Background Paper 4A

Environmental and Sustainability Challenges in the Mekong Subregion

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Background Paper 4A

Environmental and Sustainability Challenges in the Mekong Subregion

Venkatachalam Anbumozhi, Michikazu Kojima,
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The Mekong Subregion – Cambodia, the Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, and Viet Nam – is not only host to the fastest growing economies in the Association of Southeast Asian Nations (ASEAN), but is also rich in natural resources and biodiversity and has a culturally diverse urban population. Returns from the continued economic growth have raised incomes and improved people's well-being, but have also resulted in many environmental challenges. Although progress has been made, it has proved difficult to effectively integrate economic, environmental, and social objectives in pursuing sustainable development in the region. A combination of factors such as climate change, disasters, and low adaptive capacity are posing challenges to meeting the increased food demand. As countries industrialise in a phased manner and the contribution of the service sector expands, agriculture, forestry, and fisheries remain fundamental to all the countries in the subregion. Embedded with many integration efforts are conflicts over the use and management of natural resources. For instance, conflicts over water – both within and between countries – are intensifying because of escalating industrial and agricultural demand for water, interfering with river flows and creating changes in food security (Reddy, Singh, and Anbumozhi, 2016). Likewise, land for growing food and making a living is increasingly contested. In the Mekong region, rapid urbanisation is another critical process, especially in dynamic peri-urban areas where opportunities and challenges from environmental sustainability are often at a crossroads. Unfortunately, the expansion and intensification of this sectoral growth have been accompanied by the degradation of forest land and the depletion of natural resources. Deforestation and a decline in natural resources are compounded by growing plastic debris in coastal zones and pose an important threat to sustainable economic growth. The rich biodiversity in the region has already been greatly affected by land use changes and remains vulnerable to climate change. A range of economic variables, trade, demand for goods and services, labour migration as well as alterations in natural resources such as changes in river flow transmit environmental pressure from one country to another. Pressure on forests, fisheries, plastic marine debris, and urbanisation has come in part from cross-border demand for increased production and consumption.

1. Climate Change and Disaster Impact on Food Security

The climate of the Mekong Subregion is strongly influenced by the monsoon. In many parts of Cambodia, the Lao PDR, Myanmar, Thailand, and Viet Nam – the core tropical zone – several natural disasters such as floods and droughts occur in the same year or with increasing frequency across the years. With a large part of the population still living in rural areas and depending on agriculture and fishing, effective management of climate and disaster risks is important for food security. While temperatures and sea levels are expected to rise, significant uncertainties remain regarding the distributional impacts of climate change and disasters on production and supply. Abundant food is produced in the Mekong region, which includes the major rice exporting countries of Thailand and Viet Nam. Baseline studies indicate that Cambodia, Thailand, and Viet Nam will be more affected than the other countries, depending on the food grain export (Anbumozhi, Breiling, and Reddy, 2019).

While food is plentiful, access to healthy and affordable food is problematic for many low-income households in rural areas. The lack of access creates food 'deserts', defined as areas with limited access to affordable and nutritious food. Short-term disruptions to food supplies such as natural disasters exacerbate food insecurity for many households, influencing not only the availability of food supplies but also food quality and, most importantly, prices. The 2017 floods affected nearly 60% of farms in the Lao PDR, primarily the production of rice and maize. Similarly, the 2012 drought affected Viet Nam, Thailand, and Cambodia, with a 27% decrease in yields (Shiomi, Ono, and Fukushima, 2019). Crop losses were highest in the 2011 floods in Viet Nam, where nearly 8 million hectares were flooded and not harvested or planted (Kuwornu, 2019). The 2019 drought brought the Mekong River levels to their lowest point in at least 60 years. Most parts of the basin experienced an exceptionally low flow in the second half of the year. Many rice farmers in the Lao PDR, Viet Nam, and Thailand were unable to plant their main crops, resulting in a 27% decrease in production in 2019. Less water flow could also have a devastating impact on fish reproduction in the Mekong River basin. Experts expect droughts and disruptions to the flow of the Mekong River to become more common, and warn that they could eventually lead to the collapse of the entire ecosystem. Due to climate change – rising temperatures, erratic rainfall, and more frequent floods and droughts – the Mekong Subregion is expected in incur significant losses in rice, corn, sorghum, and soybean crops, reaching about 2%–6% of gross domestic product (GDP) by 2050 (Raghavan et al., 2019). The spatial patterns of food supply and distribution as well as trade are quite variable but concentrated in the Mekong River basin.

The ratio of hazard losses to GDP also varies across the countries, with an average loss ratio of 2%–3% of GDP during 1990–2015 (Liu, 2015). The relative impact of climate change and disasters in the Mekong region is driven by recurring losses from flooding and severe weather. In the cyclone-prone coastal areas of Viet Nam, Thailand, Cambodia, and Myanmar, the losses represent 5%–6% of GDP in some provinces. The relative impact

ratios account for temporal and geographical differences in the economic capacities of the localities, which in turn influence the overall food security conditions.

Enhancing supply chain resilience is one mechanism designed to reduce the impacts of climate change and natural disasters. This is broadly defined as the ability of the food production system to prepare and plan for, absorb, recover from, and successfully adapt to adverse events. There are many approaches to food supply chain resilience. Key policy measures identified by Anbumozhi et al. (2012) included both short- and long-term measures.

Short-term measures:

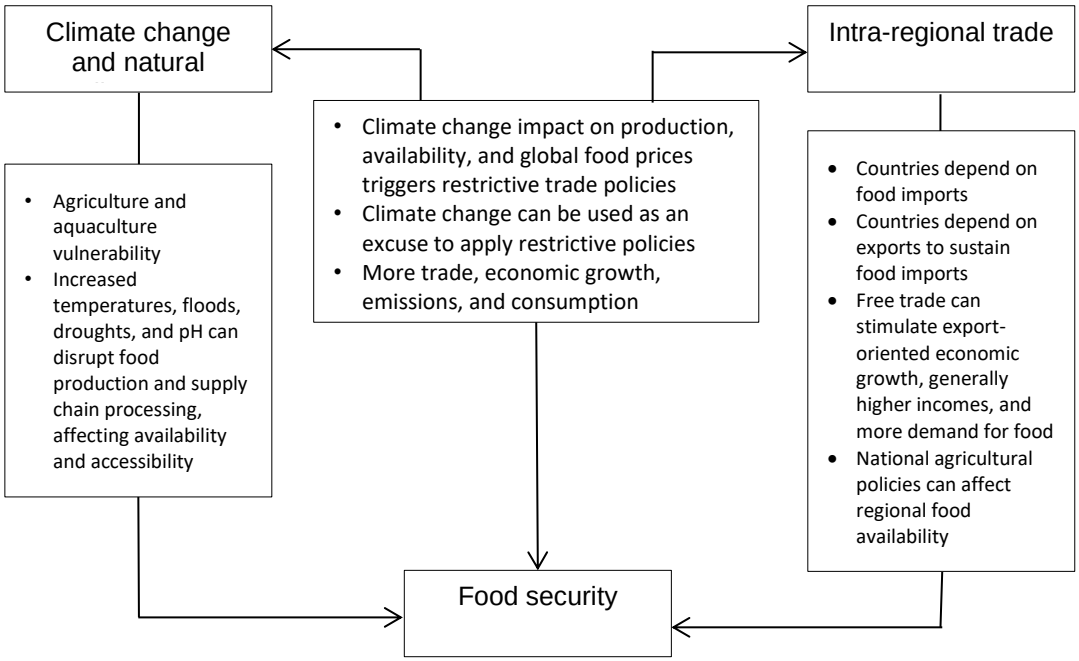
- Support farmers and local communities in developing diversified and resilient community-based agricultural systems that provide adequate food to meet local and consumer needs, while guaranteeing critical ecosystem services.
- Invest in more reliable information and weather forecasts to predict extreme weather events accurately.
- Develop new channels of information exchange and skill transfer between farmers and the research community to promote weather forecasting and mainstreaming of sustainable agricultural production methods.
- Invest in transport and storage systems. Emphasis should be placed on developing locally shared infrastructure and improving value-added activities for farmers.
- Achieve policy coherence and effective coordination of different governmental activities.
- Enhance public investment in research and development programmes on high-yield crop varieties that are tolerant to drought and nutrient stress, and encourage private sector participation in agricultural system infrastructure.

Long-term measures:

- Implement a scheme for payments to finance a sustainable agricultural development framework.
- Implement regulations in the financial sector that facilitate the international flow of funds for local communities and reduce barriers to paying farmers for environmental benefits.
- Expand agricultural official development assistance to enhance agricultural innovation and extension systems, ecological farming methods, and supportive infrastructure.
- Reform international trade policies aimed at improving market access for developing country producers and support the agricultural sector.
- Reformulate trade-related policies to strengthen food security. On the export side, increase market access in developed countries for products exported by developing countries to raise farmers' income and reinforce food security. This could be conducted by introducing insurance and financial rebate programmes.

ASEAN is home to major rice and shrimp exporting countries (Thailand and Viet Nam); key rice importers (Singapore, Indonesia, and the Philippines); and agrarian countries (the Lao PDR, Myanmar, and Cambodia). In the event of a sharp increase in world prices due to economic and natural disaster related shocks, large exporting countries such as Thailand and Viet Nam can impose export bans to bring stability and security to the domestic market. Indeed, they invoked the ASEAN agreement on agriculture when the food crisis erupted in 2008. Nevertheless, it remains unclear how free trade restrictions (e.g. sanitary and phytosanitary measures) can be reasonably implemented, if food safety under varying climate conditions is taken into consideration. These linkages are illustrated in Figure 1.

Figure 1: Climate Change, Trade, and Food Security Linkages



Source: Authors.

However, the above interlinkages should be seen from the fact that climate change and agricultural productivity are closely related, and those factors will continue to have implications for subregional food security if trade is restricted. Key factors for the resilience of any regional food supply chain include crop impacts; the vulnerability of small producers (incomes, housing, roads, and education); supply chain characteristics (logistics – technology and finance) and behaviours; and institutions (economic operators). To help food producers build their adaptive capacity, and deliver more resilient supply chains, governments should undertake the following tasks:

- Raise awareness and understanding of adaptation within suppliers/producers/retailers, drawing on their market knowledge and technical capacity
- Continuously ask producers/suppliers about current climate trends and impacts
- Work through existing institutions, including governments, to spread the risk by diversifying procurement to more sites

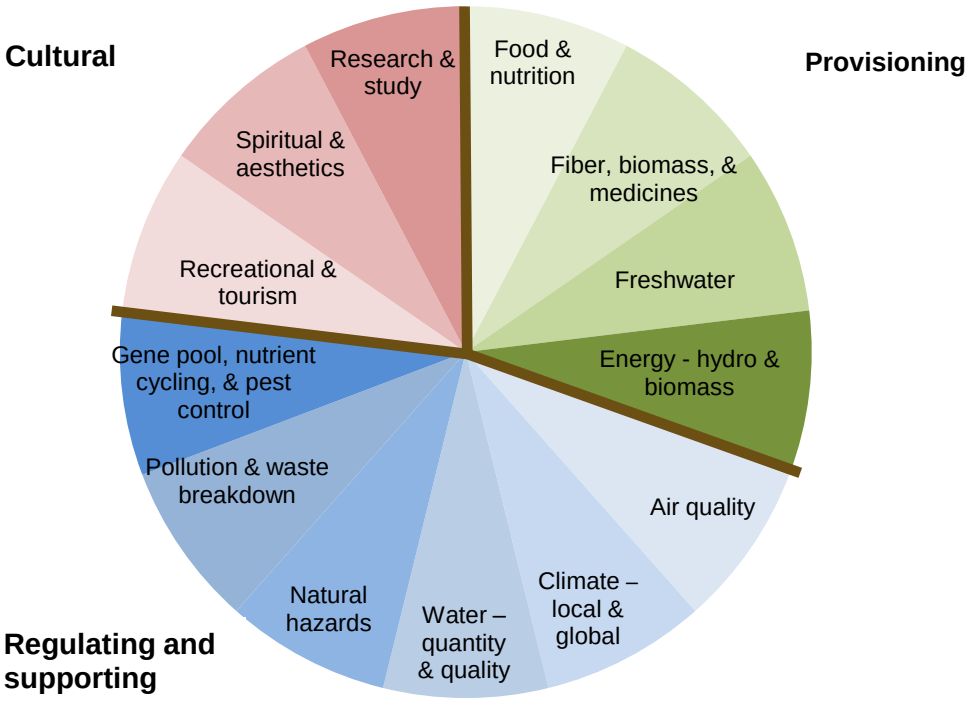
Other environmental issues, such as salinity intrusion and climate change related extremes, are also likely to affect integrated rice production and shrimp farming in the Mekong Delta. According to projections, the Mekong Subregion may lose 40%–60% of its potential fish catch due to fish migrations resulting from changes in temperature, river flow conditions, and ocean conditions. Small subsistence fishers lacking the adequate technology (e.g. satellite imaging) could lose their entire livelihoods and one of their staple foods.

2. Deforestation and Natural Resources Management

The forests of the Mekong Subregion are some of the most biologically diverse places on Earth. However, the region's forest cover decreased to 1,904,593 square kilometres in 2015 from 2,089,742 square kilometres in 2000 at an annual rate of 1.3% from 2000 to 2010 and 1.1% from 2010 to 2015 (ADB, 2008; ASEAN, 1997; 2009; 2015). The driving forces behind the deforestation include rising populations, increasing agricultural production, logging, and mining. Many countries in the Mekong Subregion still rely on timber production for their people's livelihoods. Like the terrestrial ecosystem loss, freshwater and marine ecosystems are at risk. The region has also suffered from the empty forest syndrome (forest land that has lost all its species on record) and wetland loss – adversely affecting the region's rich biodiversity. Hundreds of species in the Mekong region are being threatened by natural habitat loss due to deforestation, climate change, pollution, population growth, and poaching to fuel the illegal wildlife trade. In Cambodia and the Lao PDR, a surge of land concessions for agricultural plantations has added to pressure on both natural ecosystems and the rural communities that depend on them.

Other natural resources (e.g. forests, lakes, and oceans) are the source of various ecosystem services (Figure 2). Planning for forest and natural resources management requires a different approach than for other conventional economic planning. A bottom–up approach involving the local community will bring sustainability, as locals have better information on the status and condition of the natural assets. With practical understanding and experience regarding the potential integration of the management of production and conservation across land, air, and water boundaries, local communities can contribute tremendously in identifying future opportunities and livelihood options.

Figure 2: Type and Classification of Ecosystem Services Provided by Forests



Source: Authors.

Absent or inadequate governance (i.e. weak monitoring and implementation deficits, a top–down approach in the management of key resources such as forests, and lack of land rights) is the main challenge in natural resources management of the Mekong Subregion. Natural resources management and governance at the national level have evolved into a set of organisations, policy instruments, financing mechanisms, rules, procedures, and norms that regulate the process of natural resources management and biodiversity loss. Some successful strategies to overcome the implementation deficits are (i) moving the policy discussion to a higher level, e.g. environmental council, chaired by the President; (ii) investing in a good monitoring system and assessment; (iii) strengthening the administrative capability; and (iv) a bottom–up approach that addresses drivers, e.g. providing economic activity/alternatives for people to help communities (Sajise, 2015).

Application of the above strategic management concepts and policy tools can be innovative, if the following principles are adhered to:

- Strengthen cross-cutting policies across themes and sectors. It is important to maximise the benefits by focusing on options that are mutually reinforcing and cross-cutting. That will require introducing policy integration to manage cross-sectoral issues such as water, food, and marine resources management.

- Address the drivers. There is an increasing need to shift attention away from the effects of environmental degradation to a greater focus on underlying drivers such as population increase, poverty, lack of knowledge of the lifetime value of resources, and intergenerational equity.
- Enhance monitoring, evaluation, and accountability. Monitoring and evaluation should be used to improve policy design, increase the accountability of different stakeholders, and identify promising practices that can be subsequently applied in country settings. In this regard, key performance indicators are necessary to evaluate policy progress and clearly identify the success and shortcomings of the implementation of selected policy instruments.
- Improve multi-stakeholder participation at local and national levels. The benefits of involving stakeholders (e.g. communities, the private sector, local governments, community-based organisations, and knowledge institutes) need to be acknowledged at all levels.
- Stronger long-term policy and financial commitment. Governmental commitment is needed for the active involvement of the private sector and better use of market forces.
- More information sharing and capacity building programmes. These are needed across the region to enhance the potential for transferability and the replication of successful policy instruments.

Mekong countries should adopt a standard framework, in harmony with other ASEAN Member States, for managing natural resources. Standard cooperation frameworks, such as the ASEAN Mineral Cooperation Action Plan, 2016–2025, should address the significant interrelated and interconnected political, institutional, economic, and governance areas (ASEAN, 2016; Sunchindah, 2015). Regional monitoring is vital for a planned and adaptive approach towards natural resources management. With shared natural resource assets and differentiated programme implementation and performance, establishing a reporting mechanism at the Mekong and ASEAN levels will help to make quick policy adjustments at the national and local levels, and learn from other's experiences. Towards that end, ASEAN could establish a regional trust fund for a portfolio of projects in the Mekong Subregion and programmes that enhance current actions on natural resources management. Adopting a green economy approach could also be considered as an option for achieving sustainable growth in the Mekong and, recognising the anticipated changes in the region, is both realistic and feasible. Forest and natural resources management responses need to be strategic, addressing the need for long-term development, and where necessary tactical, using temporary measures to secure species and ecosystems under imminent threat. Multiple actions will be needed, ranging from initiatives at the international, regional, and national policy levels to thousands of projects, negotiations, and decisions at the level of sites and landscapes.

3. Marine Plastic Debris

The Mekong River is regarded as a major source of marine plastic debris. Schmidt, Krauth, and Wagner (2017) included the Mekong River in the top 10 rivers that contribute 88%–94% of the global plastic load to the ocean. Flowing 4,909 kilometres through the six countries of the Greater Mekong Subregion – Cambodia, China, the Lao PDR, Myanmar, Thailand, and Viet Nam – the Mekong River loaded 33,431 tons of microplastic and 3,330 tons of macroplastic annually to the South China Sea (Schmidt, Krauth, and Wagner, 2017). Lebreton et al. (2017) revealed that the Mekong River discharges 18,800–37,600 tons of plastic every year and is the 11th most polluting river in the world. However, Schmidt, Krauth, and Wagner (2017) and Lebreton et al. (2017) did not use actual data on microplastics measurement in the Mekong River. The measurements were based on population, the amount of mismanaged waste, monitoring data on nearby rivers, and other variables. Although the Promotion of Countermeasures Against Marine Plastic Litter in Southeast Asia and India (CounterMEASURE) Project organized by the United Nations Environment Programme (UNEP) conducted micro and macro plastic monitoring in several places (Limpiteeprakan, 2020; Pirika Inc., 2020), it is short of data to estimate the volume of leakage to the ocean from the Mekong. Hence, future research should be conducted to measure the actual leakage of micro and macro plastics in the Mekong River and the identification of potential sources of the micro and macro plastic leakage.

Table 1 shows the estimation of the potential amount of plastic leakage to the ocean from the Mekong Subregion. This estimation is based on the mismanaged or uncollected waste generated by individual countries in the Mekong Subregion. The leakage from mismanaged or uncollected waste is caused by the limited capacity of waste management and the geographic proximity of some provinces in the Mekong Subregion to the Mekong River. Those provinces, either wholly or partially, are defined as the Mekong Basin and/or Mekong Delta. The Mekong Delta particularly refers to southern Viet Nam, which becomes vulnerable downstream of the Mekong River. About 15%–40% of the leakage goes to the ocean (Jambeck et al., 2015). From around 1.8 million tons (MT) of potential plastic leakage, 0.284–0.759 MT of it might leak into the ocean annually. China and Myanmar contribute a relatively small amount of plastic leakage since only a few of their provinces are considered part of the Mekong Basin. Along 12 provinces, the Lao PDR has 50 districts considered part of the Mekong Basin, but the potential plastic leakage is relatively small due to small population and the low percentage of plastics in the waste composition. On the other hand, Cambodia has a high amount of uncollected waste, making this country contribute 0.024–0.066 MT of potential plastic leakage to the Mekong River. Thailand's Mekong Basin is the top contributor, considering potential plastic leakage of 1.3 MT (70% of the total amount), with up to 0.536 MT of it sent to the ocean. Viet Nam is the runner-up, with 0.053–0.142 MT of leakage from both the Mekong Basin and Delta.

Table 1: Potential Amount of Plastic Leakage to Ocean from the Greater Mekong Subregion

Greater Mekong Subregion (Provinces in Mekong Basin and/or Delta)	Uncollected waste (ton/year)	Plastic composition (%)	Potential plastic leakage (ton/year)	Potential plastic leakage to ocean (ton/year)
China (3 provinces)	65,308	5	3,265	490–1,306
Myanmar (2 provinces)	22,512	13	2,927	439–1,171
Lao PDR (12 provinces)	464,378	6	28,327	4,249–11,331
Thailand (24 provinces)	4,265,449	31	1,341,057	201,159–536,423
Cambodia (18 provinces)	1,054,338	16	165,953	24,893–66,381
Viet Nam (20 provinces)	2,277,487	16	355,288	53,293–142,115
Total (ton/year)			**1,896,817**	**284,523–758,727**

Source: Compiled and calculated by authors, based on Jizhe et al. (2018) for China; Ling and Fodor (2019) for Myanmar; Sang-Arun and Pasomsouk (2012) and GGGI (2018) for the Lao PDR; Vanapruk (2019) for Thailand; Pariatamby, Hamid, and Bhatti (2019) for Cambodia; and Viet Nam Waste Planning (2019) for Viet Nam.

The huge amount of potential plastic leakage from the Mekong Basin region is highly influenced by each country's characteristics. For instance, Viet Nam has a high population but poor municipal solid waste collection and treatment. The conditions eventually lead to rising environmental degradation, especially in the Mekong Delta region (Mendrik et al., 2019; Nguyen and Le, 2011). Moreover, 80% of waste in Viet Nam is disposed of in open landfills, which are not equipped with leachate and gas protection. In addition, the country does not have an official recycling and sorting system, making the waste easily reach its way from the Mekong Delta to the South China Sea (Nguyen and Le, 2011; Bauske, 2018). Besides the waste management problem, the severity of the situation in Viet Nam is exacerbated by the littering problem (Davis, 2016), while data show that each person in the country consumes up to 25–35 kilogrammes of plastic per year (Thang, 2019).

The amount of leakage of plastics from river to ocean is affected by dams and other barriers which detain plastic waste (Loftus, 2018). In accordance with this, the Mekong River has been recognised as a huge source of electricity. To support electricity generation, the development of hydropower dams is a massive issue in the Mekong Basin. Only 10% of potential hydropower dams have been developed in the lower Mekong Basin. In the future, 11 mainstream dams and more than 120 dams are planned to be developed in the Mekong tributaries (Open Development Mekong, 2017). Even the Lao PDR is determined to become the 'Battery of Asia' by building 140 hydropower dams along the Mekong Basin (Beech, 2019). However, the development of hydropower dams, which can

help reduce the amount of plastic pollution in the Mekong River, has created other environmental issues such as soil erosion, changes in the natural river hydrology and sedimentation, and exposure to fish population (Lovgren, 2018; International Rivers, 2014).

The participation of the Mekong Basin countries in international schemes to collect plastic waste from the river and to treat collected waste properly should also be considered. Such schemes could be a platform to facilitate collaboration between co-riparian countries. Collaboration between the Mekong Basin countries is addressed through the Mekong River Commission (MRC), which was legally mandated by the Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin on 5 April 1995. Article 7 of the 1995 Mekong Agreement requires each co-riparian country to make every effort to avoid, minimise, and mitigate harmful effects that might occur to the environment – especially the water quantity and quality, the aquatic ecosystem conditions, and the ecological balance of the river system – from the development and use of the Mekong River Basin water resources or the discharge of waste and return flows. This highlights regional cooperation to cover the cost of upstream effects on ecological systems downstream (Frenken, 2012). In this context, the agreement enforces the collection and proper treatment of plastic waste from the river to eliminate any cumulative downstream effect.

The Mekong River is a busy river that transports people and cargo to support international trade and tourism, so it is vulnerable to leakage. However, most of its ports have no dedicated waste reception facilities (MRC, 2013). The latest report on ports in Viet Nam shows that waste generated from ships might be treated within the port, received by the port then sent to a third party, or sent to a third party by a ship owner with support from the port (Nguyen, 2017). This variety of waste treatment methods is undertaken due to limited facilities. Among 25 ports distributed across six regions in the country, only five ports operate adequate facilities, including facilities for receiving hazardous substances, sewage, and garbage. Towards 2030, Viet Nam will invest in a synchronous and modern port system that includes infrastructure, harbours, and channels.

The International Convention for the Prevention of Pollution from Ships (MARPOL) is a related international scheme that has been adopted. MARPOL has proposed restrictions on waste discharge from ships as well as requirements on waste reception facilities for specified waste. Facilities are supposed to provide adequate waste receptacles, collection facilities, and recycling facilities. They must have sufficient capacity, not create undue delays for vessels, provide sufficient information to encourage their use, and be available for regional cooperation with other ports within a country.

International schemes prevent land-based plastic leakage as well as sea-based plastic leakage. Co-riparian countries lack research on marine plastics. The collection and proper treatment of plastic waste from the river can be conducted effectively if the status of plastic leakage is well documented through assessment and monitoring. To fill this gap, the Government of Japan and UNEP jointly supported the MRC in March 2019 to develop countermeasures against marine plastic litter (MRC, 2020). The initiative is called the

promotion of countermeasures against marine plastic litter in Southeast Asia and India. Funded by the Government of Japan, it aims to measure land-based plastic leakage to determine hotspots along the Mekong River. To do this, the MRC is collaborating technically with the UNEP Regional Office for Asia and the Pacific.

The tourism sector in the Mekong Basin is perceived as one of the main sources of plastic waste. The sector increased economic growth in the Greater Mekong Subregion (GMS) – the Lao PDR, Cambodia, Thailand, Viet Nam, Myanmar, and China's Yunnan Province and Guangxi Zhuang Autonomous Region – by 15.7% during 2006–2011 (Nonthapot and Lean, 2015). In Viet Nam, the tourism sector contributes 6.6% of GDP. Recognised for its natural beauty, the Mekong Delta is Viet Nam's main tourism destination (WWF, 2016). Unfortunately, the region is now exposed to toxic plastic waste, which contaminates the environment (Tuyen, 2019). Phu Quoc island, one of the main tourist destinations in the Mekong Delta, has struggled to deal with the excessive use of plastic bags, cups, straws, and food packages used by millions of visiting tourists. In addition, since the tap water in Viet Nam cannot be consumed, tourists mostly rely on drinking water from plastic bottles (Kerber, 2018).

Thailand, which received more than half of all international arrivals in the GMS tourism sector (ADB, 2008; Nonthapot and Lean, 2015), has experienced serious impacts from marine plastic pollution. Coldwell (2018) indicated that the ecosystem in Thailand's Maya Bay is degraded due to a huge amount of plastic waste disposed of in the sea from the high number of tourists that visit its beach every day. Consequently, the bay is closed to tourists to allow the ecosystem to recover.

Some tourism providers have undertaken preventive actions to reduce marine plastic debris. Viet Nam's tourism sector recently launched a 'Go Green' campaign, whereby businesses and workers raise awareness on environmental protection. The campaign includes a sustainable tourism label called the 'Green Lotus', targeting the establishment of accommodation in Viet Nam (VietnamPlus, 2019a). Basically, the label is granted for accommodation that reaches a certain standard for biodiversity protection, use of renewable energy, preservation of natural and cultural heritage, and promotion of environmentally friendly products (VietnamPlus, 2019b). Furthermore, the government of Phu Quoc island has conducted campaigns through clean-up activities, community meetings, and media broadcasts to raise awareness about the impacts of littering. Although the activities still require financial, human resources, and technical support, the local government of Phu Quoc island is trying to establish cooperation with other organisations to expand the scope of the activities (Kerber, 2018).

4. Urbanisation

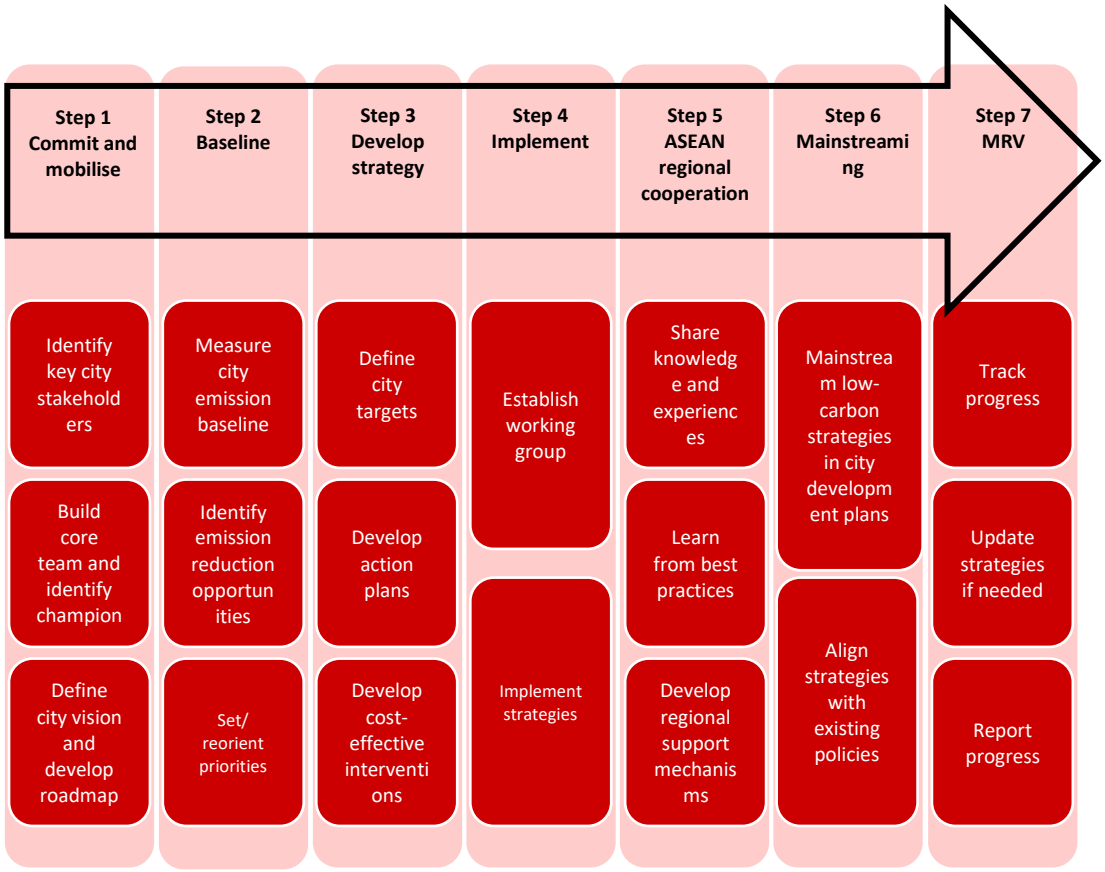
Megacities in the region, such as Bangkok, Hanoi, Phnom Penh, Vientiane, and Yangon, have been the drivers of the economy and have lifted millions out of poverty. However, the environmental consequences of this rapid urban development are apparent. Improvements in GDP and quality of life typically lead to increased resource consumption, and cities become national nodes of consumption as they grow in terms of population

and prosperity. Air pollution commonly exceeds safe levels across the cities. Emissions of noxious gases and particulate matter from motor vehicles, industry, and other causes – plus the rising urban population exposed to them – are increasing the regional burden of respiratory illnesses and cancer (WHO and UN Habitat, 2016). On a regional basis, it is estimated that 55% of urban air pollution mortality occurs in the Mekong (UNEP, 2018).

As the economies of the Mekong become more urbanised, more water will need to be reallocated from the 70%–90% consumed by agriculture to other economic activities such as domestic, industrial, and commercial use (Kumar, 2015). On the other hand, liveable and resilient cities are characterised by less air pollution and virtually no waste or traffic congestion. The planning of future cities requires every part of the design to include principles that shape the city: citizens to live, nature to thrive, business to invest, cultures to celebrate, and visitors to enjoy (Anbumozhi and Intal, 2015). The foregoing conditions are not utopian, though their integration is only achievable through a multi-stakeholder and multifaceted integrated planning approach. The concepts of the circular economy and smart cities have been developed recently to drive diverse agendas of liveable and sustainable cities. The circular economy understands and analyses the stocks and flows of energy and material consumption, understanding their economic value as an external source of resources and as a waste sink for the city's by-products (Anbumozhi and Kimura, 2018). Smart cities understand cities as a complex service delivery system and investigate the effects of the application of information and communication technology (ICT) and big data at different layers of city governance, particularly in the context of low-carbon imperatives (Anbumozhi, Kumar, and Adhityan, 2020). This approach incorporates planners, designers, architects, engineers, and municipal leaders with the common goal of creating liveable and sustainable cities that can sustain the environmental challenges of today and the aspirations of tomorrow.

Figure 3 summarises the above-mentioned framework and takes into consideration the Mekong context in a seven-step approach for building liveable cities in ASEAN.

Figure 3: ASEAN Framework for Liveable and Sustainable City Development



ASEAN = Association of Southeast Asian Nations; MRV = monitoring, reporting, and verification.
Source: Kumar (2015).

The Mekong countries are already implementing various measures pertaining to the Sustainable Development Goals. However, a complete and well-constructed approach to develop smart cities, which fosters the circular economy and low-carbon growth, is an imperative. For that to happen, a city-level decision-making process will need to involve all levels of stakeholders, including national governments, the research community, practitioners, nongovernmental organisations, and the private sector. Engineering sustainable cities in the Mekong region will need to address the following:

- City leaders should advocate for national policy adjustments to support cities as green liveable spaces.
- Cities need to start the process of measuring their emissions and pollution, i.e. the development of an emissions inventory. While national level emissions inventories have been developed for some countries, city-level emissions inventories are generally absent. The focus should be on using a consistent framework of emissions accounting to ensure the cross-border applicability of emissions data.

- Consider the development of a knowledge management centre to share experiences and lessons learned to maximise regional cooperation. This will help cities learn from each other and implement best practices.
- City-level targets should take into consideration any existing national and regional targets and policies to avoid conflicts in the longer term. Such targets and policies should be carefully tied to incorporate the 2030 Sustainable Development Agenda and Paris Climate Agreement targets.
- Liveable, resilient, and green initiatives should be linked with wider food security, energy security, and water security to maximise the benefits of city transformation and ensure alignment with the overall developmental agenda.

5. Subregional Cooperation and Harnessing New Technologies for Environmental Sustainability

Subregional cooperation has the potential to reduce sustainability challenges through its impacts on social and economic areas. However, a reallocation of public and private investments – spurred on through the broader principles of the ASEAN Socio-Cultural Blueprint (ASEAN, 2009) – is needed to build up or enhance natural capital such as forests, water, land, fish stocks, coastal areas, and cities, which are particularly important for countries to reach the Sustainable Development Goals. For that, Mekong countries should recognise that sustainable development is the main priority, and an environmentally efficient and resilient development path provides the opportunity to contribute towards this objective in a more efficient manner. A shared governance policy framework to promote a resource-efficient development path needs to clearly demonstrate strategies for removing current knowledge, capacity, and finance barriers to reap the co-benefits of development and environmental preservation:

- To promote a better understanding of public–private partnership participation, it will be necessary to enable countries to quantify the benefits that come from community involvement in setting targets for climate change actions, natural resources management, and plastic debris; and monitoring progress under ASEAN community blueprints.
- Realization of national sustainable development goals requires regionally coordinated technology transfer and financial mechanisms through innovative policies. More creative financing schemes at the regional level will be needed to implement strategies for access to clean water services, reduce land degradation, and improve air quality – fostering resource efficiency, reducing plastic debris, and promoting climate-resilient actions.

It is in the environmental and economic interests of Mekong countries to implement these strategic actions on a priority basis, through collaboration, cooperation, and coordination. The region has already started to embrace the digital revolution – encompassing clusters of transformative technologies in the domain of ICT, such as artificial intelligence, the internet of things, robotics, 3D printing, neuro-technologies, drones, virtual and augmented reality, and blockchain. This has profound implications for innovative

approaches to managing environmental footprints. Table 2 shows how the application of new ICTs to preserve the environment and tackle vulnerability seem to be around the corner and how data will be the foundation of the revolution, as all digital technologies will be built upon it.

Table 2: Developmental Level Digital Technologies that Could Address Environmental Challenges

Digital technologies	Energy use and sharing economy	Resource management and circular economy	Preventing pollution	Protecting biodiversity	Resilience and climate change adaptation
3D printing					
Artificial intelligence					
Advanced materials					
Advanced sensor platforms					
Biotechnologies					
Blockchain					
Drones and self-driving vehicles					
Internet of things					
Robotics					
Augmented reality and new computing technologies					

Source: Authors based on ERIA (2019).

In exploring this transformation, however, the debate needs to focus not just on technological applications, but also on reshaping mindsets, incentives, polices, and institutions. Without adequate governance, the practical application of these digital technologies will most likely respond to market needs and not necessarily to the broader sustainability goals of the Mekong Subregion. However, the success of these new

technology-based approaches and their digital interface platforms may cope with several implementation challenges due to associated changes needed in regulations. Current ASEAN agreements, commitments, declarations, and decrees often focus on specific environmental problems and cannot tackle the different issues of sustainability as a whole. Countries tend to free-ride on regional issues, as they are rarely in a position to coordinate action across sectors. 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.

6. Key Policy Recommendations

Understanding and accounting for climate change, deforestation, waste generation, and urbanisation are priority issues, as they have the potential to create a vicious cycle of poverty and vulnerability. However, emerging best practices indicate that a country can alleviate the negative impacts through physical, economic, and institutional development. From that perspective, the following policy recommendations are made.

- The adaptative capacity of sectors sensitive to climate change has to be implemented at two levels. Household and community level strategies must be put in place to reduce risks by strengthening early warning systems. Such strategies may include investing in climate-smart technologies and diversifying the income sources of agriculture households.
- At the public level, a short-term policy for countries to improve climate resilience could include designing a contingency fund within national budgets to provide aid when a climate-induced natural disaster takes place. A tricky balance may be needed at the subregional level to strike a balance between providing crop insurance in case a drought-related disaster hits and not encouraging moral hazard and adverse behaviour (such as settlement, farming, and investment in climate-sensitive areas) through such provisions.
- Mekong countries face the choice of continuing prevailing forest management practices (e.g. standards and certification schemes that provide a sound basis but whose widespread uptake requires more strict implementation and enforcement policies) or introducing market-based mechanisms (e.g. payments for ecosystem services such as carbon and biodiversity). Protecting forests to maintain the livelihoods of the poor, preserve biodiversity, and reduce carbon emissions requires modern technological scrutiny, location-specific protection, and stable financial mechanisms.
- Innovative financial mechanisms such as Reducing Emissions from Deforestation and forest Degradation (REDD+) and payments for ecosystem services are innovative avenues for funding afforestation programmes. Their interface with existing standards, certification schemes, and the network of protected forest areas needs to be monitored objectively.

- The Mekong River is regarded as a major source of plastic waste, based on the estimation of plastic waste leakage, using the amount of mismanaged waste, the composition of plastics in waste, and other measures. Monitoring of plastics flowing in the river should be conducted to measure actual leakage.
- Although exact data on the plastic leakage via the Mekong are not available, governments should reduce single-use plastics, provide waste collection services, dispose of waste properly, and promote recycling of plastic waste. International schemes should facilitate collaboration between co-riparian countries.
- Governments must consider appropriate actions to combat marine plastic in the Mekong Basin without sacrificing other environmental concerns. This refers to the continuous establishment of hydropower dams along the river, which can help retain the flow of marine plastic but brings negative impacts to the Mekong's ecosystem.
- The Mekong River basin is a main tourism destination in Southeast Asia. Governments should undertake preventive actions to reduce the marine plastic debris generated from the tourism sector, such as the 'Go Green' campaign in Viet Nam, which promotes green accommodation through green labelling.
- Cities are where some of the Mekong's sustainability challenges are concentrated – unsustainable resource consumption, air pollution, and waterborne deceases. They are also magnets for rural migrants in search of economic opportunities and thus become sources of income inequality. Transforming cities into smart cities, based on the principles of a low-carbon and circular economy, provide opportunities to promote economic growth, offer equitable social benefits, and minimise environmental risks.
- Numerous instruments for enabling smart and sustainable cities are available and tested at the ASEAN level, but need to be applied in a tailored, context-specific way, with appropriate application of the internet of things technologies for the Mekong Subregion. In this regard, city governments need to coordinate policies and decisions with other levels of governments, but more importantly, they need to be equipped with strategic and integrated planning capacities, including the capacity to choose regulatory tools, technology choices, and economic incentives for locally appropriate sustainable city objectives.

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