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Resilience and Environmental Sustainability

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Introduction

Almost all of the Association of Southeast Asian Nations (ASEAN) countries are vulnerable to natural disasters, having long experienced a disproportionate share of global floods with high fatalities and economic damages. Large segments of ASEAN people live in low-lying coastal areas, river deltas, or floodplains. These areas are particularly prone to frequent and severe floods. Future climate change will cause more intense typhoons, coastal floods, droughts, heatwaves, and landslides. By 2040, countries must find innovative ways to reduce their vulnerability and increase their resilience. Since the 1970s, ASEAN Member States have witnessed remarkable demographic and industrial changes, exacerbating serious risks to environmental sustainability. These include worsening air pollution, degradation of land and water resources, and rising greenhouse gas emissions. Today, many of those seemingly far-off concerns of vulnerability, resilience, and sustainability are becoming a reality. This has sobering implications for achieving the Sustainable Development Goals (SDGs), and challenges the ability of 600 million people to survive and thrive in the ASEAN single market. This chapter offers a visionary pathway towards a resilient and sustainable ASEAN

by 2040. These new ideas are disruptive, but far less disrupting than an ASEAN running low on drinking water, with unproductive land and polluted air, against a backdrop of climate change, extreme weather events, and rising natural resource scarcity.

The first section of this paper reviews the future of a resilient and sustainable ASEAN and provides a brief assessment of activities so far. It shows that ASEAN and its member states (AMS) are aware of the importance of resilience and sustainability, but that some indicators reflect weak implementation towards a resilient and sustainable ASEAN. The second section considers possible technological development that may contribute to improve resilience and reduce the environmental burden of economic growth. To maximise the benefit of economic integration of ASEAN in these fields, some product standards related to resilience and environmental sustainability should be harmonised. The need for such harmonisation is discussed in section 3. A vision for resilience and sustainability is proposed in section 4.

1. Existing Visions and Targets for Resilience and Sustainability in ASEAN

Resilience and environmental sustainability are not new concepts for ASEAN and its member states; rather, they are identified as imperatives in the ASEAN community building process. The ASEAN Vision 2020 stated that 'we envision a clean and green ASEAN with fully established mechanisms for sustainable development to ensure the protection of the region's environment, the sustainability of its natural resources, and the high quality of life of its peoples' (ASEAN, 1997).

The ASEAN Socio-Cultural Community Blueprint (ASEAN, 2009; hereafter, Blueprint 2015) and ASEAN 2025: Forging Ahead Together (ASEAN 2015a; hereafter Blueprint 2025) highlighted both resilience and environmental sustainability. Various actions have been implemented. AMS have also participated in international initiatives to improve resilience and environmental sustainability, such as United Nations activity toward the SDGs, the Paris Agreement under the United Nations Framework Convention on Climate Change, and the Sendai Framework for Disaster

Risk Reduction. This section reviews the existing vision and related actions in the future.

1-1. ASEAN Blueprints

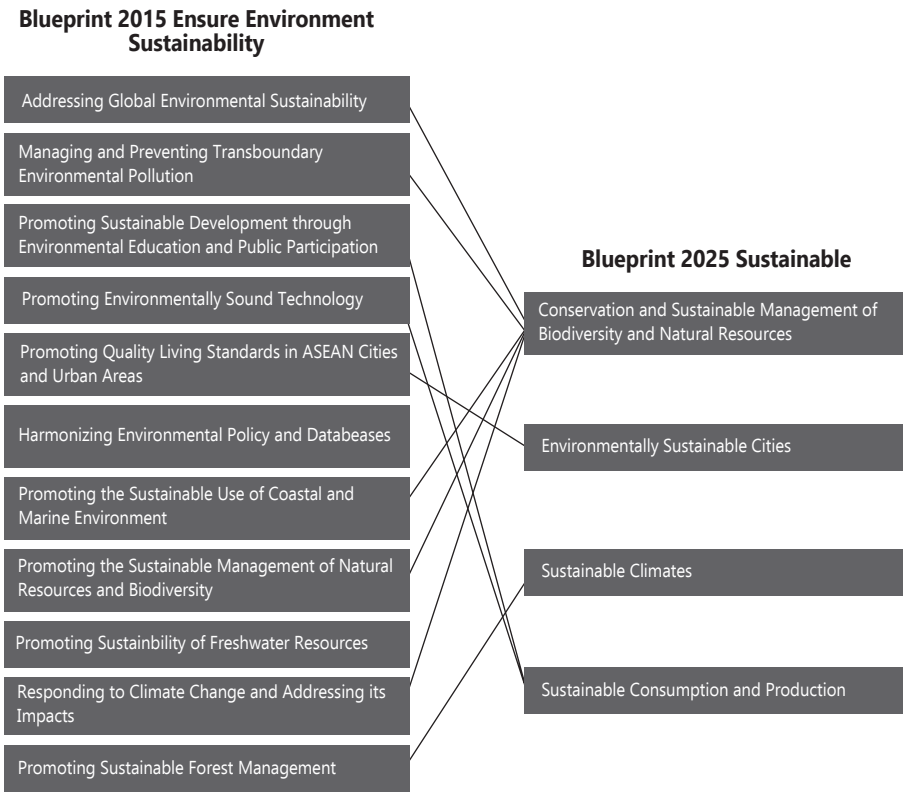
In the Blueprint 2015, resilience was dealt with as a subsection for social welfare protection. In the B.7 section (Building disaster-resilient nations and safer communities), the stated strategic objective is to 'Strengthen effective mechanisms and capabilities to prevent and reduce disaster losses in lives, and in social, economic, and environmental assets of ASEAN Member States and to jointly respond to disaster emergencies through concerted national efforts and intensified regional and international cooperation' (ASEAN, 2009: 11). Various actions were also specified, such as the full implementation of the ASEAN Agreement on Disaster Management and Emergency Response by 2015, support for the establishment and operationalisation of the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre), and functioning of the ASEAN Disaster Information Sharing and Communication Network.

Resilience has a higher profile in the Blueprint 2025, becoming one of the sections under the ASEAN Socio-Cultural Community Blueprint 2025. Section D addresses disaster resilience (D.1), resilience to health-related hazards (D.2), adaptation to climate change (D.3), and other aspects (ASEAN, 2015a).

Environmental sustainability was also emphasised in the 2015 and 2025 blueprints. Four areas of activities were mentioned in the Blueprint 2025: (i) conservation and sustainable management of biodiversity and natural resources, (ii) environmentally sustainable cities, (iii) sustainable climate, and (iv) sustainable consumption and production. The Blueprint 2015 mentioned 11 areas of activities. Although the number of areas in the sustainability section of the Blueprint 2025 decreased, most of the areas in the Blueprint 2015 are covered in the Blueprint 2025 (Figure 1). For example, environmental education and environmental technology, which were included as sub-sections of 'Ensure Environmental Sustainability' in Blueprint 2015, are not included as sub-sections, but covered in the sub-

section of 'sustainable consumption and production' in Blueprint 2025. Similarly, in Blueprint 2015, natural resource management was separately mentioned in the sub-sections for marine and coastal resources, forests, natural resource and biodiversity, and global environmental sustainability. They were integrated into 'Conservation and Sustainable Management of Biodiversity and Natural Resources'.

Figure 1: Environmental Sustainability Topics in the 2015 and 2025 Blueprints under ASEAN Social and Cultural Community



ASEAN = Association of Southeast Asian Nations.

Source: Authors, based on ASEAN (2009) and ASEAN (2015a).

Although strategic measures are listed for each sub-section in the Blueprint 2025, no clear targets are specified. Sustainability aspects are not only mentioned in the Blueprint for the ASEAN Socio-Cultural Community, but also in various sections of the ASEAN Economic Community in Blueprint 2025. Chapter B (A Competitive, Innovative and Dynamic ASEAN) of the AEC states that sustainable economic development is regarded as an integral part of the region's growth strategy. Various strategic measures are also mentioned, such as supporting renewable energy, promoting the use of biofuels for transportation, and promoting forest management involving the community living within and surrounding the forest.

Section C-1 (Transport) also stressed the importance of the sustainability of ASEAN transportation, with connectivity, efficiency, integration, and safety. The Kuala Lumpur Transport Strategic Plan, 2016–2025 (ASEAN, 2015b) also mentions actions for sustainable transport, such as fuel economy policies and standards, green and efficient freight, and logistics.

Section C-5 (Food, Agriculture and Forestry) mentioned the promotion of sustainable forestry and organic agriculture. Section C-6 on tourism emphasised the necessity of environmental protection to make tourism more sustainable, in addition to the necessity of adaptation to climate change. Section C-8 pointed out that the mining industry should become more environmentally and socially sustainable. The ASEAN Minerals Cooperation Action Plan, 2016–2025 (ASEAN, 2016) includes more concrete activities such as implementing the sustainability assessment framework and guidelines; and conducting training to strengthen the capacities of national authorities to ensure safe, responsible, and sustainable mineral development.

Efforts to ensure environmental sustainability are being conducted not only under the Socio-Cultural Community but also in the Economic Community.

1-2. Other Visions: SDGs and Paris Agreement

The SDGs were adopted in September 2015 at the United Nations Sustainable Development Summit. Table 1 shows the complementarities between the SDGs and the Blueprint 2025 which cut across the three pillars of the ASEAN community vision – the ASEAN Economic Community, the ASEAN Socio-Cultural Community, and the ASEAN Political-Security Community.

Table 1: Cross-Sector ASEAN Coordinating Bodies on SDGs

SDGs	Occurrence in the blueprints of the ASEAN Community			Corresponding mechanisms
	AEC	APSC	ASCC	
Goal 1 (poverty)	X		X	Ministerial meeting on rural development
Goal 2 (hunger)	X		X	Ministerial meeting on agriculture and forestry
Goal 3 (health)			X	Ministerial meeting on health development
Goal 4 (education)			X	Ministerial meeting on education
Goal 5 (gender)			X	ASEAN committee on women
Goal 6 (water)			X	Ministerial meeting on environment
Goal 7 (energy)	X			Ministerial meeting on energy
Goal 8 (work)	X		X	Ministerial meeting on labour
Goal 9 (innovation)	X		X	ASEAN committee on science and technology
Goal 10 (inequality)			X	Initiative for ASEAN Integration task force (narrowing development gaps)
Goal 11 (cities)	X		X	Ministerial meeting on development planning
Goal 12 (consumption)	X		X	Ministerial meeting on economy
Goal 13 (climate)	X		X	Ministerial meeting on environment
Goal 14 (ocean)		X		Ministerial meeting on maritime
Goal 15 (land)			X	Ministerial meeting on land and infrastructure
Goal 16 (peace)		X		Ministerial meeting on foreign affairs
Goal 17 (partnership)	X	X	X	All sectoral bodies

AEC = ASEAN Economic Community, APSC = ASEAN Political-Security Community, ASCC = ASEAN Socio-Cultural Community, ASEAN = Association of Southeast Asian Nations, SDG = Sustainable Development Goal.

Source: Authors.

For example, the High-Level Brainstorming Dialogue on Enhancing Complementarities between the ASEAN Community Vision 2025 and the 2030 Agenda for Sustainable Development was held in March 2017, wherein ASEAN sectoral bodies reaffirmed their commitment to building synergy and complementarities between the Blueprint 2025 and the SDGs.

The SDGs have various goals and targets, including resilience and sustainability, some of which are presented in Table 2.

Table 2: Selected Goal and Target Related Resilience and Sustainability in SDGs

Goals	Targets and indicators
Goal 6: Ensure availability and sustainable management of water and sanitation for all	By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations
	By 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
	By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all	By 2030, increase substantially the share of renewable energy in the global energy mix
	By 2030, double the global rate of improvement in energy efficiency
Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable	By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations

Goals	Targets and indicators
Goal 12 : Ensure sustainable consumption and production patterns	By 2030, achieve the sustainable management and efficient use of natural resources
	By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimise their adverse impacts on human health and the environment
Goal 13: Take urgent action to combat climate change and its impacts	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
	Integrate climate change measures into national policies, strategies and planning
Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development	By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution
	By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans
Goal 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	By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally
	By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development

Source: Compiled from United Nations General Assembly (2015).

The AMS ratified the Paris Agreement in December 2015, committing to reduce annual emissions from 20% to 65% by 2030. The nationally determined contributions (NDCs) represent a new level of engagement towards green growth. Achieving the NDC targets will require accelerated investments in low-carbon infrastructure.[1]

As mitigation and adaptation have co-benefits, some of the AMS mention the forestry sector in mitigation measures. Brunei Darussalam declares that the total gazetted forest reserve will be increased to 55% of its total land area by 2030, compared with 2018 levels of 41%. Cambodia also revealed its intention to undertake voluntary and conditional actions to achieve the target of increasing forest cover to 60% of its land area by 2030. This would result in the net sequestration from land use, land-use change, and forestry (LULUCF) falling to 7,897 GgCO2 in 2030 compared with projected sequestration of 18,492 GgCO2 in 2010. For Indonesia, land use change and forestry, including peat fires, is the largest source of greenhouse gas (GHG) emissions, accounting for 47.8%, while the energy sector contributes 34.9%.

Most of the AMS' NDCs also mention adaptation. The NDCs of the Lao People's Democratic Republic (Lao PDR) focus on adaptation projects and programs in agriculture, water resources, and public health. Myanmar also stresses the importance of adaptation, and has initiated new plans in the agriculture, livestock, and water resources sub-sectors. The Philippines also identifies agriculture, water, and health as key sectors for adaptation.

1.3 Moving Towards Resilience and Sustainability: The Achievements

The United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) reported on the progress of the SDGs for Asia and the Pacific, stating that 20 out of 53 targets are on track to be achieved (UNESCAP, 2018). Regarding environmental issues, Southeast Asia is on track to achieve the goals for 'affordable and clean energy' and

[1] The chapter on energy deals with the vision on energy. This chapter discusses mitigation measures in other sectors such as deforestation, and adaptation measures.

'sustainable cities and communities'. However, progress is not observed in climate change and life below the water. UNESCAP (2018) also pointed out that the material footprint and material consumption such as water, raw materials, and forest products have increased. Such trends should be reversed to achieve the SDGs.

UNESCAP (2018) classified the indicators into three categories: (i) 'current rate of progress needs to be MAINTAINED to meet the target', (ii) 'need to ACCELERATE current rate of progress to meet the target', and (iii) 'current trend needs to be REVERSED to meet the target' (Table 3).

Table 3: Anticipated Progress on Resilience and Sustainability in 2030 by Southeast Asia

Progress Level	Strategy
Current rate of progress needs to be MAINTAINED to meet the target	Safely managed sanitation, reliance on clean energy, economic loss from disasters, CO_2 emissions per manufacturing value added
Need to ACCELERATE current rate of progress to meet the target	Renewable energy share, CO_2 emission intensity, Ocean Health Index, terrestrial and freshwater biodiversity
Current trend needs to be REVERSED to meet the target	Material footprint, domestic material consumption, forest area (% of land)

CO_2 = carbon dioxide.

Source: UNESCAP (2018).

Table 4 shows some indicators related to environmental sustainability and resilience. The forest area (% of land) indicator is categorised 'needs to be REVERSED' for Southeast Asia, but some AMS such as the Lao PDR, Malaysia, and the Philippines increased the forest area. Regarding the proportion of the population practising open defecation, most AMS show a significant improvement. All AMS increased their material footprint, although huge differences in the material footprint per capita can be observed among them. Singapore is the largest, reaching 73.04 tons, while Myanmar only produces 1.50 tons.

Table 4: Selected Indicators of Sustainability and Resilience

Country	Proportion of population practising open defecation (%)		Material footprint per capita (ton)		Forest area as a proportion of total land area (%)		Climate Risk Index score (rank)
	2000	2015	2000	2017	2000	2015	2016
Brunei Darussalam	2.5*	2.6	12.60	19.09	75.33	72.11	109.50 (120)
Cambodia	82.7	40.6	1.66	3.57	65.41	53.57	95.17 (111)
Indonesia	32.2	12.4	3.36	6.23	54.87	50.24	46.17 (37)
Lao PDR	62.0	22.1	1.26	7.37	71.60	81.29	109.50 (120)
Malaysia	1.6	0.3	19.19	22.61	65.72	67.55	65.50 (72)
Myanmar	11.2	4.7	0.53	1.50	53.39	44.47	57.17 (53)
Philippines	10.9	5.7	4.00	4.34	23.57	29.96	31.33 (16)
Singapore			51.14	73.04	23.06	23.06	109.50 (120)
Thailand	1.0	0.3	7.75	14.90	33.30	32.10	37.50 (20)
Viet Nam	17.7	3.9	3.42	10.01	37.82	47.64	15.33 (5)

Lao PDR = Lao People's Democratic Republic.*2007.

Source: United Nations, Global SDG Indicators Database, https://unstats.un.org/sdgs/indicators/database/ (accessed 5 August 2018).

The Climate Risk Index (CRI), shown in Table 4, quantifies the impacts of extreme weather events – both in terms of fatalities as well as economic losses – based on the Nat CatSERVICE database. The countries ranking highest were the ones most impacted in 2016.

The United Nations identified indicators for SDGs, but some indicators related to sustainability and resilience issues have not been measured in Southeast Asian countries, so data collection should be strengthened. Furthermore, some of these indicators did not capture the sustainability costs of economic growth.

Southeast Asian countries have a challenge to tackle environmental issues, with conflicting demand for accelerated economic growth and poverty reduction, among others. The management of resources to reduce the ecological footprint of the AMS needs to involve new approaches to planning for cities and rural areas that incorporate

resource efficiency in the production process; energy efficiency in building regulations, land use, and transport planning; and management of water, air, and solid waste to promote a circular economy – a closed loop material system wherein raw material needs are minimised and economic benefits are maximised. The region needs ambitious and achievable targets for sustainable development, reflecting multidimensional challenges. The programs and their implementation plans are still patchy, which is problematic for implementing and monitoring the SDGs.

Countries can reduce disaster, environmental, and climate risks by developing and periodically updating systematic risk management plans to minimise the economic impact of and vulnerability to climate-induced disasters. Disaster risk reduction and management programs should be accorded the highest priority in all national resilience programs. The sectors most vulnerable to disasters and climate change are agriculture, urban development, water supply and sanitation, transport, and health (Anbumozhi, 2018). Climate change will necessitate shifts in crop production and land management techniques in many AMS, as well as changes in water use (Anbumozhi et al, 2017). There is an urgent need to develop both country level and regional knowledge on the links between climate change, disasters, water availability, and dry land management. In many countries efforts need to be initiated to search for more climate-smart agriculture that involves new information and communication technology (ICT). From now until 2040, policymakers need to dramatically increase efforts to adapt their development strategies and programs to the impacts of disasters and climate change. With the accelerated absorption of ICT and above-ground sensors and satellites, by 2040 they should be in a position to take full advantage of early warning systems.

Improving the resilience of global and regional value chains is critical for the AMS. Reducing the severity of disruptions in the flow of goods and services across borders to customers very much depends on improving the capabilities of enterprises along the value chain, which could be catalysed by strengthening the disaster readiness of locations and functions at the nodes in the value chains. Establishing multiple channels between suppliers, company sites, and functions could be established under business continuity plans. Countries and companies can reduce

disaster and climate risk by developing systematic business continuity plans that incorporate innovative risk financing instruments and techniques. Experience in the region and in other small island countries has shown that disaster risk finance and crop insurance schemes can play a pivotal role in developing active risk management capacity along the value chains, and reduce the economic impact of and vulnerability to climate-related disasters. Financing instruments, when combined with other emerging technologies such as blockchain, can provide effective risk reduction capability for small and medium-sized enterprises (SMEs), emergency credit or liquidity, and access to external risk transfer markets including reinsurance.

2. Impact of Digital Economy and Industry 4.0 on Resilience and Sustainability

The progress of the digital economy and the Industry 4.0 (fourth industrial revolution technologies) may have a large impact not only on our consumption and production patterns, but also on resilience and sustainability. We need to utilise this new technology to improve resilience and sustainability.

2.1 Industry 4.0 and Opportunities for Resilience and Sustainability Leapfrogging

Technologies of Industry 4.0 create opportunities for some of the AMS to bypass traditional phases of industrial development. Online and mobile banking is reducing the need to build physical networks. While the infrastructure needs of ASEAN remain formidable, developments driven by Industry 4.0 suggest they could be lower, and certainly different and more circular, than they would be otherwise (Anbumozhi and Kimura, 2018). Localised and close-looped production networks with 3D printing technologies could reduce the need for raw materials and enable firms to manufacture products in small and required quantities, without much waste getting into the system. SMEs are the backbone of ASEAN economies, but their environmental impacts are significant, as they are limited in their access to technology, finance, and business information. The rise of the internet of things and artificial intelligence can empower SMEs to produce in a more eco-efficient way and connect them to the

giant ASEAN single market rather than just local customers. Technologies such as blockchain will revolutionise the procurement of eco-products and services, logistics, and payments – enabling small and micro firms to interact with new customers on a trust basis, never having met each other (Nielsen, 2014).

Equally, the Industry 4.0 technologies can provide new ways of preparing for disasters and climate risks. Some ASEAN nations are archipelagic, and physical connectivity has long been a concern for growth and resilience. Other AMS have large rural and agricultural populations. In general, the use of ICT in the context of resilience has the potential to achieve the resilience objectives of developing early warning and hazard risk information, developing mapping tools to map vulnerable areas, and transmitting adaptation choices and the availability of financial resources to support that. Artificial intelligence, drones, and remote sensing offer opportunities to monitor agriculture, forestry, and fishery activities much more effectively. Irrigation systems can be automated and blockchains can be used to manage water allocation among farmers.

2.2 Digital Economy and Environmental Sustainability

Diffusion for the digital economy increases resource consumption such as energy, water, and materials for data exchanges, calculation, and others. It is a direct impact of the digital economy on resource consumption. Blockchain technology may stimulate more energy consumption because data mining activities consume a significant amount of energy.

Studies on the energy consumption of data centres in the United States (US) show an improvement in energy efficiency, having stabilised since 2008 (Shehabi et al., 2016). The energy efficiency of hardware has been improved through software. Shehabi et al. (2016) predicts that total energy consumption from data centres will not grow rapidly. It is also forecasts that more energy efficiency hardware and blockchain technology will be introduced in the future.

The US, European Union (EU), and Japan have an index and guidelines for energy efficiency in data centres. For example, the US Department of Energy issued a best practice guide for energy-efficient date centre design (US Department of Energy, 2011). Since more data centres are likely to be established in Southeast Asia, it would be an economic and environmental burden to the region if their energy efficiency were low. Therefore, energy efficiency guidelines and regulations for data centres should be developed at the ASEAN level.

On the other hand, teleworking and teleconferencing could reduce the need for commuting and business trips – decreasing energy consumption and GHGs. Onley (2015) estimated that teleworkers at Dell, Aetna, and Xerox in the US saved 95,294 metric tons of GHGs in 2014.

Many ASEAN countries have a large agriculture sector, which could enjoy a positive impact from the digital economy. In the short term, the impact of connecting farmers to telecommunication facilities has brought improvements to farm labour productivity, profitability, and resilience. Smartphones give workers and farmers better access to work choices, climate information, and knowledge about inputs and outputs. When connected to GPS, smartphones may also enable the sharing economy to take hold, whereby users such as farmers who cannot afford to buy mechanical or transport equipment can rent it by the hour from other farmers via online sharing sites.

2.3. Self-Driving Automobiles and the Sharing Economy

Many automobile companies, information technology industries, and car sharing companies invest in self-driving cars, which are projected to be on the market from 2020. This will have an impact on the business model in the automobile sector, taxi and car sharing services, and the ownership rate of automobiles.

Berret et al. (2017) argue that many people would not buy a car again if fully autonomous robocabs – driverless taxis – could be used at a lower cost per trip than their own car. In Singapore, 51% of respondents

answered that they would not buy a car again. Car owners in India and China were more likely to buy a car again, but 33% in India and 27% in China said they would not buy a car if robocabs were cheaper than owning a car.

Although the survey did not cover ASEAN countries, except Singapore, the car ownership rate in other ASEAN countries is not expected to reach the same level as in developed countries. Reduced car ownership would cut the resource consumption of automobiles.

Consumers will also be able to choose types of cars according to their demand. Mini vehicles for one to two people will be used for short tips of a few kilometres (transport to/from the transit point of public transportation, e.g. bus stop or subway station). Such usage will also reduce materials and energy for transportation.

Digital market platforms, usually referred to as the sharing economy, should become an essential part of city planning. Connectivity between public transport and self-driving cars should be carefully designed in that digital-driven city economy. Otherwise, many people will use automobiles and public transport will be decreased, which would have a negative impact on sustainability. As the trends of increasing connectivity, low-cost hardware, and informal and social entrepreneurship continue to advance in ASEAN, it is not yet clear whether traditional regulations will stifle progress on normalising the environmental and safety risks.

Carbon pricing is being highlighted as a key policy instrument to support changes in consumer behaviour. It was found successful in promoting innovation, creating new businesses, and delivering meaningful emissions reduction – particularly in urban centres – by forcing commuters to shift to public transport systems (Tamilian, Cao, Ho, 2017).

On the other hand, relatively high population densities in ASEAN cities mean that rail mass transit will have a significant place in the future of ASEAN in 2040. However, rail mass transit is expensive and not the

only solution, especially for medium-sized to small cities. Curitiba, Brazil (through its TranMilino system), Jakarta (through its TransCity express bus), and Manila (with elevated city terminals) have become successful low-carbon transport systems by reducing private car use.

3. Regional Approaches and Single Market for Resilience and Sustainability

As ASEAN has intensified its efforts to create a single market for products and services, it is becoming easier for goods, services, and factors of production to be moved across countries as easily as within countries. To maximise the benefit of the single market in environmental goods, some standards should be harmonised in ASEAN countries.

3.1 Consumer and Product-Related Environmental Regulations

Consumers – either individuals or industries – considering buying an environmental good or service go through three stages. First, they become aware of the environmental threat and become keen to help mitigate it through consumption. Second, they acquire the necessary information about the good. Third, they buy the good. Labelling and certification are crucial for highlighting the environmental attributes of products. Economic integration in ASEAN increases the need for harmonisation of not only conventional goods but also product-related environmental standards, such as measurement methods of the energy efficiency of appliances and automobiles, labelling requirements related to energy efficiency and environmental issues, and evaluation methods of decentralised wastewater systems. Without harmonisation for evaluation methods, manufacturers would have to conduct multiple tests for each country.

Although international standards may be created for these aspects, some regional standards should be developed in ASEAN because certain conditions (e.g. climate and culture) differ by region. For example, the efficiency of decentralised wastewater treatment depends on temperature, which affects the speed of decomposing. As a result, the size of tanks in Southeast Asia can be smaller than in Europe, Japan, or

the US. Appropriate regional standards should be developed, based on scientific research and agreement, among stakeholders in the region.

Similarly, governments may directly affect the demand for environmental goods and services. The public sector – national, provincial, and local government – is the largest consumer of finished goods and transport services in many ASEAN countries. Given such volume, governments can drive the markets to scale up the purchase of products. This combined approach of market push and harmonised regulatory pull could bring radical changes in production standards and consumers.

3.2 Circular Economy

The circular economy can reduce the environmental burden in various ways. Promotion of the circular economy should be harmonised in the region. When ASEAN economies are fully integrated, international trade of recyclable waste, used goods, core for remanufactured goods, and remanufactured goods itself will increase, because of scale economies in recycling, repairing, and remanufacturing industries. The EU issued the Circular Economy Package in 2016, which has various actions to stimulate the circular economy in the region.

Marine plastics issues have highlighted insufficient waste management and recycling in Southeast Asian countries. Jambeck et al. (2015) estimated the volume of marine plastic generation from land around the world, based on the population within 50 kilometres of the coastline, waste generation per day, the rate of plastic waste in waste generation, and the rate of improper treatment of plastics. This method revealed China to be the top marine plastics generator, followed by Indonesia, the Philippines, and Viet Nam. Total marine plastics generation in ASEAN countries is estimated to exceed that of China. Although this estimate is based on very strong assumptions, the findings of the study suggest that ASEAN countries should put more effort into waste management and recycling.

Small-scale recycling industries in ASEAN countries have caused pollution. It is costly for small-scale recyclers to install wastewater treatment and air pollution control equipment. Some countries, such as Japan and China, conduct stricter enforcement of pollution control and promote recycling industrial parks, where small recyclers can move their factories and invest in pollution control.

Industrial standards for recycled products should also be established. For example, Japan has set various industrial standards for recycled goods, such as aluminium dross for iron and steel making (JIS2402) and eco-cement (JIS5214). Such standards should be harmonised in the ASEAN region because recycled products are traded in the region.

When combined with circularity principles, the sharing economy can also contribute to reducing environmental burdens. The EU regards sharing as part of the circular economy. Some surveys show that sharing is very popular in ASEAN countries, even compared with developed countries. Nielsen conducted a worldwide consumer survey on the sharing economy in 2013, which found that consumers in Southeast Asia are more likely to share than in other regions (Nielsen, 2014). Some 87% of Indonesian consumers said they were likely to share from others, which is second highest after China's 94%, while Slovenia (87%) ranked 3rd, the Philippines (85%) ranked 4th, and Thailand (84%) ranked 5th. Similar results are reflected in Rakuten-AIP (2017), which conducted a consumer survey in Japan, Singapore, the US, and Viet Nam, showing that 53% of Vietnamese people had used ride/car sharing, which is higher that Singapore (28%), the US (23%), and Japan (4%). Therefore, ASEAN countries may be able to improve resource efficiency through the sharing economy.

On the other hand, remanufacturing is not very popular in ASEAN countries. Rebuilt automobile parts are not well recognised by customers, and remanufactured goods and cores for remanufactured goods are often regarded as used goods and prohibited for import to the region (Kojima, 2017).

Ekins et al. (2017) pointed out that remanufacturing has the potential to improve resource efficiency. The Government of Singapore, with Nanyang Technological University, established the Advanced Remanufacturing and Technology Centre in 2012. Research and development for the sector should be strengthened. Regulatory barriers for the remanufacturing business, such as import restrictions on cores for remanufactured goods, should also be removed.

3.3 Building Standards

Across ASEAN, making housing and buildings safer is a concern as some areas have a higher risk of earthquakes, flood storms, landslides, etc. To reduce the risk of collapse of buildings from earthquakes, building standards for resilience to earthquakes should be developed. Such standards should be required for the construction of new buildings. Since many construction companies are expected to provide services in more than two ASEAN countries, it would be advisable to create an ASEAN building code to reduce the risk from earthquakes and associated risks. Local governments should become visibly more committed to safe housing and prohibit the occupancy of structures in high-risk areas. In the planning arena, governments, the private sector, and housing finance institutions should take a joint lead in the implementation of standards.

4. Vision 2040 for Resilience and Sustainability

4.1 Vision for Disaster Risk Reduction and Climate Change Adaptation

Disaster risk reduction and climate change adaptation are among the main goals of the SDGs. The Blueprint 2025 identified climate change and variability as a driver of disaster risk, along with uncontrolled urbanisation and poor land management. Tackling these by 2040 is expected to lead to a sizable reduction in disaster risk and resilience.

Risk assessments can further be improved through the results of new ICT and high-performance computing, a new generation of early warning systems and disaster loss models, and increased availability of high-resolution exposure datasets, as well as an improved stakeholder engagement and knowledge synthesis process. As shown in Figure 2, a comprehensive multi-hazard risk and vulnerability assessment framework can support evidence-based robust decision making.

Figure 2: Application of ICT in Disaster Resilience – A 2040 Roadmap

Resilience Options	Drought	Current and Short-term (Present - 2020)	Mid-term (2021 - 2030)	Mid-term (2026 - 2040)
Risk Management Risk Assessment Climate and siasters Risk	**Step I** Harmonized Data collection	• Meteorological data (i.e. hazard) • Socioeconomic data)i.e. exposure) • Climate change scenarios • Projections of socioeconomic conditions	• Updating meteorological data and improving data quality • Expanding data categories relevant to climate risk conditions • Updating socioeconomic and climate change scenarios	• Updating database and advancing quality control procedure • Real-time collection of meteorological data and R/S data
	Step II Risk Analysis	• Analysis of extreme occurrence and severity w/ meteorological data • Assessing spatial extent of hazards • Inventory resources and indetify groups at risk	• Updating climate and disaster risk properties (e.g spatial extent, occurrence) • Assessing further impacts of climate induced disaster on socieies • Assessing social resilience to expected impacts of droughts	• Establishing forecast based climate and disaster risk analysis framework
	Step III Understanding the risks	• Mapping hazard risks in term of hazard, exposure, and vulnerability • Assessing risk of climate change on weather events with scenarios • Assessing risk of changing socioeconomic conditions	• Developing mitigation plans for reducing climate risk under cahanging adaptive conditions • Finding and assessing adaption strategies	• Assessing drought hazard and vulnerability under forecastedclimatic conditions
	Step IV Developing System for disasters and climate risk management	• Developing hazard monitoring system • Archiving past drought events and their consequences	• Finding predictors for early warning • Improving social communication system (Mass media, Telecommunication)	• Developing real-time forecasting and early warning-system • Integrated multi-hazard detection system
	Step V Strengthening and enhancing risk manaement plan	• Review on existing strategies, policy, plans, laws and regulations • Developing climate risk education and training program • Policy for emergency response and relief • Establishing local climate adaption and resilience policy framework	• Improving governance and stakeholders's cooperation • Regional resilience policy framework • Developing risk mitigation and control plan • Identifiying and fill institutional gaps	• Developing and publicizing national resilience policy framework • Evaluating and revising adaption and resilience plans

ICT = information and communication technology.

Source: Adopted from Anbumozhi et al. (2012).

In some ASEAN countries, policies for disaster risk reduction and climate change adaptation are well integrated. New institutions have been established to develop joint actions towards resilience, benefitting both policy areas. Responding to extreme events is the prime responsibility of local governments, but provincial and central governments have a role in supporting local governments at different stages and periods of resilience building. This entails effective multilevel governance. Better coherence between disaster risk reduction and climate change adaptation can be fostered through the development of a high-level strategic vision and local level engagement of key actors, supported by adequate funding.

Community-based organisations have been playing an important role in co-managing natural resources and strengthening resilience. They are often best positioned to bridge the real need and the emerging technological possibilities. As new digital technologies (e.g. sensors, drones, and artificial intelligence) provide increasingly powerful traceability of resource depletion and co-management of common property resources such as water and forests, the services of community-based organisations are needed to establish the norms and institutional capacity of communities for harvesting the resources in a sustainable manner. Multi-stakeholder collaboration and co-management also have an important role in creating market demand. Over the past 20 years, sustainable forest councils and the sustainable seafood movement – involving diverse collaboration among non-governmental organisations, leading companies, farmers, fishers, and governments – have been a powerful market driver for better management of resources. Multi-stakeholder collaboration on the traceability of these public goods provides a clear signal for maximising the benefits of digital technologies.

The economic costs of climate risks can be reduced through well-designed ex ante financial management and protection instruments. Public–private partnerships can provide services with joint bearing of responsibilities and efficient risk sharing. A number of public–private partnerships under the ASEAN Single Market could be conceptualised and promoted, aiming at increasing insurance coverage and market penetration, and ensuring strong financial backing for low-probability high-impact risks. A well-functioning system of public and private user-driven ICT-based climate and disaster risk services could catalyse

economic and societal action and transformation which reduces risks and improves societal resilience.

The Economic Research Institute for ASEAN and East Asia (ERIA) has developed resilience roadmaps for the region, which are planned sectoral actions to be adopted over a period of time. They give a prioritised data service perspective on resilience – moving away from supplier- to user-driven – and are scientifically e-informed, underpinned by an approach to innovation based on co-design, co-development, and co-evaluation of resilience services. Improved alignment of demand-led climate change adaptation and disaster risk service products would require policymakers to have stronger linkages. Adding climate change and disaster resilience to the considerations used to motivate and design nature- or ecosystem-based solutions would add to the multipurpose nature of these solutions, help to leverage funding, and help to connect communities working on joint solutions.

The above measures require the establishment of national level indicators for monitoring actions towards improved resilience. Progress in implementing the Sendai Framework for Disaster Risk Reduction will be monitored through an agreed set of indicators, while the United Nations Framework Convention on Climate Change is considering how best to track resilience efforts at the national level. SDGs will also require countries to report on progress. There are opportunities to improve connectivity and coherence between these indicators and data requirements at the ASEAN level, improve the efficiency of data collection at the national level, and build a more complete picture of climate change adaptation and disaster risk progress and priorities at the national level.

A multi-stakeholder approach should be strengthened for information sharing and coordination within each country and among AMS. Resilience and environmental sustainability issues require the collaboration and cooperation of various sectors such as governments, industries, academics, and non-governmental organisations. Even in government, various ministries and agencies should cooperate with each other. Institutional arrangements within various stakeholders should be strengthened.

The ASEAN single market is bound to the rest of the economies through multiple systems that enable two-way flows of materials, financial resources, ideas, and innovations. The pace of technological change – particularly Industry 4.0 in the fields of information, communication, nanotechnology, and biotechnologies – is unprecedented. These innovations can help to reduce the waste and impact of industrial development. A circular economy could contribute to this. Unlike the traditional linear take–make–consume–dispose approach, a circular economy seeks to respect physical boundaries by increasing the share of renewables or recyclable resources while reducing the consumption of raw materials. Approaches such as eco-design and sharing, reusing, repairing, refurbishing, and recycling existing products and materials will play a significant role in maintaining the utility of products, components, and materials retaining their economic value. A circular economy at ASEAN level offers considerable benefits, reducing the ecological footprint. Circular economy strategies could also result in substantial cost savings, increasing the competitiveness of the ASEAN single market while delivering benefits in terms of job opportunities.

4.2 Vision for Environmental Sustainability

AMS have committed to improve sustainability by subscribing to the Blueprint 2025, adopting the SDGs, and ratifying the Paris Agreement. These commitments represent a new level of engagement towards green growth. Achieving these visions and goals will require accelerated investments in infrastructure for reducing risks caused by disaster risks, protecting natural resources, constructing low-carbon energy infrastructure, formulating a circular economy, and protecting natural resources.

Both the public and private sectors are playing a prominent role in meeting ASEAN's green investment needs. On the other hand, the current deployment of green technologies – in terms of installed capacity, patents registered, and new business development – is not yet in line with the level of ambition expressed in their national targets or the commitment to international society, which suggests there is a gap in investment flows, particularly from the private sector. Further, it seems that the regional aspirational targets for environment-friendly cities, living

environment, and 2030 sustainability agenda do not play a major role in the definition of NDC targets and the innovation capacity at the national level, which again retard private investment.

Huge potential exists for private sector investment in the region. From 2005 to 2015, private investments in ASEAN totalled $4,280 billion, of which foreign direct investment accounted for 33.7% (United Nations Conference on Trade and Development, 2017). A key question for policymakers in ASEAN is how to direct large cross-border private investments towards cleaner production systems to meet these targets. The private sector is bound by fiduciary duty to maximise the shareholder values of current assets. .Green financing carries high risks. Perceived risks in ASEAN countries are also high, where market-based mechanisms to finance green initiatives are in the early stage of development. Producer and consumer responsibilities are low, with subsidies remaining, and they do not reflect the full costs, including environment externalities. Regulatory regimes are also complicated, creating additional uncertainties. These conditions do not provide adequate incentives for private investment, resulting in different levels of readiness towards sustainability, such as a circular economy.

Table 5: Enablers and Readiness Rating of ASEAN for a Circular Economy

Country	Higher Education and Training	Good Market Efficiency	Labour Market Efficiency	Financial Market Development	Technological Readiness	Market Size	Overal Rating
Cambodia	2.8	4.2	4.5	3.9	3.0	3.0	3.6
Indonesia	4.5	4.4	3.7	4.2	3.5	5.7	4.3
Lao PDR	3.2	4.3	4.5	3.8	2.8	2.9	3.6
Malaysia	5.0	5.4	4.9	5.2	4.6	5.0	5.0
Myanmar	2.5	3.6	4.2	2.4	2.2	4.2	3.2
Philippines	4.5	4.2	4.1	4.2	3.9	4.9	4.3
Singapore	6.2	5.7	5.7	5.6	6.2	4.8	5.7
Thailand	4.6	4.7	4.2	4.4	4.2	5.2	4.6
Viet Nam	3.8	4.2	4.4	3.7	3.3	4.8	4.0

Lao PDR = Lao People's Democratic Republic.

Source: Viswanathan and Anbumozhi (2018).

Sufficient time is required to develop and mature market mechanisms and regulatory capacity in individual countries. In a long-standing regional cooperation arrangement like ASEAN, member countries can work together to support market development, innovation, and regulatory capacity. There are feasible opportunities for such regional efforts. Here, we highlight five regulatory factors that need to be addressed at the regional level to promote the green economy.

First, private financial institutions operate in an environment where prices for ecosystem-based natural resources management are very low and volatile. Where permits and approvals are required to implement the green economy, delays can be lengthy. Both banking and regulatory authorities grapple with assessing new investments based on old risk assessment methods (Hongo and Anbumozhi, 2015). This becomes more complicated when the users are state-owned enterprises. Individual mandates for meeting goals and targets are neither agreed nor generally consulted during the performance reviews. This results in shareholders or entrepreneurs not being ready to increase their investments.

Second, private investors in green economy systems operate a capital-intensive business model. Foundational capital stocks such as green bonds and innovation funds are still in the establishment stage in ASEAN countries. As a result, pioneering investors need to balance intense competing demand for capital within firms. At the corporate level, the competing demand for capital is subject to intense management scrutiny, in an effort to allocate scarce capital for low-carbon risky investment).

Third, low-carbon economy, circular economy, and sharing economy projects or other areas of environmental project developers are often called on to provide solutions for investors with long lived assets. Some of these potential investors may also operate under reduced competitive pressures because of fiscal and public finance subsidies to conventional polluting industries. These subsidies or incentives put green investors at a competitive disadvantage and subject them to unfair market conditions (Yao and Anbumozhi, 2015).

Fourth, product standards related to environmental goods should be harmonised in the region to reduce the cost of production and testing, as explained in 4.1. Such efforts would contribute to diffuse environmentally sound goods, which have better performance in GHG emissions, energy efficiency, or resource efficiency. In addition, transaction costs between consumers and producers on the environmental performance of goods can be reduced.

Fifth, AMS should use ICT to improve environmental sustainability. As shown in section 3, ICT may have an impact on commuting, urbanisation, the number of automobiles, and other factors. Existing regulations often hamper such new technologies. If they are beneficial to human well-being and sustainability, governments should revise such regulations to facilitate new technologies.

Decoupling economic growth from pollution and emissions in ASEAN also implies coordination problems across different ministries within ASEAN governments. The target year of the Paris Agreement is 2030. If voluntary commitment under the Paris Agreement is effective and if GHG emissions are reduced significantly by 2030, a similar approach will be used after 2030. Otherwise, the international community will seek stricter international commitments to reduce GHGs. However, meeting the Paris Agreement targets does not mean that ASEAN will be on a sustainable development path. The commitments are modest, especially when compared with the business-as-usual scenario of ASEAN growth, not the ASEAN single market.

The target year of the SDGs is also 2030. As shown in section 1, most of the indicators related to environmental sustainability show that the current rate of progress is not sufficient to achieve the SDGs in 2030.

Further, a one-size-fits-all approach is not viable across ASEAN. Instead, green economy priorities should be based on each country's economic circumstances. Countries with high and medium levels of resource consumption and pollution levels must invest more in eco-innovations and reorient policies to drastically increase resource efficiency and limit

or reduce emissions. For dynamic emerging economies, priorities are improving resource efficiency in new infrastructure and basic industries. Countries with low consumption levels will require support from other ASEAN countries to increase material affluence with green economic opportunities. These countries may particularly benefit from the transfer of green technologies from abroad, adapted to local conditions.

Conclusion

ASEAN has come a long way in building resilient and sustainable societies. ASEAN and its member countries have a clear vision and ambitious targets which are covered in the 2015 and 2025 blueprints, the SDGs, and the Paris Agreement. Actions towards the vision have also been identified in other documents, as shown in section 1. However, the success of current approaches faces many implementation challenges. Current agreements, commitments, declarations, and decrees often focus on specific environmental problems and cannot tackle the different issues of sustainability and resilience as a whole. Countries tend to free-ride on regional issues, as they are rarely in a position to coordinate action across the sectors. This results in differentiated progress in some indicators, such as sanitation, and reliance on clean energy. However, some of the indicators, such as domestic material consumption and forest area, show a negative trend which should be reversed in the future.

To implement planned actions for resilience and sustainability in ASEAN, various stakeholders should be involved. Governments should develop and enforce appropriate regulations, producers should have cleaner production processes, and people should have viable choices to ensure their resilience and environmental sustainability. No one should be left behind in resilience and environmental sustainability, and the effort to facilitate multi-stakeholder involvement should be strengthened.

Having said that, a sustainable and resilient ASEAN under the ASEAN single market, driven by the application of progressive technologies, should been seen as an economic imperative to improve people's lives by generating new business opportunities and incentivising social inclusion

while mitigating negative impacts on the environment. The coherence and consistency of this agenda are key for its success by 2040.

Second, it is critical to support the development of local capacity for a sustainable and resilient ASEAN. When indigenous innovations are connected with international models, they provide a different profile for low-carbon, circular, and sharing economies – which will serve as a tool to enhance competitiveness and attract talent.

Third, the key aspects of such a new paradigm should be addressed in a cross-sectoral manner to maximise the benefits. Issues such as taxation, social benefits, licences, ecosystem payments, and employment conditions should be addressed to reduce vulnerability and enhance competition among key stakeholders.

Towards that end, capacity development for various stakeholders should be enhanced, including government capacity in various ministries to enforce regulations, incentives, and rewards; and industrial capacity to use resources efficiently to make industry more competitive.

As shown in section 2, ICT can be used to reduce the environmental burden. AMS should carefully use such opportunities to realise the vision. Creating harmonised product standards in ASEAN, related to resilience and sustainability, is beneficial to reduce the cost of such products, as shown in section 3.

Within governments, various ministries and local governments should share information and cooperate to develop appropriate regulations and enhance enforcement capacity. Such a multi-stakeholder approach is crucial to achieving a resilient and sustainable ASEAN in 2040.

These aspects require an expanded mandate for specialised ASEAN institutes like the ASEAN Centre for Biodiversity, ASEAN Centre for Energy, ASEAN Centre for Green Growth, the AHA Centre, and ERIA –

particularly in generating solid knowledge and convening spaces to discuss issues openly and share good practices. Having those capacities available regionally would make the country actions faster, cheaper, and culturally more acceptable.

References

Anbumozhi, V., M. Breiling, S. Pathmarajah, and V.R. Reddy (2012), *Climate Change in Asia and the Pacific: How Can Countries Adapt?* New Delhi: Sage Publications.

Anbumozhi, V. and F. Kimura (2018), 'Industry 4.0: What Does it Mean for the Circular Economy in ASEAN?', in V. Anbumozhi and F. Kimura (eds.), *Industry 4.0: Empowering ASEAN for the Circular Economy*. Jakarta: ERIA, pp.1–35.

ASEAN (1997), ASEAN Vision 2020. Jakarta: ASEAN Secretariat.

ASEAN (2009), ASEAN Socio-Cultural Community Blueprint. Jakarta: ASEAN Secretariat.

ASEAN (2015a), ASEAN 2025: Forging Ahead Together. Jakarta: ASEAN Secretariat.

ASEAN (2015b), Kuala Lumpur Transport Strategic Plan (ASEAN Transport Strategic Plan), 2016–2025. Jakarta: ASEAN Secretariat.

ASEAN (2016), ASEAN Minerals Cooperation Action Plan, 2016–2025 (AMCAP-III). Jakarta: ASEAN Secretariat.

Berret, M., R. Seyger, W. Bernhart, E. Kirstetter, M. Winterhoff, and S. Riederle (2017), 'Tracking Disruption Signals in the Automotive Industry', Automotive Disruption Radar, 1. Munich: Roland Berger.

Ekins, P. et al. (2017), Resource Efficiency: Potential and Economic Implications. A report of the International Resource Panel. Nairobi: United Nations Environment Programme.

Hongo, T. and V. Anbumozhi (2015), 'Reforms for Private Finance toward Green Growth in Asia', in V. Anbumozhi, M. Kawai, and B.N. Lohani (eds.) Managing the Transition to a Low-Carbon Economy: Perspectives, Policies, and Practices from Asia. Manila and Tokyo: Asian Development Bank and Asian Development Bank Institute, pp.251–78.

Jambeck, J.R. et al. (2015), 'Plastic waste inputs from land into the ocean,' Science, 347(6223), pp.768–71.

Kojima, M. (2017), 'Remanufacturing and Trade Regulation', Procedia CIRP, 61, pp.641–44.

Kojima, M. and V. Atienza (2010), 'Industrial Standard for Recycled Goods in Japan and South East Asian Countries', in M. Kojima, (ed.), 3R Policies for Southeast and East Asia. ERIA Research Project Report 2009-10, Jakarta: ERIA. pp.216–34.

Nielsen (2014), Is Sharing the New Buying? Reputation and Trust are Emerging as New Currencies. https://www.nielsen.com/content/dam/nielsenglobal/eu/nielseninsights/pdfs/Nielsen-Global-Share-Community-Report-May-2014.pdf (accessed on 8 September 2018).

Onley, D.S. (2015), 'How Telecommuting Helps the Environment' https://www.shrm.org/ResourcesAndTools/hr-topics/technology/Pages/How-Telecommuting-Helps-the-Environment.aspx (accessed on 8 September 2018).

Rakuten-AIP (2017), 'Can sharing economy succeed in Asia? Consumer acceptance of Uber, Airbnb in Asia'. Self Study Report. 3.

Reddy V.R., S. K. Singh, and V. Anbumozhi (2016), 'Food Supply Chain Disruption due to Natural Disasters: Entities, Risks, and Strategies for Resilience', Discussion Paper 2016-18, Jakarta: ERIA.

Shehabi, A. et al. (2016), United States Data Center Energy Usage Report. Berkeley, CA: Lawrence Berkeley National Laboratory.

Timilsina, G.R., J. Cao, and M. Ho (2017), 'World Bank Experience in Low-Carbon Investments and the Role of Carbon Pricing in China', in V. Anbumozhi and K. Kalirajan (eds.), *Globalization of Low-Carbon Technologies: The Impact of the Paris Agreement*. Sydney: ERIA and Springer, pp.513–35.

UNESCAP (2018), Asia and the Pacific SDG Progress Report 2017. Bangkok: United Nations.

United Nations Conference on Trade and Development (2017), World Investment Report: Investment and the Digital Economy. Geneva: United Nations Conference on Trade and Development.

United Nations General Assembly (2015), 'Transforming our world: the 2030 Agenda for Sustainable Development', Resolution adopted by the General Assembly on 25 September 2015. New York: United Nations.

US Department of Energy (2011), Best Practices Guide for Energy-Efficient Data Center Design, Revised March 2011. https://www.energy.gov/sites/prod/files/2013/10/f3/eedatacenterbestpractices.pdf (accessed on 8 September 2018).

Viswanathan, C. and V. Anbumozhi (2018), 'Evolutionary Acts and Global Economic Transition: Progress of the Circular Economy in ASEAN', in V. Anbumozhi and F. Kimura (eds.), Industry 4.0: Empowering ASEAN for the Circular Economy. Jakarta: ERIA, pp.67–105.

Yao, X. and V. Anbumozhi (2015), 'Low Carbon Green Growth as an Inclusive Development Model: Assessing Policy Changes and Initial Lessons from Developing Asia', The International Journal on Green Growth and Development, 1(1), pp.15–38.