Convention was adopted on 10 September 1998 to promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals including pesticides and industrial chemicals and contribute to the environmentally sound use of those hazardous chemicals. It entered into force on 24 February 2004.
47. Stockholm Convention on Persistent Organic Pollutants was adopted on 22 May 2001 and entered into force on 17 May 2004. It aims to minimize the risks from the agreed list of POPs through measures to reduce and/or eliminate their emissions or discharges.
48. Minamata Convention is to protect the human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds. It was adopted on 10 October 2013 and enters into force on 16 August 2017.

Regional effort

The ASEAN Working Group on Multilateral Environmental Agreements has been formed to facilitate regional cooperation in capacity building, experience and best practices sharing, and collaboration to implement the four international conventions – Basel, Rotterdam, Stockholm and Minamata. It was renamed in the 26th ASOEN Meeting as "ASEAN Working Group on Chemicals and Waste (AWGCW)", whose first meeting was held in 2016 to present updates on ASEAN-UNEP IETC Joint Activities on Waste Management, E-Waste Management and Mercury Inventory in Bali, Indonesia.

At the beginning of 2017, the ASEAN Joint Declaration on Hazardous Chemicals and Wastes Management was conveyed to the following meetings of the conventions: the 13th Meeting of the Conference of the Parties to the Basel Convention (BC COP-13), the 8th Meeting of the Conference of the Parties to the Rotterdam Convention (RC COP-8), and the 8th Meeting of the Conference of the Parties to the Stockholm Convention (SC COP-8) in Geneva, Switzerland during 24 April to 5 May 2017 and submitted to the respective convention secretariat.

The East and South East Asia (ESEA) Forum on Best Available Techniques (BAT) and Best Environmental Practices (BEP) was established by the UN Industrial Development Organization (UNIDO) to support member countries in the ESEA region to fulfil their obligation obligations to Article 5 of the Stockholm Convention on Persistent Organic Pollutants (POPs): "Regional Plan for the introduction of BAT / BEP strategies to industrial source categories of the Stockholm Convention Annex C of Article 5 in the ESEA region"(Merck 2012). It was launched on October 5, 2007 during the Inaugural Ministerial Meeting in Bangkok. With financial support from Global Environment Facility (GEF), BAT/ BEP guidelines have been developed, translated into local languages, disseminated, and implemented in 2013 (Marchich 2014).

In 2007, a thematic working group of World Health Organisation (WHO) was established to work on toxic chemicals and hazardous substances in Thailand. It also launched the 2007-2010 regional work plan, aiming at building the capacity of member countries and strengthening the collaboration on toxic waste management (Marchich 2014).

With the support from seven AMS, the FAO published its guidance for harmonizing pesticide regulatory management in Southeast Asia (RAP Publication 2012/13). The document serves as a reference manual to support pesticide management in ASEAN. It is also recognized that further consultations and cooperation are needed to carry out these guidelines (WHO 2009).

Back to 2015, ASEAN and Japan reached an agreement on co-developing the ASEAN-Japan Chemical Safety Database (AJCSD) to facilitate the development of a chemicals management system in the region (FAO 2013).

Cross-cutting responses

Sustainable production and consumption is a cross-cutting issue highly related to other themes, such as economic growth, wellbeing, agriculture, cities, climate change and energy, biodiversity and natural resources, governance and technologies (Asano 2015).

ASEAN Environmentally Sustainable Cities (ESC) initiative

To stimulate, benchmark, and recognize exemplary efforts on environmental sustainability especially in the aspects of Clean Air, Clean Water, and Clean Land, ASEAN has initiated

the ASEAN Environmentally Sustainable City (ESC) Award programme. The inaugural ASEAN ESC Award ceremony was held in Ha Noi, Viet Nam in 2008, on the occasion of the 11th Informal ASEAN Ministerial Meeting on Environment (IAMME), and subsequently in 2011 and 2014. The ASEAN Environment Ministers presented the awards to ten cities/townships/districts in ASEAN that had made exemplary efforts towards environmental sustainability. The ESC Award is held every 4 years and recipients in the past are shown in Table 61.

Table 61. List of ESC Model Cities

ASEAN Member State	Cities
Cambodia	Phnom Penh, Pursat and Siem Reap
Indonesia	Balikpapan, Lamongan, Malang, Palembang, Surabaya, and Tangerang
Lao PDR	Luang Prabang, and Xamneua
Malaysia	North Kucing
Myanmar	Mandalay, Pyin Oo Lwin, Yangon
Philippines	Legazpi, Palo, Puerto Princesa, San Carlos
Thailand	Chilang Rai, Maenhongson, Muangklang, Nonteng, Panus Nikhom, Phicit, Phitsanulok, and Renunakhon
Viet Nam	Cao Lanh, Da Lat, and Da Nang

ASEAN ESC Model Cities

The ASEAN ESC Model Cities Programme is a regional initiative aimed at promoting the development of Environmentally Sustainable Cities (ESC) across ASEAN countries. It provides seed funding, technical assistance and other forms of support to raise local capacity for implementing innovative and voluntary bottom-up initiatives, as well as to strengthen national ESC frameworks and actions that facilitate the replication and scaling up of good practices and policies within and across countries. It also promotes city-to-city collaboration and provides a broad and inclusive platform matching ASEAN cities with interested resource partners. This programme has been realised with the generous support from the Japan-ASEAN Integration Fund (JAIF).

Table 62. ASEAN ESC Award recipients

ASEAN Member State	1st ASEAN ESC Awards (2008)	2nd ASEAN ESC Awards (2011)	3rd ASEAN ESC Awards (2014)
Brunei Darussalam	Temburong	National Housing Scheme Rimba	Bandar Seri Begawan
Cambodia	Phnom Penh	Phnom Penh	Battambang Municipality
Indonesia	Palembang	Surabaya	Balikpapan
Lao PDR	Luang Prabang	Xamneau	Luang Prabang
Malaysia	North Kuching City Hall	Perbadanan Putrajaya	Melaka
Myanmar	Taungyl	Pyin Oo Lwin	Yangon
Philippines	Puerto Princesa	Puerto Princesa	San Carlos
Singapore	South West Community Develelopment Council	South West Community Develelopment Council	North West District
Thailand	Bangkok	Phuket	Chiang Rai City
Viet Nam	Ha Long	Danang	Hue City

The ESC Model Cities Year 1 was conducted from 2011-2013, Year 2: 2014-2015, and Year 3: 2016-2017. The program has been implemented in 31 cities in 8 ASEAN Member States (Table 63).

ASEAN Eco-Schools Award Programme

This is one of the flagship programmes under the ASEAN Cooperation on Environment and aims to create a school culture geared towards environmental protection and preservation through management, commitment and infusion into curriculum, co-curriculum and greening activities. Such activities are dedicated to education, facilitating and inspiring school communities to protect and sustain the environment, be it in schools, at home, in the community, within the society and the nation at large, such as: child friendly school, and eco club (Cambodia); Adiwiyata Program (Indonesia); Sekolah Lestari/ Environmental Award Programme (Malaysia); and Ecofriend Award, and Singapore Environment Council's Schools' Green Audit Award (Singapore).

The ASEAN Environment Ministers have endorsed the proposal to conduct an ASEAN Eco-schools Award, initially on a non-competitive basis in 2012, to encourage schools in AMS to adopt environmentally friendly practices in the schools and their surrounding communities. Such recognition also provides an opportunity for information and experience sharing among the schools which may encourage schools in AMS to continue or start to do more for environment.

The presentation ceremony of the 1st ASEAN Eco-School Award was s conducted in Malaysia 2012 on 17-18 July 2012 in Kuala Lumpur, Malaysia back-to-back with the ASEAN Environment Year. The 2nd ASEAN Eco-Schools Award 2015 Presentation Ceremony was held on 29-30 July 2015 in Nay Pyi Taw, Myanmar, with support from Japan-ASEAN Integration Fund (JAIF) and Hanns Seidel Foundation (HSF). It granted ASEAN awards to the 20 selected schools from 10 AMS.

Box 18. The Sustainable Singapore Blueprint 2015

The Sustainable Singapore Blueprint 2015 aims for Singapore to become:

A liveable and endearing home

"*Eco-Smart*" *endearing towns*: more facilities such as parks, sports facilities and other community amenities will be developed to promote a green lifestyle for citizens to save energy and water and segregate recyclables.

A "*car-lite*" *Singapore*: To reduce the carbon footprint and ensure a healthier lifestyle, a denser rail network and extensive bus services will be provided; cycling and walking and electric car-sharing will be encouraged.

A vibrant and sustainable city

Towards a zero waste nation: The Government, the community and businesses will work together to reduce the consumption ofmaterials as well as reuse and recycle all of them them to give them a second lease of life.

A leading green economy: Greener practices will be adopted by businesses. The proportion of solar power within the energy system will be increased, and the percentage of BCA '*Green Mark standard*' achieved by buildings will be increased from 25 percent to 80 percent.

An active and gracious community

A joint effort from all stakeholders will be made to achieve this blueprint.

Source: Government of Singapore, 2015

The awardees of ASEAN Eco Schools Award in the past are shown in Table 63.

Table 63. Awardees of ASEAN Eco Schools Award.

ASEAN Member State	2012		2015	
	Primary School	Secondary School	Primary School	Primary School
Brunei Darussalam	Kuala Belait Primary School	Sayyidina Hasan Secondary School	Jerudong Primary School	Sekolah Menengah Muda Hashim
Cambodia	Hun Sen sandan Primary School	Treng Trayoeung Secondary School	Wat Bo Primary School	Preah Sisowath High School
Indonesia	Tanjung Sekar 1 Elementary School	Muhammadiyah 1 Junior High School	SMPN 4 Martapura, South Kalimantan, Indonesia	SMA Negeri 2 Temanggung, Central Java
Lao PDR	Sokpaluang Primary School	Sisattanak Lower Secondary School	Thongkang Primary School, Lao PDR	Saysetha Secondary School
Malaysia	Chinese National Type Primary School Tung Hua	Saint Michael Secondary School	Sekolah Kebangsaan Bukit Baru, Malaka	Sekolah Menengah Kebangsaan Seri Aman, Kota Tinggi, Johor
Myanmar	No. 3 Basic Education Post Primary School	No. 2 Basic Education High School, Myanmar	Basic Primary School Ywarthitsu	Basic High School Chanmyatharzi Township
Philippines	Iliranan Primary School	Camarines Sur National High School	Dubinan Elementary School	Ateneo De Davao University High School
Singapore	Fuhua Primary School	Commonwealth Secondary School	East View Primary School	Woodgrove Secondary School
Thailand	Ban Tha Kam School	Muang Krabi School	Bannammin School	Mattayomsuwitserianus on School
Viet Nam	Thuc Nghiem Primary School	Chu Van An National High School, Viet Nam	Hanoi-Amsterdam High School for the Gifted	Foreign Language Specialised School

The 27th Meeting of ASEAN Senior Official on Environment (ASOEN) held in 2016 in Nay Pyi Taw, Myanmar agreed that ASEAN Eco Schools Award shall be conducted every 4 years back-to-back with the ASEAN Ministers Meeting on Environment.

ASEAN Youth Environment Forum

The ASEAN Youth Environment Forum (AYEF) is one of the priority actions under the ASEAN Environmental Education Action Plan (AEEAP) 2008-2012, and its successor plan, the AEEAP 2014-2018 (the AEEAP 2014-2018 is now being incorporated into the ASEAN Post Strategic Plan on Environment (ASPEN)). This AYEF aimed to promote the exchange of environmental ideas and experiences amongst the youth. This will build on and emulate the knowledge and experiences gained in their respective countries. Through the contact established at the forum, they can continue to communicate and interact with their peers in the region and develop a culture of learning and sharing information, ideas and experiences amongst themselves.

The forum participation comprised youth from ASEAN Plus Three countries (China, Japan, and Korea) in ages ranging from 15 to 20 years old. The AYEF activities are as follows:

1. The 1st AYEF was held on 22-25 April 2010 in Brunei Darussalam. The activity was co-funded by Brunei Darussalam and Japan ASEAN Integration Fund (JAIF). The Forum with the theme; "Creating a Climate for Change" was attended by a total of 140 youth participants, consisting of 5 youths from each ASEAN Member State, China, and Japan; 3 youths from the Republic of Korea; 80 local youths from Brunei Darussalam.

2. Brunei Darussalam with support from Hanns Seidel Foundation (HSF) hosted the 2nd AYEF that was held on 2-4 December 2013, with the theme: "'Youth and Sustainability'. The forum had the participation of 80 young people from ASEAN and Plus Three Countries.
3. The 3rd AYEF with the theme "Imagine. Create. Change" was conducted on 8-10 April 2017 hosted by Singapore. The 3rd Forum was co-supported by ASEAN plus Three Cooperation Fund (APTCF) and HSF. The forum was participated by 175 local and international youths from ASEAN Member States, and China.

ASEAN Forum on SCP

In the 14th Informal ASEAN Ministerial Meeting on the Environment in September 2013, ASEAN Ministers Responsible for Environment announced the Joint Statement on the Implementation of Sustainable Consumption and Production in ASEAN to implement sustainable consumption and production towards achieving sustainable development and explore the possibility of establishing an ASEAN Forum on Sustainable Consumption and Production (AFSCP) (ASEAN Environment Division 2013).

Box 19. Search for "Sustainable and Eco-friendly Schools" in the Philippines

Now in its fifth leg, the country's National Search for Sustainable and Eco-friendly Schools continue to recognize environmental champions in the elementary, secondary and tertiary levels. It is a joint program of the Department of Environment and Natural Resources-Environmental Management Bureau (DENR-EMB), Department of Education (DepEd) and the Commission on Higher Education (CHED). It was first held in 2009 and has since been initiated biennially. The Search has two main objectives: first, to encourage schools and academic institutions to become more actively involved in environmental issues at a practical and local level; and second, to develop skills and understanding among students, faculty and school administrators in initiating active responses and increasing community awareness and participation on environmental concerns.

The strengthening of sustainable and eco-friendly schools is also enshrined as priorities in the ASEAN Environmental Education Action Plan for 2014-2018 and Roadmap for the Implementation of Republic Act No. 9512 (Environmental Awareness and Education Act) under the National Environmental Education Action Plan (2014-2018).

For 2015, national champions in elementary (Divisoria Elem School, Isabela); high school (Bintawan National High School, Nueva Vizcaya), and college (Foundation University, Negros Oriental) were all recognized for their best practices in waste management, water, electricity and paper conservation including their active involvement in greening programs.

The EMB-DENR also steers the Philippine Eco-friendly and Healthy Cities Program, as espoused under the ASEAN Environmentally-Sustainable Cities Program. The program is geared towards mentoring local government units (LGUs) to embrace Clean Land, Clean Water and Clean Air Programs. In February 2016, the EMB-DENR has completed (with Green Convergence) the National Search for Local Government Units (LGU) Eco-Champions, and recognized a number of environmentally-sustainable local government units.

Source: Government of the Philippines, 2017

AFSCP's main body is the member forum of high-level policy dialogue with support from its Scientific and Technical Advisory Group to identify gaps, provide knowledge base and develop policy proposals as well as its Technical Support Unit on capacity development and liaising with AMS (Akenji 2011). AFSCP has three phases: Phase I - Harvesting low-

hanging fruits (until 2015), Phase II – Resource efficiency; regional harmonization (until 2018) and Phase III – Integrating well-being indicators in measuring development (until 2020) (Akenji 2011).

SDGs in ASEAN

Sustainable domestic material consumption is a key focus of SDG 12: Ensure sustainable consumption and production patterns. The target 12.1.1 (number of countries with sustainable consumption and production (SCP) national action plans or SCP mainstreamed as a priority or a target into national policies) and the target 12.2.2 (domestic material consumption, domestic material consumption per capita, and domestic material consumption GDP) call on relevant policies to address resource and process efficiency.

SDG 12 (ensure sustainable consumption and production patterns) has encouraged countries to ratify the Basel, Rotterdam, and Stockholm Conventions for better chemicals management. It is recommended that all countries proceed to the process of ratification of these conventions to achieve Target 12.4.1 (number of parties to international multilateral environmental agreements on hazardous waste, and other chemicals that meet their commitments and obligations in transmitting information as required by each relevant agreement).

7. References

AIT (2016) Regional Collaboration on Ecolabelling – Asia Pacific *Deliverable 1: Report on Key Opportunities for Pilot Products, with Policies and Challenges*. http://www.scpclearinghouse.org/sites/default/files/report_on_key_opportunities_for_pilot_products_with_policies_and_challenges.pdf.

Akenji, L. (2011) '*A proposal to the ASEAN Member States through the ASOEN Chair of ASEAN*'. https://pub.iges.or.jp/system/files/publication_documents/pub/presentation/2731/Forum_Jakarta_Nov2011_akenji.pdf.

An, D. T. (2014) '*Viet Nam Green Label and Green Public Procurement in Viet Nam*'. https://www.env.go.jp/policy/hozen/green/kokusai_platform/2014symposium/06VietNam.pdf.

Asano, Y. (2015) '*ASEAN Japan Chemical Safety Database (AJCSD) Launched On-line – a First Step towards a Harmonized Chemical Management System in Asia?*'

ASEAN (2014) '*ASEAN Joint Statement on Climate Change 2014*'. http://www.asean.org/images/pdf/2014_upload/ASEAN%20Joint%20Statement%20on%20Climate%20Change%202014.pdf.

ASEAN Centre for Energy (2017) '*Green Building Awards 2014*'. http://www.aseanenergy.org/aea/green-building-awards-2014/.

ASEAN Centre for Energy (2016) '*Improving Energy Efficiency Standard and Labelling for Refrigerators in Cambodia*'. April. http://www.aseanenergy.org/articles/improving-energy-efficiency-standard-and-labelling-for-refrigerators-in-cambodia/.

ASEAN Environment Division (2013) '*Joint Statement on the Implementation of Sustainable Consumption and Production in ASEAN by the ASEAN Ministers Responsible for Environment*'. 27 September. http://environment.asean.org/joint-statement-on-the-implementation-of-sustainable-consumption-and-production-in-asean-by-the-asean-ministers-responsible-for-environment/.

Association for Sustainable & Responsible Investment in Asia (ASrIA) (2014) 2014 *Asia Sustainable Investment Review*. http://www.igcc.org.au/Resources/Documents/2014%20Asia%20Sustainable%20Investment%20Review%20-%20Dec%202014.pdf.

Bakar, S. K. B. A. (2016) '*Enforcement of waste separation law starts today*'. http://www.freemalaysiatoday.com/category/nation/2016/06/01/enforcement-of-waste-separation-law-starts-today/.

Basel Convention Regional Centre for South-East Asia (2016) Study on E-Waste Management in ASEAN Countries.

Brunei National Energy Research Institute (BNERI) (2015) Comparative Study on Energy Efficiency Ratings and Labelling for Air-Conditioners: Proposal for Brunei. http://www.bneri.org.bn/PublishingImages/Lists/Recent%20Publications/NewForm/Comparative%20Study%20on%20Energy%20Efficiency%20Ratings%20and%20Labelling%20for%20Air-conditioners%20Proposal%20for%20Brunei(R).pdf.

Building & Construction Authority, Singapore (2016) BCA Green Mark Assessment Fees For Building Projects in Singapore.

Cadorna, J. A., Garcia, C. M., Israita, I. C. S., Lim, F. D. T. and Tejada, J. M. A. (2014) Development of an ASEAN Green Building Rating System Framework. http://fs.mapua.edu.ph/MapuaLibrary/Thesis/Development%20of%20an%20ASEAN%20Green%20Building%20Rating%20System%20Framework.pdf.

Chun, N. (2010) '*Middle Class Size in the Past, Present, and Future: A Description of Trends in Asia*'.

C.P., B., F., W., R., K. and J., H. (2015) The Global E-Waste Monitor 2014 - Quantities, Flows, and Resources.

Dao, T. (2016) '*Viet Nam suspends rice exports to US after pesticide violations*'. http://e.vnexpress.net/news/business/Viet Nam-suspends-rice-exports-to-us-after-pesticide-violations-3476874.html.

Department of Environment and Natural Resources, Environmental Management Bureau and National Solid Waste Management Commission (2015) *National Solid Waste Management Status Report* (2008 – 2015).

Düsseldorf, M. (2016) '*From challenges to opportunities: favourable climate for the plastics industry*'. http://www.k-online.com/cgi-bin/md_k/lib/all/lob/return_download.cgi/FA01_Asean_Plastics_Industry_long_Logo_EN.pdf?ticket=g_u_e_s_t&bid=3096&no_mime_type=0.

EEA (2012) Movements of Waste across the EU's Internal and External Borders.

FAO (2013) 'Advancement of Pesticide Regulatory Management in Asia'.

FAO (2011a) Global Food Losses and Food Waste.

FAO (2011b) '*International workshop to strengthen capacities for sound chemicals management in the WHO South-East Asia Region and an introduction to the Regional Chemical Help Desk*'. http://apps.searo.who.int/pds_docs/B4812.pdf.

FMT Reporters (2016) '*Selangor to ban retail use of plastic bags in 2017*'. http://www.freemalaysiatoday.com/category/nation/2016/12/21/selangor-to-ban-retail-use-of-plastic-bags-in-2017/.

GBI Research (2012) *E-Waste Management Market To 2020 - Expansion Of Domestic Electronics Sector To Drive Asia Pacific Growth Despite Ban On Illegal Exports From Developed Countries*.

Huyen, P. A. (2016) '*Viet Nam Green Label and Green Public Procurement*'. http://www.env.go.jp/policy/hozen/green/kokusai_platform/2016symposium/03_Viet Nam.pdf.

IEA (2014) *Regional Energy Effciency Policy Recommendations*. https://www.iea.org/publications/freepublications/publication/RegionalEnergyEfficiencyPolicyRecommendationsSoutheastAsiaRegion.pdf.

IEA (2013) *SOUTHEAST ASIA ENERGY OUTLOOK*. https://www.iea.org/publications/freepublications/publication/SoutheastAsiaEnergyOutlook_WEO2013SpecialReport.pdf.

IGES (2016) *Quick Study on Waste Management in Myanmar - Current Situation and Key Challenges*. http://www.iges.or.jp/files/research/scp/PDF/20160613/17_Quick_study_Web.pdf.

Kao, C. (2013) '*National productivity of Southeast Asia Countries*'.

Lam, N. T. (n.d.) '*Waste Management in Viet Nam Potential for power generation*'. https://www.giz.de/fachexpertise/downloads/2014-en-nguyenthanhlam-pep-informationsveranstaltung-Viet Nam-bioenergie.pdf.

Leadership Council of the Sustainable Development Solutions Network (2014) *Indicators for Sustainable Development Goals*. https://sustainabledevelopment.un.org/content/documents/3233indicatorreport.pdf.

Liang, C. Y. (2015) *The Emerging Powerhouse of South East Asia: What Does It Mean for Real Estate Investors?* http://www.ap.jll.com/asia-pacific/en-gb/Research/SEA-TheEmergingPowerhouse.pdf.

Marchich, M. (2014) *Regional Plan for the Introduction of BAT/BEP Strategies to Industrial Source Categories of Stockholm Convention Annex C of Article 5 in ESEA Region*. https://www.thegef.org/sites/default/files/project_documents/Final%2520Evaluation%2520Report%2520ESEA%2520GF-RAS-10-006%2520GEF%25203572_0.pdf.

McKinsey Global Institute (2014) *Southeast Asia at the Crossroads: Three Paths to Prosperity.*

Merck (2012) *Merck Corporate Responsibility Report 2012*.

Ministry of Environment & Forestry and Ministry of Industry (2016) '*Indonesia Country Report on the Implementation of 3R Program*'. http://www.uncrd.or.jp/content/documents/456620-CB1-Indonesia.pdf.

National Environment Agency (2017) '*Waste Management*'. http://www.nea.gov.sg/energy-waste/waste-management#solid.

Ocean Conservancy and McKinsey Center for Business and Environment (2015) *Stemming the Tide: Land-Based Strategies for a Plastic- Free Ocean*. https://oceanconservancy.org/wp-content/uploads/2017/04/full-report-stemming-the.pdf.

OECD (2015) *Economic Outlook for Southeast Asia, China and India 2016 - Enhancing Regional Ties.*

OECD (2014) *Towards Green Growth in Southeast Asia - Solutions for Policy Makers*.

OECD (2013a) E*conomic Outlook for Southeast Asia, China and India 2014 - Beyond the Middle-Income Tra*p. https://www.oecd.org/site/seao/Pocket%20Edition%20SAEO2014.pdf.

OECD (2013b) *Southeast Asian Economic Outlook 2013* With Perspectives on China and India.

Phalla, S. (2016) '*Current waste management situation in Cambodia (Siem Reap Municipality)*'. http://www.switch-asia.eu/fileadmin/user_upload/Events/Cambodia_16/PPTs/9_Introduction_to_field_visit_Waste_management_in_Cambodia_COMPED.pdf.

Rosenthal, S. S. and Strange, W. C. (2003) '*Evidence on the nature and sources of agglomeration economies*'.

San, L. M. and Nordin, D. (2016) '*ASEAN Capital Market Regulators Intensify Efforts to Promote ASEAN Asset Classes*'. Jakarta. http://www.theacmf.org/ACMF/upload/file09092016.pdf.

Schandl, H., West, J., Baynes, T. and Hosking, K. (2016a) *Natural Resource Use Indicators in the SDGs* - Cambodia. UNEP.

Schandl, H., West, J., Baynes, T. and Hosking, K. (2016b) *Natural Resource Use Indicators in the SDGs* - Indonesia. UNEP.

Schandl, H., West, J., Baynes, T. and Hosking, K. (2016c) *Natural Resource Use Indicators in the SDGs* - Lao PDR. UNEP.

Schandl, H., West, J., Baynes, T. and Hosking, K. (2016d) *Natural Resource Use Indicators in the SDGs* - Malaysia. UNEP.

Schandl, H., West, J., Baynes, T. and Hosking, K. (2016e) *Natural Resource Use Indicators in the SDGs* - Myanmar. UNEP.

Schandl, H., West, J., Baynes, T. and Hosking, K. (2016f) *Natural Resource Use Indicators in the SDGs* - Philippines. UNEP.

Schandl, H., West, J., Baynes, T. and Hosking, K. (2016g) *Natural Resource Use Indicators in the SDGs* - Thailand. UNEP.

Schandl, H., West, J., Baynes, T. and Hosking, K. (2016h) *Natural Resource Use Indicators in the SDGs* - Viet Nam. UNEP.

Schandl, H., West, J., Baynes, T. and Hosking, K. (2015) *Indicators for a Resource Efficient and Green Asia and the Pacific*. UNEP. https://wedocs.unep.org/rest/bitstreams/17411/retrieve.

Solid and Hazardous Substances Management Bureau (n.d.) 'Waste *Management in Thailand*'. http://infofile.pcd.go.th/mgt/ait14dec10_3rs.pdf.

Stephenson, J. B. (2008) '*Harmful U.S. Exports Flow Virtually Unrestricted Because of Minimal EPA Enforcement and Narrow Regulation*'.

Swedish Chemicals Agency (2016) Towards a Non-Toxic South-East Asia.

Sin, T. J., Chen, G. K., Long, K. S. and Hwang, G. H. (2013) '*Current practice of waste management system in Malaysia: towards sustainable waste management*'. Presented at the 1st FPTP Postgraduate Seminar 'Towards Sustainable Management', Johor, Malaysia. http://eprints.uthm.edu.my/5381/1/FPTP_Paper.pdf.

UNEP (2016) *Global Environment Outlook GEO-6* - Regional Assessment for Asia and the Pacific.

UNEP (2015) Waste Crime - *Waste Risks Gaps in Meeting the Global Waste Challenge*.

UNEP (2013) *Recent Trends in Material Flows and Resource Productivity in Asia and the Pacific*. UNEP.

UNEP (2004) *State of Waste Management in Southeast Asia*. UNEP. http://www.asean.org/uploads/archive/files/UNEP.pdf.

UNEP and ISWA (2015) *Global Waste Management Outlook*. UNEP. https://www.iswa.org/fileadmin/galleries/Publications/ISWA_Reports/GWMO_summary_web.pdf.

United Nations University (2017) '*E-waste in East and Southeast Asia jumps 63 percent in five years*'. https://phys.org/news/2017-01-e-waste-east-southeast-asia-percent.html.

Viet Nam Recycling Platform (VRP) (n.d.) *Viet Nam Recycles Programme*. http://www.Viet Namrecycles.com.

Volz, U. (2016) *Fostering Green Finance in Asia*. https://www.die-gdi.de/uploads/media/Fostering_Green_Finance_in_Asia_Volz.pdf.

WHO (2016) *Public Health Impact of Chemicals: Knowns and Unknowns*.

WHO (2009) '*Policy Brief : Sustainable Chemicals Management*'.

Winn, P. (2016) '*5 countries dump more plastic into the oceans than the rest of the world combined*'. https://www.pri.org/stories/2016-01-13/5-countries-dump-more-plastic-oceans-rest-world-combined.

Wirdana, A. (2016) '*How much is too much to pay for plastic bags?'* https://www.aseantoday.com/2016/02/how-much-is-too-much-to-pay-for-plastic-bags/.

World Bank (2011) '*Philippines: Manila Water Inaugurates US$4.69 Million WB-Financed Marikina Sewage Treatment Plant for 40,000 Residents*'. 26 January. http://www.worldbank.org/en/news/press-release/2011/01/26/philippines-manila-water-inaugurates-us469-million-wb-financed-marikina-sewage-treatment-plant-40000-residents.

Yaker, F. (2014) '*SPP and Eco-labelling: The global contribution of UNEP*'.

Yunos, H. M. R. D. P. H., Tarip, H. Z. H. and Salleh, H. M. N. H. (2010) '*3R (Reduce, Reuse, Recycle Concept) in Brunei Darussalam*'. http://www.uncrd.or.jp/content/documents/RT2_02_Brunei.pdf.

ZHAO, Y. and Hathaway, D. (2011) '*Energy Efficiency Standards and Labeling in Asia*'.

Section 3
Policy Recommendations and Way Forward

Section 3: Policy Recommendations and Way Forward

1. Sectoral Policy Recommendations based on the DPSIR Assessment

The DPSIR analytical framework employed in the previous chapter to analyze the six key environmental themes in ASEAN had revealed certain areas of shortcomings and gaps which would require concerted and timely action on the part of concerned ASEAN sectoral bodies. These are outlined below.

1.1 Atmosphere

- Support policies and programmes to address the rising air pollution levels in the region, in particular, that of the energy sector which is responsible for the largest CO2 emissions.
- Since ASEAN cities are major sources of greenhouse gases, support policies and programmes that promote low carbon activities and investments in GHG emission reductions in cities across ASEAN, particularly supporting the development of low-carbon economies, infrastructure and transport.
- Support policies and programmes that focus on decreasing the growing emission levels of all major greenhouse gases (GHG). This includes reducing carbon dioxide and methane levels, a focus of many recent national, regional and international efforts, as well as other potent GHGs, such as chlorofluorocarbons, hydrofluorocarbons, and perfluorocarbons, which are often less prioritized.
- More holistic measures are needed to address the issue of transboundary haze at its source by improved land management and controls on the expansion of commercial plantations.
- Develop consistent and systematic ways of monitoring air quality and pollution levels across ASEAN as data is often fragmented and not comparable across the region. ASEAN should support the establishment of standard air quality monitoring mechanisms, guidelines and databases.
- Establish improved public awareness programmes to better communicate knowledge and foster change in behavior, including concrete examples of good practices and lessons learned in air quality management, impacts of air pollution on health, environment and economies, as well as on climate change issues.
- Organize frequent consultations and public fora among relevant ASEAN working groups and stakeholders to monitor progress on the Paris climate agreement and it's targets, so that development goals are linked to environmental protection; update ASEAN's strategies and action plans on the climate agreement targets on a regular basis.

1.2 Land

- Land erosion and soil fertility loss from forest conversion emerge as urgent concerns that need to be addressed by developing stronger and more appropriate policies; research is needed to fill the knowledge gaps through an updated study of soil status within the region.
- Illegal conversion of forest areas for commercial plantations is an ongoing practice of serious concern. AMS need to develop regulations to monitor, control and respond to prevent illegal forest conversion. More studies are also needed to understand the extent and impact of illegal forest conversion practices.
- Similar to peatlands and peat forests, ASEAN needs to develop a program to manage, map and preserve mangroves.
- Organize a regional conference to discuss trends in agriculture and the state of knowledge on quality and quantity of viable agricultural land remaining within ASEAN. Outcomes of the conference may be used by AMS to develop more appropriate national work plans for sustainable agricultural development.
- Organize an ASEAN-wide forum involving relevant stakeholders including commercial agricultural firms, smallholder farmers, forest dependent communities, environmental experts and government representatives around issues related to agricultural expansion to fully understand and address the livelihood and environmental impacts of rapid commercial agricultural expansion.

1.3 Biota and Ecosystems

- In order to address the underlying causes of biodiversity loss, mainstream biodiversity conservation and management into regional development plans and across government and society.
- Develop a minimum standard on Environmental Impact Assessments (EIA), safeguards, and other legal mechanisms among AMS to closely monitor, prevent, or reduce the impact of, large-scale infrastructure and other investments, including transboundary investments, on protected areas and other important natural habitats.
- Develop and enforce laws that protect indigenous peoples' ownership and knowledge of biological and genetic resources in all ASEAN Members States.
- Encourage cooperation and knowledge exchange between ASEAN Member States in conserving vulnerable and threatened species and preventing extinctions.
- Undertake a comprehensive analysis of the region's agrobiodiversity, including crops and livestock, soil biota, and pollinators. Develop and implement a regional plan for agrobiodiversity conservation for food security and climate change resilience in the agricultural sector.
- Undertake a full assessment of the region's urban ecosystems and biodiversity; establish a regional platform between ASEAN cities of different scales for cooperation and exchange in the area of ecosystem management and human wellbeing.
- Integrate environmental education into schools in ASEAN, especially on the topics of biodiversity, ecosystems, and their association with human wellbeing.

- Develop an effective monitoring and evaluation framework and conduct regular monitoring of the drivers, pressures, states, impacts and responses on key biodiversity and ecosystem issues. Responses must sufficiently address the drivers and pressures, and must be evaluated to ensure they produce the expected outcomes. Towards this end, establish a multi-sectoral regional platform to align biodiversity conservation with regional economic development goals.

1.4 Freshwater

- Expedite improving sources and access of drinking water and sanitation, particularly in the rural areas and marginal groups with the aim of reducing the number or people without access to such services to within internationally accepted standards such as SDGs as well as ASEAN's own development goals.
- Implement more effective water-related data sharing to support a regional monitoring system on water quality and quality and assessing status of freshwater resources and potential impacts from key drivers in the region.
- Rapidly close knowledge gaps with respect to risks and impacts of floods and droughts as well as impacts of climate change across the region to minimize risks and provide .enhanced capabilities to cope with these adverse events.
- Develop more robust regional water quality monitoring and management strategies as well as guidelines for the best-practice on water restoration, water treatment and recycling to monitor and improve health of freshwater resources, especially in critical rivers, lakes and wetlands.
- Increase policy dialogue and synergy between regional and national plans on integrated water resources management to enhance basin-wide benefits, minimize adverse transboundary impacts, and provide water security.
- Build and enhance networks and partnerships of water-related academic institutions to support scientific information and evidence and provide innovative solutions/ technologies for addressing priority water resources management issues in the region in the current ASEAN framework.

1.5 Coasts and Oceans

- Enable a closer collaboration between the ASEAN's Environment and Fisheries working groups to ensure that there are complementarities in their interventions from the perspective of conservation, management and wise use of the region's coasts and oceans.
- Promote policies and programmes to address the rising poverty among the coastal populations in the low elevation coastal zones (LECZ) that continues to be of significant concern.
- ASEAN should develop and implement improved laws and regulations to address the problem of marine litter or debris pollution as it is becoming a major threat to the integrity of its coasts and oceans. Organize a regional conference on marine debris pollution in the region.
- Undertake a comprehensive assessment of the region's coral reefs. Facilitate a methodological review of reef assessment standards to ensure replicability and comparability; As part of this process, ASEAN could initiate a regional dialogue on establishing appropriate frameworks and models of assessment.

- Develop a regional platform to assist AMS to gather data on reef biomass to assess and ensure existing conservation efforts such as Marine Protected Areas are successful.
- Hold consultations among relevant sectoral working groups of ASEAN, not just within the environment agencies, to develop an integrated plan of interventions on the use and governance of coastal and ocean resources and environment in the region.
- Monitor mangrove degradation and implement remedial actions for rehabilitation of mangrove forests especially where coastal populations depend on them for livelihoods.
- ASEAN, through its programmes, projects, bodies and working groups, needs to support the expansion of marine protected areas (MPA) and achieve the Aichi targets (11 and 14), thereby also utilizing the collective expertise and experience of researchers in the region.

1.6 Production and Consumption

- Promote and adopt more sustainable forms of consumption and production patterns for achieving economic development while conserving the environment and natural resources.
- Support and coordinate the shift towards improvement in the quality of human and other capital to transition towards more sustainable productivity-driven growth and technology-intensive development
- Intensify the "reduce, reuse, recycle" (3R) concept more vigorously through a combination of appropriate incentives and disincentives especially to minimize the usage of plastics.
- Pay special policy attention to management of plastic bags, e-waste and food waste and provide advice and support for customized measures for action on these specific kinds of waste.
- Encourage all AMS to ratify the four international conventions on chemicals management – Basel, Rotterdam, Stockholm and Minamata Convention to achieve SDG 12 Target 12.4.1.
- Provide relevant policies, regulations, infrastructure and facilities to improve resource and production sustainability, and waste and chemicals management.
- Support and promote green initiatives across ASEAN including green finance, green/sustainable public procurement (GPP/SPP) and ecolabelling, green building rating systems and energy labelling schemes.
- Embed sustainable production and consumption across the sectors of economic growth, human wellbeing, agriculture, cities, climate change and energy, biodiversity and natural resources, governance and technologies.

2. Current ASEAN Policy and Institutional Framework on Environmental Issues

2.1 Current Policy and Institutional Framework

Policy Framework

The ASEAN 2025: Forging Ahead Together which contains APSC, AEC, and ASCC Blueprints 2025 highlighted in Chapter 1 forms the current policy framework for ASEAN

cooperation until 2025. ASEAN priority areas of cooperation on environment are outlined mainly in the ASCC Blueprint 2025, with strong inter-linkages with relevant elements of other Community Blueprints.

The ASCC Blueprint 2025 envisions "an ASEAN Community that engages and benefits the peoples and is inclusive, sustainable, resilient, and dynamic". Guided by the Vision, ASEAN cooperation on environment particularly focuses on, but not limited to, the following key result areas under the characteristic 'Sustainable' of the ASCC Blueprint 2025:

- Conservation and Sustainable Management of Biodiversity and Natural Resources
- Environmentally Sustainable Cities
- Sustainable Climate
- Sustainable Consumption and Production

In addition to the Blueprints, ASEAN regional cooperation on environment is guided by Statements and Declarations issued by the Leaders and the Environment Ministers from time to time.

ASEAN Strategic Plan on Environment (ASPEN)

The ASEAN Strategic Plan on Environment (ASPEN) has been developed to translate the above priorities together with other identified priorities into more detailed plans of action, which will serve as a guiding document for ASEAN cooperation on environment until 2025. The ASPEN consists of action plans for the following seven agreed strategic priorities:

1. Nature conservation and biodiversity
2. Coastal and marine environment
3. Water resources management
4. Environmentally sustainable cities
5. Climate change
6. Chemicals and waste
7. Environmental education

Institutional Framework

The ASEAN Summit, the supreme policy-making body of ASEAN, now meets twice a year in addition to having special or ad-hoc meetings. The ASEAN Leaders provide the vision and broad thrust for co-operation in various sectors, including cooperation on environment.

The ASEAN Coordinating Council comprising the ASEAN Foreign Ministers will, among others, coordinate with the three ASEAN Community Councils, representing the three pillars of ASEAN cooperation, to enhance policy coherence, efficiency and cooperation among them. Each of the three ASEAN Community Councils will ensure the implementation of the relevant decisions of the ASEAN Summit, and coordinate the work of the different sectors under its purview and on issues which cut across the other Community Councils. The ASEAN Socio-Cultural Community Council will oversee the work of the ASEAN Environment Ministers.

The ASEAN Environment Ministers meet formally once every two years and are primarily responsible for policy and strategic matters related to the environment.

The ASEAN Senior Officials on the Environment (ASOEN) meet annually and are responsible for supporting the ASEAN Environment Ministers in terms of formulation, implementation and monitoring of regional programmes and activities. ASOEN comprises heads of environmental ministries/departments/agencies who are responsible for environmental matters in their respective countries. ASOEN members also serve as the national ASOEN focal points for promoting ASEAN's activities in their respective countries. ASOEN is assisted by seven subsidiary bodies or working groups, namely theASEAN Working Group on Climate Change (AWGCC), ASEAN Working Group on Coastal and Marine Environment (AWGCME), the ASEAN Working Group on Chemicals and Waste (AWGCW), the ASEAN Working Group on Environmental Education (AWGEE), the ASEAN Working Group on Environmentally Sustainable Cities (AWGESC), the ASEAN Working Group on Nature Conservation and Biodiversity (AWGNCB), and the ASEAN Working Group on Water Resources Management (AWGWRM).

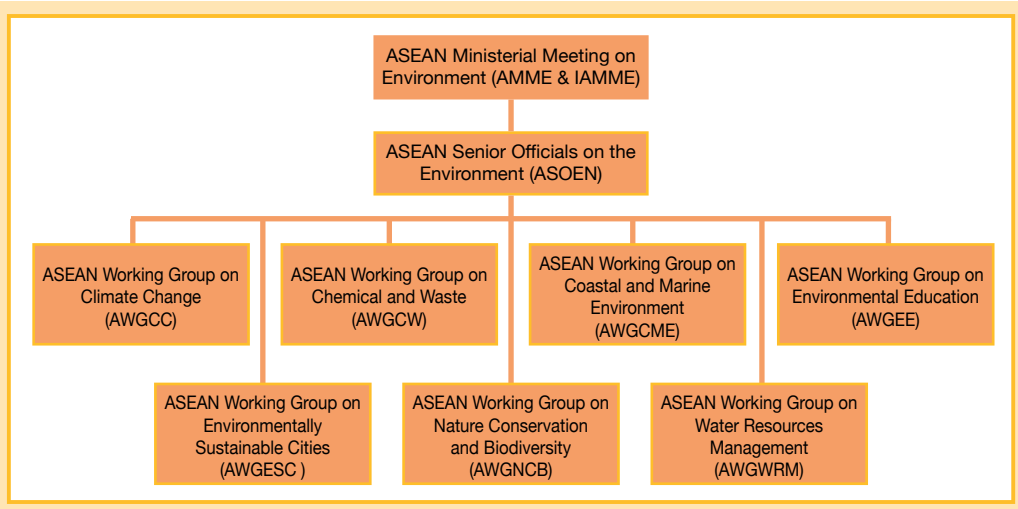


Figure 54. ASEAN Institutional Framework on Environment

The ASEAN Environment Ministers meeting as the Conference of the Parties (COP) are responsible for the implementation of the ASEAN Agreement on Transboundary Haze Pollution (Haze Agreement), including the Roadmap on ASEAN Cooperation towards Transboundary Haze Pollution Control with Means of Implementation. The Committee or COM under the COP to the Haze Agreement meets prior to the COP meetings. COP and COM meet back-to-back at least once a year.

The ASEAN Task Force on Peatlands was established in 2013 to assist COM in monitoring and supporting the implementation of the ASEAN Peatland Management Strategy 2006-2020, which was developed with a goal of promoting sustainable management of peatlands in the ASEAN region, through collective actions and enhanced cooperation, to support and sustain local livelihoods, reduce risk of fire and associated haze and contribute to global environmental management.

In addition, considering the different circumstances and weather patterns in the southern and the northern ASEAN or Mekong sub-regions, two sub-regional institutional frameworks have been established to address the fire and haze situations in the

respective sub-regions. Environment Ministers from Brunei Darussalam, Indonesia, Malaysia, Singapore and Thailand meet regularly as the Sub-Regional Ministerial Steering Committee (MSC) on Transboundary Haze Pollution to undertake activities for the southern region. Environment Ministers from Cambodia, Lao PDR, Myanmar, Thailand and Viet Nam meet regularly as the Sub-Regional Ministerial Steering Committee on Transboundary Haze Pollution in the Mekong Sub-region (MSC Mekong). Both MSCs are supported by respective Technical Working Groups (TWG and TWG Mekong) comprising senior officials.

The ASEAN Secretariat provides support for all the above-mentioned institutional bodies. In particular, the ASEAN Secretariat acts as a resource base, providing advice and information and coordinates the implementation of regional activities and programmes, in addition to providing support services for the meetings of the ASEAN bodies. It also ensures proper coordination on related activities of various other sectoral bodies so as to promote synergy and avoid duplication. Another important role played by the ASEAN Secretariat is the coordination between ASEAN bodies and its programmes with those of ASEAN Dialogue Partners and other international organisations in terms of resource mobilisation, programme implementation, and in general, enhancing institutional linkages.

The institutional framework of ASEAN Environment Sector is depicted in Figure 50.

ASEAN Centre for Biodiversity (ACB)

The ASEAN Centre for Biodiversity (ACB) was established in 2005 and is located in Los Banos, Philippines. Pursuant to Article II of the Establishment Agreement, ACB shall facilitate cooperation and coordination among AMS and with relevant national government, regional and international organizations, on the conservation and sustainable use of biological diversity and the fair and equitable sharing of benefits arising from the use of such biodiversity in the ASEAN region. ACB performs its mandates through five components:

- Programme development and policy coordination
- Human and institutional capacity development
- Biodiversity information management
- Communication and public affairs
- Organisational management and resource mobilisation

ACB is managed by a Governing Board (GB), which is composed of the ASEAN Senior Officials on the Environment (ASOEN) and the Secretary-General of ASEAN. The GB, headed by the ASOEN Chairperson, has the overall responsibility and accountability on the operations of ACB. The ASEAN Working Group on Nature Conservation and Biodiversity (AWGNCB), on the other hand, provides technical guidance to ACB by recommending key areas of focus for its work. The AWGNCB members also serve as ACB's National Contact Points in their respective countries

ACB also serves as the Secretariat of ASEAN Heritage Parks Programme, which is one of ASEAN's flagship programmes promoting a regional network of national protected areas of high conservation importance, preserving a complete spectrum of representative ecosystems, and to generate greater awareness, pride, appreciation, enjoyment, and conservation of ASEAN's rich natural heritage. In 2016, 38 ASEAN Heritage Parks had been established.

2.2 Environmental Issues in Other Relevant ASEAN Sectoral Work Plans

As environmental issues are often cross-sectoral in nature and inter-linked with other concerned areas, ASEAN cooperation on environment also addresses, directly or indirectly, other relevant strategic measures in all three Blueprints. Environmental issues are addressed not only by ASOEN and its subsidiary bodies, but also by other relevant ASEAN sectoral bodies such as those overseeing the issues of forestry and agriculture, transport and energy, tourism, education, youth, health, social welfare, and disaster management. This is illustrated in Appendix 1: Cross-sectoral references on environment-related issues in the ASEAN Community Blueprint 2025 which maps out strategic measures related to environment across all three Community blueprints and the relevant sectoral bodies and work plans.

In addition, there are work plans of some additional sectors which also contain cross–references to environmentally-related issues which would also require close consultation and coordination. These are elaborated further below.

Education Sectoral Plan

Under the ASEAN Work Plan on Education 2016-2020, there is a Sub-Goal entitled "Complement the efforts of other sectors in meeting the objectives of Education for Sustainable Development (ESD)" and with a priority area of "Strengthening collaboration between the education and other sectors related to ESD". One of the two projects/ activities under this priority area is to strengthen cross-sectoral collaboration and synergies for ESD between environment (ASOEN) and education (SOM-ED) sectors, with a key performance indicator (KPI) for all AMS, to implement the ASEAN Environmental Education Action Plan (AAEAP) 2014-2018. The expected output here is to support the conduct of ASEAN Eco-Schools Award Programme and the ASEAN Environmental Education Forum for eco-/sustainable/green schools under the auspices of ASOEN. The second project/activity under the above-stated priority area is to conduct multi-disciplinary research on social and sustainability sciences for understanding social, environmental and economic issues and impacts of ASEAN integration including analyses of significant policy implications for governments. The KPI here is the establishment of an ASEAN Scholars Network on Social and Sustainability Sciences to facilitate knowledge, exchange, cross-disciplinary learning and collaborative policy-relevant research with an expected output of producing a publication on ASEAN State of Social and Sustainability Sciences Report.

Health Sectoral Plan

Under the ASEAN Post-2015 Health Development Agenda Work Programme for 2016-2020, there is a specific need to address environmental and disaster health issues. One of the priority areas is to strengthen ASEAN capacity to manage environmental health risks and issues including the establishment of ASEAN environmental health knowledge network by 2020. The identified risks and issues include water and sanitation, solid and hazardous waste, toxic chemicals, transboundary pollution and climate change. The other priority issue is related to establishment of disaster medicine and emergency medical system network and strengthening of ASEAN collaboration on disaster management, also by 2020.

2.3 Complementarities with UN 2030 Agenda or SDGs

The SDGs and the ASEAN 2025 agenda are viewed as having mutually-reinforcing goals. It had been agreed in early 2016 that Thailand would serve as the ASEAN Coordinator on

the SDGs and the UN 2030 Agenda with the aim of developing closer complementarities and better alignment between the ASEAN 2025 priorities and the key areas as specified in the UN 2030 Agenda and the SDGs.

Although the timeline for these two initiatives are slightly different, they do coincide for the first ten years of their respective implementation intervals from 2016 until 2025, while the SDGs continue on to 2030. Since environment and natural resources management issues are contained in several SDGs, as well as the ASEAN 2025 blueprint, especially in the economic and socio-cultural pillars, there is plenty of room for developing synergies and complementarities in this connection. Both the UN as well as the ASEAN sides, together with other Development and Dialogue Partners of ASEAN, are working closely on formulating their joint activities manyof which revolve around the SDGs.

UN Environment and ASEAN were engaged in formulating the Plan of Action to Implement the Joint Declaration on Comprehensive Partnership between ASEAN and the United Nations (2016-2020) and the ASEAN-UN Environment and Climate Change Action Plan 2016-2020, the former of which was adopted at the 8th ASEAN-United Nations (UN) Summit held on 7 September 2016 in Vientiane, Lao PDR. The Plan of Action, which includes current priority areas of social, economic and environmental cooperation and considers the ASEAN Community Vision 2025 and the UN 2030 Agenda for Sustainable Development, will guide both sides to realising the full potential of the comprehensive partnership in the next five years.

3. General Policy Recommendations on the Way Forward

a. Enhanced cross-sectoral/cross-pillar/integrated coordination mechanisms

As evident from the descriptions in the earlier parts of this section, many of the economic sectoral bodies especially under the ASEAN Economic Community (AEC) pillar now touch on environmental sustainability issues and therefore require good coordination mechanisms to ensure proper alignment and balance between economic pursuits and environmental considerations. Even within the ASCC pillar sectors, there remains a crucial need to take into account the various nexus issues, for example on the nexus between health, education, gender, disaster and human rights with environment-related matters.

It is also worth noting under the ASEAN Political-Security 2025 Blueprint, there are references to environment-related issues like transnational crimes, including illicit trafficking of wildlife and timber and illegal, unregulated and unreported (IUU) fishing, the movements of hazardous waste as well as transboundary challenges as non-traditional security issues. These may include management of oil spills and other pollution incidents whether on land, freshwater or marine environments, and critically, smoke haze pollution from land/forest fires as well as protection and preservation of land-based and marine natural resources.

The AEC Blueprint 2025 is the greenest when compared to any of such previous blueprints. There is now a strong focus on environmental and sustainability matters, including a dedicated section on sustainable economic development as a key element of a competitive, innovative and dynamic ASEAN.

There is thus a growing recognition on the need for more cross-sectoral and cross-pillar coordination and collaboration especially among concerned elements when dealing with matters that share common interest under the three pillars of the ASEAN

Community. This is reflected in each of the three blueprints as well as in the Monitoring and Evaluation frameworks being developed and implemented across all the three pillars. In this regard, although each pillar has set up its own coordination mechanism for bodies under its purview, amore institutionalized and in-depth cross-sectoral/ pillar mechanism would need to be further enhanced to ensure adequate information exchange as well as close coordination and collaboration among the key parties at the operational levels. One recommendation is to develop a task force revolving around certain identified nexus or clusters, where a clearly identified need for consultation and cooperation is essential.

b. Effective and timely monitoring and evaluation systems

It goes without saying that having in place appropriate monitoring and evaluation systems to provide effective tracking of progress or otherwise, in the environmental cooperation activities undertaken by ASEAN, is essential in order to provide the concerned decision-makers at the ASOEN and ministerial levels, with timely and up to date evidence-based information for good policy making and thus ensuring good progress in implementation of agreed activities. In this regard, efforts are being made to integrate M&E of environmental sector projects into the overall ASCC M&E framework, based on the SMART (Specific, Measurable, Achievable, Realistic and Time-bound) approach. Besides monitoring the achievements made in the environmental sector proper, it would also help track collaboration among relevant parties on issues where environmentally related concerns have been identified as areas of mutual or common interest. Indicators to measure performance would need to be developed and put in place and to the extent possible, be aligned with the UN's SDG indicators.

c. Better prioritization and implementation mechanisms

Overseeing a very multi-disciplinary and inter-sectoral subject matter like environment and natural resources demands a proper prioritization of activities based on sound and integrated analysis, which in turn is dependent on having reliable and timely data. Implementation of such cooperation activities would also require a robust mechanism for channeling resources (human, financial, material, etc.) and other necessary inputs to ensure that agreed joint activities are implemented in a timely and effective fashion. The ASEAN Secretariat, which has oversight and facilitation role to ensure the proper and timely functioning of the entire ASEAN machinery, should be strengthened considerably in order to perform such a necessary and vital role.

d. Higher commitment and resource mobilization especially to have more systematic and timely collection and analysis of data and information

As alluded to earlier, investing in a good statistical system to monitor and evaluate achievement or otherwise is crucial to the success of any development-oriented endeavor and in this connection, it would be well worth the investment to provide adequate resources to build an appropriate data collection and analysis unit within the ASEAN Secretariat, which should function as a "nerve center" for processing the required information to eventually produce periodic assessment reports like the SOER, as well as to provide appropriate guidance to the overall direction and detailed aspects of implementation of strategic plans related to the environment like ASPEN.

e. Closer synchronization and increased synergy between SOER and ASPEN

While ASEAN has published five volumes of SOER since 1997, there has been no real concerted effort to link the periodic state of the environment reports produced,

to the operational policies and plans of actions of the various concerned ASEAN sectoral bodies like ASPEN. This will be critical for the environmental sector in future so as to address the various pressing issues concerning the state of natural resources and environment in the region. Using the analogy of the DPSIR analytical framework employed in this SOER, there should in principle, be a connection between the regular progress report on the actual situation of environmental conditions in ASEAN and the responses that ASEAN has taken to confront such challenges. Only then would there be enhanced synchronization and resulting synergies of the state-response mechanisms, so that ASEAN will be perceived as truly doing something beneficial to solving the myriad of critical environmental problems facing the region.

If the proposed recommendations as elaborated earlier are taken into due consideration such as building up the statistical capabilities that are required to support the future production of such periodic SOERs, this would then also provide input and feedback to the development and implementation of strategic measures needed to tackle the priority natural resource and environmental issues that the people of ASEAN face.

If achieved, then ASEAN can rightly claim to be a truly people-oriented and people-centered community, responding to its declared need of protecting the environment and promoting sustainable development.

Appendix 1: Cross-sectoral references on environment-related issues in the ASEAN Community Blueprint 2025

Reference in Blueprints/Plans	Relevant ASEAN Sectoral Bodies	Relevant Sectoral Work Plans
I. ASEAN Political-Security Community Blueprint 2025		
B.3. Enhance ASEAN capacity to address non-traditional security issues effectively and in a timely manner **B.3.1 Strengthen cooperation in addressing and combating transnational crimes** v. Enhance cooperation in addressing other emerging transnational crimes, including illicit trafficking of wildlife and timber as well as people smuggling, in accordance with relevant international conventions	ASOEN SOM-AMAF SOMTC ASEAN-SOM	• ASEAN Strategic Plan on Environment (ASPEN), 2016-2025 • Vision and Strategic Plan for ASEAN Cooperation in Food, Agriculture and Forestry (2016-2025) or SOM-AMAF Plan • Plan on Illicit Trafficking of Wildlife and Timber
B3.9 Enhance ASEAN capacity to address transnational crimes and transboundary challenges ii. Convene special meetings, as and when necessary, at Senior Officials' level to address challenges of transboundary or transnational nature such as haze pollution, pandemics, transnational organized crimes, irregular movement of persons, hazardous waste, oil spill incidents, trafficking in wildlife and timber	Same as above	• Same as above
B.6. Enhance maritime security and promote maritime cooperation in ASEAN region and beyond, through the strengthening of ASEAN-led mechanisms and the adoption of internationally accepted maritime conventions and principles **B6.1Maintain the South China Sea as a sea of peace, prosperity and cooperation** viii. Explore or undertake cooperative activities among parties concerned on marine environmental protection	ASEAN-SOM ASOEN	• relevant ASEAN-SOM work plan • ASPEN
ix. Explore or undertake cooperative activities among parties concerned on marine scientific research and other agreed activities	Same as above COST	• Same as above • APASTI
B6.2.Promote maritime cooperation to comprehensively address maritime issues vi. Promote closer maritime cooperation in the protection and preservation of the marine environment, including the sustainable use of maritime resources and the protection of biodiversity	Same as above	• Same as above
vii. Expand ASEAN maritime cooperation to effectively combat transnational crimes such as maritime terrorism, smuggling of goods, people and weapons, drug trafficking, trafficking in persons, piracy, hijacking, armed robbery against ships, as well as to address transboundary challenges including oil spill incidents and illegal, unreported, and unregulated fishing, through concrete and practical activities	ASOEN SOM-AMAF SOMTC ASEAN-SOM	• ASPEN • SOM-AMAF Plan • Plan on Illicit Trafficking of Wildlife and Timber

Reference in Blueprints/Plans	Relevant ASEAN Sectoral Bodies	Relevant Sectoral Work Plans
viii. Strengthen ASEAN cooperation in enhancing maritime domain awareness and its increased impact on security, safety, economy and environment of the region	ASOEN ASEAN-SOM SOMRI	• ASPEN
B.6.3 Ensure peaceful, safe, free and unimpeded international navigation and overflight, in accordance with relevant international laws iv. Enhance dialogue and cooperation with relevant international organisations, such as the UN, the International Maritime Organization and the International Labour Organization to ensure the effective implementation of conventions and instruments related to maritime cooperation, including, but not limited to, safety of life at sea, the welfare of seafarers, and prevention of pollution from ships	ASOEN STOM ASEAN-SOM	• ASPEN • ASEAN Transport Strategic Plan
v. Enhance the implementation of the MoU on ASEAN Cooperation Mechanism for Joint Oil Spill Preparedness and Responses as a regional collaborative mechanism to build capacities and capabilities and promote mutual assistance	Same as above	• Same as above
II. ASEAN Economic Community Blueprint 2025		
B. A COMPETITIVE, INNOVATIVE & DYNAMIC ASEAN **B.2.Consumer Protection** iii. Build higher consumer confidence and cross-border commercial transactions by strengthening product safety enforcement, stronger participation of consumer representatives and promotion of sustainableconsumption	ASEAN Committee on Consumer Protection (ACCP)	• Strategic ASEAN Action Plan for Consumer Protection (2016-2025); • ASPEN
B.8.Sustainable Economic Development i. Foster policies supportive of renewable energy and set collective targets accordingly	ASEAN Senior Officials Meeting on Energy(SOME) ASOEN	• ASEAN Plan of Action for Energy Cooperation(APAEC) 2016-2025; • ASPEN
ii. Develop a framework to support the deployment and utilisation of efficient and low carbon technologies, and call for international support to ensure ASEAN access to mechanisms that foster more affordable low carbon technologies	Same as above	• Same as above
iii. Promote the use of biofuels for transportation. This includes ensuring free trade in biofuels within the region and investment in R&D on third-generation biofuels	Same as above Plus STOM	• Same as above plus ASEAN Transport Strategic Plan
vi. Develop new and appropriate technologies, best practices and management systems to ensure food safety and address health/disease and environmental issues, particularly in the fast growing aquaculture, livestock and horticulture subsectors	ASOEN SOM-AMAF SOMHD	• ASPEN • SOM-AMAF Plan • SOMHD Plan

Reference in Blueprints/Plans	Relevant ASEAN Sectoral Bodies	Relevant Sectoral Work Plans
vii. Promote good agriculture practices to minimise the negative effects on natural resources such as soil, forest and water and reduce the greenhouse gas emission	ASOEN SOM-AMAF	• ASPEN • SOM-AMAF Plan
viii. Promote forest management involving the community living within, and surrounding, the forest for the sustainability of the forest and prosperity of the people	Same as above	• Same as above
B. ENHANCED CONNECTIVITY AND SECTORAL COOPERATION **C.1Transport** v. Sustainable transport: To formulate a regional policy framework to support sustainable transport which includes low carbon modes of transport, energy efficiency and user-friendly transport initiatives, integration of transport, and land use planning	ASOEN STOM	• ASPEN • ASEAN Transport Strategic Plan
C.4.Energy iii. Coal and Clean Coal Technology: Enhance the image of coal in ASEAN through promotion of clean coal technologies (CCT) as well as increase in the number of CCT projects by 202045F	SOME ASOEN	• APAEC • ASPEN
iv. Energy Efficiency and Conservation: Reduce energy intensity in ASEAN by 20% as a medium-term target in 2020 and 30% as a long term target in 2025based on 2005 level	Same as above	• Same as above
v. Renewable Energy (RE): Increase the component of RE to a mutually agreed percentage number in the ASEAN Energy Mix (Total Primary Energy Supply) by 2020 Revised strategic measure based on the adopted APAEC 2016-2025 Phase 1: Renewable Energy (RE): Increase the component of RE to an aspirational target of 23% in the ASEAN Energy Mix (Total Primary Energy Supply) by 2025	Same as above	• Same as above
C.5.Food, Agriculture & Forestry **iii. Enable sustainable production and equitable distribution**	ASOEN SOM-AMAF	• ASPEN • SOM-AMAF Plan
iv. Increase the resilience to climate change, natural disasters and other shocks	ASOEN ACDM	• ASPEN • AADMER Work Programme
vi. Promote sustainable forest management	ASOEN SOM-AMAF	• ASPEN • SOM-AMAF Plan

Reference in Blueprints/Plans	Relevant ASEAN Sectoral Bodies	Relevant Sectoral Work Plans
C.6. Tourism i. Achieve a more sustainable and inclusive pattern of ASEAN tourism (particularly sub-section c on "increase responsiveness to environmental protection and climate change")	ASEAN-NTOs ASOEN	• ASEAN Tourism Strategic Plan2016-2025; • ASPEN
C.8.Minerals i. Promote environmentally and socially sustainable mineral development	ASOMM ASOEN	• ASEAN Minerals Cooperation Action Plan (AMCAP)III, Phase 1(2016-2020) • ASPEN
D. A RESILIENT, INCLUSIVE, PEOPLE-ORIENTED AND PEOPLE-CENTERED ASEAN D.3. Public-Private Partnership v. Encourage the ASEAN Infrastructure Fund (AIF) to study ways to act as a catalyst in order to attract private sector funding for financing commercially viable PPP projects that will contribute towards poverty reduction, inclusive growth, environmental sustainability and regional integration	ASOEN SEOM (AIF)	• ASPEN • SEOM (AIF) Plan
III. ASEAN Socio-Cultural Community Blueprint 2025		
A. ENGAGED AND BENEFITS THE PEOPLE **A.1. Engaged Stakeholders in ASEAN Process** i. Institutionalise ASEAN policies on relevant stakeholders' consultations and engagement in the work of ASEAN Organs and Bodies including policy making initiatives, integration of impact assessment into policy development, programme development, implementation and monitoring, among others	All ASCC sectoral bodies including ASOEN	All Work Plans under ASCC sectoral bodies including ASPEN
ii. Promote partnership frameworks and guidelines in engaging the stakeholders for the effective implementation of ASEAN initiatives and promotion of public awareness of ASCC programmes and accomplishments	Same as above	Same as above
A.2. Empowered People and Strengthened Institutions i. Increase competencies and resilience of relevant stakeholders with advanced technological and managerial skills so as to improve institutional capacity to address current challenges and emerging trends, such as disasters, pandemics and climate change	Same as above	Same as above

Reference in Blueprints/Plans	Relevant ASEAN Sectoral Bodies	Relevant Sectoral Work Plans
A. SUSTAINABLE C.1. Conservation and Sustainable Management of Biodiversity i. Strengthen regional cooperation to protect, restore, and promote sustainable use of terrestrial ecosystems resources, combat desertification, halt biodiversity loss, and halt and reverse land degradation	ACB/ASOEN ASOF/ SOM-AMAF	Work Plans of the concerned sectoral bodies
ii. Strengthen regional cooperation on sustainable forest management in the context of forest fire prevention and control, including through the implementation of the ASEAN Agreement on Transboundary Haze Pollution, to effectively address transboundary haze pollution	ASOEN/COM-COP/ACB ACDM/AHA SOM-AMAF/ASOF	Work Plans of the concerned sectoral bodies including Roadmap on ASEAN Cooperation towards Transboundary Haze PollutionControl with Means of Implementation(Haze Roadmap)
iii. Promote cooperation for the protection, restoration and sustainable use of coastal and marine environment, respond and deal with the risk of pollution and threats to marine ecosystem and coastal environment, in particular in respect of ecologically sensitive areas	ASOF SOM-AMAF, COST SOMTC ARF-SOM ACB	Work Plans of the concerned sectoral bodies
iv. Adopt good management practices and strengthen policies to address the impact of development projects on coastal and international waters and transboundary environmental issues, including pollution, illegal movement and disposal of hazardous substances and waste, and in doing so, utilise existing regional and international institutions and agreements	ASOEN/ACB SOMTC COST SOM-AMAF/ASOF	Work Plans of the concerned sectoral bodies
v. Enhance policy and capacity development and best practices to conserve, develop and sustainably manage marine, wetlands, peatlands, biodiversity, and land and water resources	COM-COP/ASOEN/ACB SOM-AMAF/ASOF COST	Work Plans of the concerned sectoral bodies
vi. Promote capacity building in a continuous effort to have sustainable management of ecosystems and natural resources	ASOEN/COM-COP/ACB ACW	Work Plans of the concerned sectoral bodies
vii. Promote cooperation on environmental management towards sustainable use of ecosystems and natural resources through environmental education, community engagement and public outreach	ASOEN/COM-COP/ACB SOMY SOM-ED	Work Plans of the concerned sectoral bodies
viii. Strengthen global and regional partnerships and support the implementation of relevant international agreements and frameworks	ASOEN/COM-COP	Haze Roadmap and international conventions which AMS are parties to

Reference in Blueprints/Plans	Relevant ASEAN Sectoral Bodies	Relevant Sectoral Work Plans
ix. Promote the role of the ASEAN Centre for Biodiversity as the centre of excellence in conservation and sustainable use of biodiversity	ACB/ASOEN SOM-AMAF/ASOF	Work Plans of the concerned sectoral bodies
x. Support the full implementation of the Strategic Plan for Biodiversity 2011-2020 and the Aichi Targets	ASOEN/ACB SOM-AMAF/ASOF	ASPEN and other relevant sectoral plans
C.1. Environmentally Sustainable Cities i. Enhance participatory and integrated approaches in urban planning and management for sustainable urbanisation towards a clean and green ASEAN	ASOEN, STOM,SOME,NTOs,SOMHD (Environmental Health)	Work Plans of the concerned sectoral bodies
ii. Strengthen the capacity of national and local institutions to implement strategies and programmes towards liveable cities	Same as above	Same as above
iii. Promote coordination among relevant sectors to provide access to clean land, green public space, clean air, clean and safe water, and sanitation	Same as above	Same as above
iv. Promote cities that are child-, youths-, the elderly/older persons, and persons with disabilities-friendly through enhanced coordination with relevant sectors to provide sustainable and accessible infrastructure systems	ASOEN, SOM-ED, STOM, SOMY, SOMHD, SOMSWD	Work Plans of the concerned sectoral bodies
v. Strengthen positive economic, social and environmental linkages among urban, peri-urban and rural areas	ASOEN, SOMY, SOMRDPE, SEOM	Work Plans of the concerned sectoral bodies
vi. Strengthen policies and strategies for the effective impact management of population growth and migration on cities	ASOEN, SOMSWD	Work Plans of the concerned sectoral bodies
C.3 Sustainable Climate i. Strengthen human and institutional capacity in implementing climate change adaptation and mitigation, especially on vulnerable and marginalised communities	ASOENN, SOMSWD, SOMRDPE	Work Plans of the concerned sectoral bodies
ii. Facilitate the development of comprehensive and coherent responses to climate change challenges, such as but not limited to multi-stakeholder and multi-sectoral approaches	ASOEN, SOMHD, SOMRDPE, SOMY, SOME, SOM-AMAF/ASOF, AICHR, ACDM, STOM, NTOs	ASOEN, SOMHD, SOMRDPE, SOMY, SOME, SOM-AMAF/ASOF, AICHR, ACDM, STOM, NTOs
iii. Leverage on private sector and community to have access to new and innovative financing mechanisms to address climate change	ASOEN, SOM-AMAF/ASOF, ASEAN-CSR Network, ABAC, SEOM	Work Plans of the concerned sectoral bodies
iv. Strengthen the capacity of sectoral institutions and local governments in conducting Greenhouse Gas (GHG) inventory, and vulnerability assessments and adaptation needs;	Same as above	Same as above
v. Strengthen the effort of government, private sector and community in reducing GHG emission from main activities of development	Same as above	Same as above

Reference in Blueprints/Plans	Relevant ASEAN Sectoral Bodies	Relevant Sectoral Work Plans
vi. Mainstream climate change risk management and GHG emission reduction on sectoral planning	Same as above	Same as above
vii. Strengthen global partnerships and support the implementation of relevant international agreements and frameworks, e.g. the United Nations Framework Convention on Climate Change (UNFCCC)	ASOEN, SOM-AMAF/ASOF	Same as above
C.4 Sustainable Consumption and Production (SCP) i. Strengthen public-private partnerships to promote the adoption of environmentally-sound technologies for maximising resource efficiency	ASOEN, COST, SEOM, ABAC, ASEAN-CSR Network, ASEAN Forum on SCP	Same as above
ii. Promote environmental education (including eco-school practice), awareness, and capacity to adopt sustainable consumption and green lifestyle at all levels	ASOEN, SOM-ED, SOMY, ASEAN Forum on SCP	Same as above
iii. Enhance capacity of relevant stakeholders to implement sound waste management and energy efficiency	ASOEN, SOME, ASEAN Forum on SCP	Same as above
iv. Promote the integration of Sustainable Consumption and Production strategy and best practices into national and regional policies or as part of CSR activities	ASOEN, ASEAN-CSR Network, ASEAN Forum on SCP	Same as above
D. RESILIENT **D.1. A Disaster Resilient ASEAN that is able to Anticipate, Respond, Cope, Adapt, and Build Back Better, Smarter, and Faster** iv. Promote policy coherence and interlinkages, and synergise initiatives on disaster risk reduction, climate change adaptation and mitigation, humanitarian actions and sustainable development	ASOEN ACDM	ASPEN AADMER Work Programme
D.3. A Climate Adaptive ASEAN with Enhanced Institutional and Human Capacities to Adapt to the Impacts of Climate Change **i. Expand regional cross-sectoral platforms and establish shared strategies to respond to the impacts of climate change**	Same as above	Same as above
ii. Promote sound scientific and evidence-based policies on climate change adaptation	Same as above plus COST	Work Plans of the concerned sectoral bodies
iii. Promote and consider indigenous and traditional knowledge and practices in responding and adapting to the impacts of climate change	Same as above	Same as above

Reference in Blueprints/Plans	Relevant ASEAN Sectoral Bodies	Relevant Sectoral Work Plans
D.4. Strengthened Social Protection for Women, Children, Youths, the Elderly/ Older Persons, Persons with Disabilities, Ethnic Minority Groups, Migrant Workers, Vulnerable and Marginalised Groups, and People Living in At-risk Areas, including People Living in Remote and Border Areas and Climate Sensitive Areas, to Reduce Vulnerabilities in Times of Climate Change-related Crises, Disasters and other Environmental Changes i. Encourage risk and vulnerability assessments and other scientific and evidence-based measures for policies and plans to ensure targeted response measures	SOMSWD ASOEN ACDM	Strategic Framework on Social Welfare and Development 2016-2020 ASPEN AADMER Work Programme
ii. Establish platforms to empower people living in at-risk areas to become resilient by reducing their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters	Same as above	
D.5. Enhanced and Optimised Financing Systems, Food, Water, Energy Availability, and other Social Safety Nets in Times of Crises by making Resources more Available, Accessible, Affordable and Sustainable ii. Enhance cross-sectoral and cross-pillar coordination to ensure availability and accessibility of affordable energy services at the household level and promote utilisation of renewable energy and green technologies	SOME ASOEN	APAEC ASPEN
iii. Enhance cross-sectoral and cross-pillar coordination to ensure availability of clean water, sanitation facilities and electricity to households in times of crises	ASOEN - ASEAN Strategic Plan on Environment (ASPEN) SOMHD	ASPEN ASEAN Post-2015 Health Development Agenda (APHDA)
v. Explore the possibility of establishing financial and insurance mechanisms and strategies for disaster risk reduction and climate change adaptation	ASOEN ACDM	ASPEN AADMER Work Programme
E. DYNAMIC **E.2. Towards a Creative, Innovative and Responsive ASEAN** x. Promote registration of intellectual property rights (IPR), and strengthen its cooperation and implementation in ASEAN in areas such as food safety, medicines, traditional cultural assets and biodiversity-based products	ASOEN/ACB SOMHD SEOM	ASPEN and the work plans/initiatives of other relevant sectoral bodies
E.3. Engender a Culture of Entrepreneurship in ASEAN i. Strengthen the supportive environment for socially and environmentally responsible entrepreneurship, such as mentoring, providing seed money, venture and crowd funding, and marketing support	ASOEN SEOM	Work Plans of the concerned sectoral bodies

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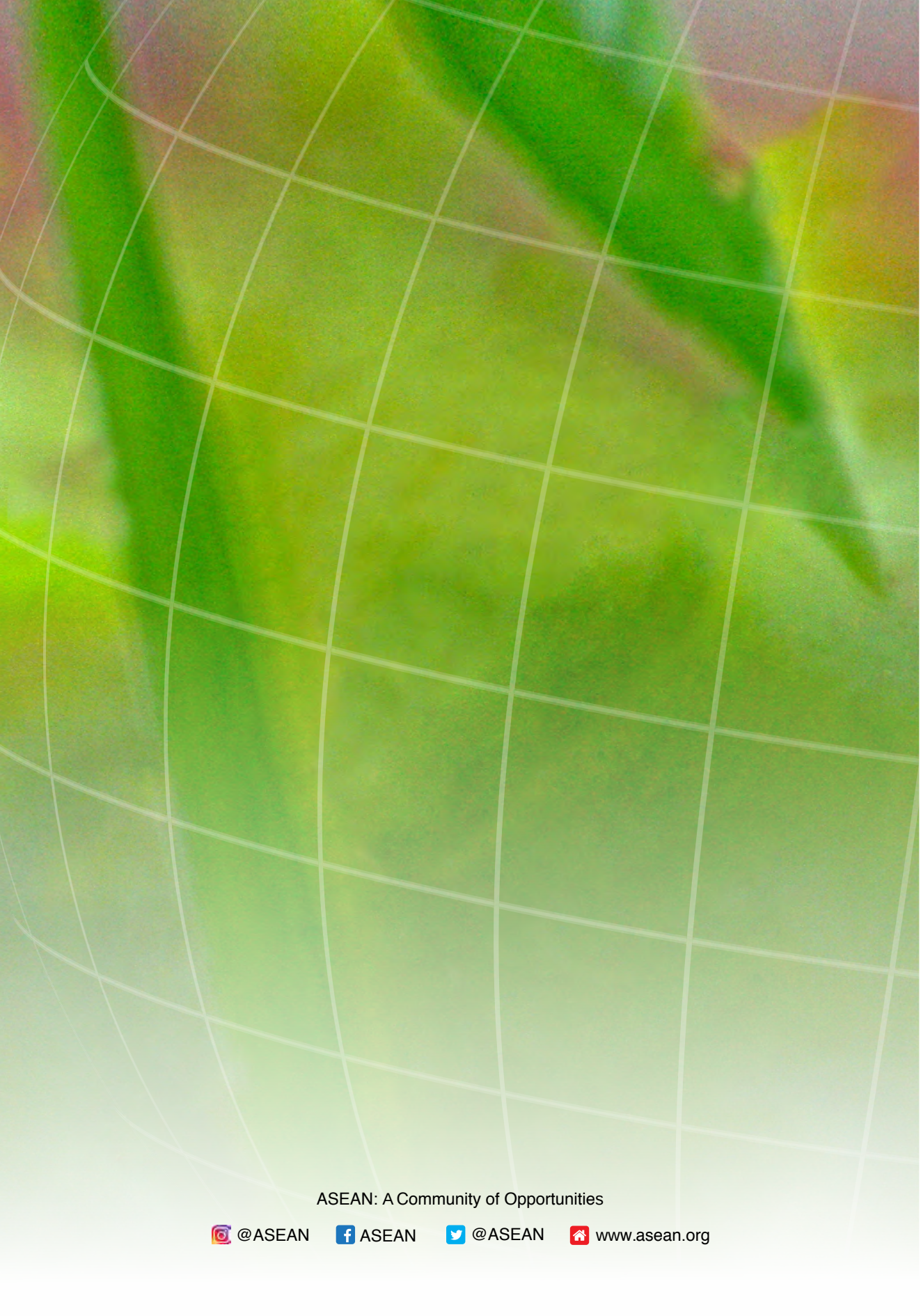

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