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Can Thinking Green and Sustainability Be an Economic Opportunity for ASEAN?

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Abstract *ASEAN member states (AMS) are confronted by serious environmental problems that threaten to undermine future growth and regional stability. This paper considers four major environmental challenges that policymakers across ASEAN will need to address towards 2030: water management, deforestation and land degradation, air pollution, and climate change. We argue that these challenges, each unique in its own way, exhibit the characteristics of wicked problems. As developed in the planning literature, and now applied much more broadly, wicked problems are dynamic and complex, encompass many issues and stakeholders, and evade straightforward, lasting solutions. Detailed case studies are presented to illustrate the complexity and significance of these environmental challenges, as well as their nature as wicked problems. The most important implication of this finding is that there will be no easy or universal solutions to environmental problems across ASEAN, as Environmental Performance Indicators (EPI) illustrate. This is a caution against over-optimism for formulating sector-specific solutions. It is not, however, a counsel for despair. We suggest general principles which may be useful across the board to tackle the issues and accelerate green growth. These are: a focus on co-benefits; an emphasis on stakeholder participation; a commitment to scientific and technological research; an emphasis on long-term planning; pricing reform; tackling governance issues, in addition to generally bolstering institutional capacity with regard to environmental regulation; and a strengthening of regionally coordinated approaches and international support.*

Keywords: green growth, environmental performance indicators, regional cooperation, sustainability

JEL Classification: Q32, Q34, Q37

1. Introduction

Towards the end of the 20th century, governments began to seriously acknowledge the central importance of environmental sustainability to the process of economic development (Arrow *et al.*, 1995; Dasgupta, 1996). It is now widely accepted that long-term economic growth requires not just accumulation of technology, physical capital, and labour, but also the preservation of the natural capital base (Brock and Taylor, 2005; OECD, 2011).

Whereas other factors of production may be replaceable and are often substitutable, ecosystem services provided by waterways, forests, and fertile lands are essential but largely finite resources. Once damaged, they may become unusable for long periods, and their repair often an expensive and protracted process. As these natural systems are the primary source of economic inputs such as food and clean water, their degradation through pollution and over-use is an enduring brake on economic development. For this reason, academics and policymakers have become increasingly concerned with national accounting procedures that include measures of environmental capital (Stiglitz *et al.*, 2009).

In 1987 the United Nations report on sustainable development foresaw the need for 'a new era of economic growth, one that must be based on policies that sustain and expand the environmental resource base' (WCED, 1987).

The ASEAN economies are incredibly successful when judged by their rapid growth, but less so when environmental damage is accounted for.[1] They are now confronted by the prospect of a dwindling supply of environmental capital to support the growing demands of a more numerous, wealthier, and increasingly urbanised population. Clean and ample water, arable land, and unpolluted air are just some of the vital ecosystem services necessary to maintain ASEAN's emergence as the engine of the global economy. Yet recent economic expansion has largely been pursued at the expense of the environment, undermining delivery of these ecosystem services in the

[1] China's one-off attempt to calculate 'Green GDP' found that environmental pollution cost 3.05 percent of GDP in 2004, or around one-third of GDP growth in that year (GoC, 2006). Although such estimates are unavoidably speculative, it is indicative of the true magnitude of damages that this particular figure encompassed only direct economic losses (such as agricultural production and health) and not natural resource degradation or long-term ecological damage.

future. This unsustainable trajectory will, if allowed to continue, progressively hinder future development.

Environmental damage not only undermines the sustainability of growth, putting future welfare at risk, it also exacts a large welfare cost here and now. Low-income groups, particularly in rural areas, disproportionately subsist on environmental services. Poverty limits the ability of poor households to find alternatives to a contaminated water source or harmful cooking fuels. Where the capacity to earn income or receive education is affected, such as health problems related to pollution and food insecurity, environmental problems reinforce poverty. Consequently, environmental degradation is a fundamental development issue in ASEAN today and beyond 2015.

The economic imperative for environmental protection is now a principal policy issue as ASEAN member states (AMS) formally and progressively recognise the necessity of environmentally sustainable growth in various declarations and implementation plans such as the ASEAN Socio-cultural Community Blueprint (ASEAN, 2009), the State of the Environment Report (ASEAN, 2007, 2009), the mid-term Review of Socio-cultural Community Blueprint (ASEAN 2014), the ASCC Score Card (ASEAN, 2013), etc.

Table 1: Environmental Performance Indicators

EPI Index	2010	2014	10-year trend
Brunei Darussalam	60.8	66.49	-0.84
Cambodia	41.7	35.44	+7.52
Indonesia	44.6	44.36	+4.80
Lao PDR	59.6	40.37	+2.96
Malaysia	65.0	62.51	+2.51
Myanmar	51.3	27.44	+6.11
Philippines	65.7	44.02	+3.21
Singapore	69.6	81.78	+0.94
Thailand	62.2	52.83	+1.91
Viet Nam	559.0	50.64	+3.19

EPI = environmental performance index.
Source: ASCC Scorecard (2013), Yale University (2014).

The Environmental Performance Index is a composite indicator for measuring environmental challenges and analysing the implementation deficits. The environmental performance index of ASEAN countries (Table 1) shows varying levels

of challenges, progress, and indicates that headway will not be easy, as AMS hold a range of diverse environmental problems and threats. What they have in common is their complexity. We believe that it is useful to think of these complex environmental challenges as 'wicked problems,' a concept taken from social planning literature, and now deployed more broadly. One characteristic of 'wicked problems' is that there are no easy solutions. Certainly, one cannot expect any of these problems to lessen, let alone disappear, as ASEAN integrates economically and grows fast. To the contrary, without sustained policy effort, these will persist if not worsen. While in general an automatic relationship between environmental quality and income per capita does not exist (Stern, 2004; Carson, 2010), the sort of problems facing ASEAN will not, by and large, reduce with growth that will further be engineered by economic integration. Accelerated economic growth will make more resources available to address these problems. However, without effective environmental management, growth will simply heighten the divergence across many facets of economic activity between private and social costs.

The Asian Development Bank Institute (2013) analysed the relationship between economic growth and environmental resources in different parts of the ASEAN as part of documenting ASEAN aspirations and achieving RICH (resilient, inclusive, competitive, and harmonious) targets in 2030. Anbumozhi and Bhatacharyaa (2014) reviewed environmental degradation due to burgeoning energy demand across AMS, and recommended several policies to address this issue as economic expansion continues. They also discussed the competitive use of resources by ASEAN, India, and China; the need for inter-state cooperation over environmental issues; and the impact of these major players on the broader region. These earlier analyses lacked a coherent conceptual framework to provide general observations concerning the origins and management of ASEAN's range of environmental problems. This paper seeks to address this deficiency at the broader level by the formulation and application of ASEAN Socio-cultural Community (ASCC) framework, an approach that lends itself to detailed analysis of specific issues outlined in ASCC Scorecard, section D – Ensuring Environmental Sustainability and ASCC Blue Print-Mid-term review.

The following section illustrates the importance of ASEAN's natural resource base to economic development, through an analysis of four major environmental

challenges beyond 2015. Section 3 presents seven in-depth case studies. Section 4 outlines the concept of wicked problems using examples from the case studies and AMS's broader environmental challenges. Section 5 outlines opportunities available with Green Growth paradigm. Section 6 explores the implications and presents some general management strategies to minimise economic and social damages. Section 7 concludes with policy recommendations to take forward ASCC Blueprint.

2. Major Environmental Issues for ASEAN— Beyond 2015

Appendix A-1 lists a composite image of common environment challenges faced by ASEAN. The major environmental problems confronting ASEAN are grouped under four themes: water management, deforestation and land degradation, air pollution, and climate change[2].

To analyse these four broad themes, we present related case studies to bring some benchmarks.

- The challenge of water management is illustrated by the dam construction on the Mekong River.
- The challenge of deforestation and land degradation is illustrated by a case study on deforestation in Indonesia and afforestation programmes in China.
- The challenge of air pollution is illustrated by regulatory reforms regarding air pollutants in India, and the Indonesian deforestation case.
- Climate change crosses all of the above challenges and associated cases, and is also the focus of a section covering climate change mitigation in Southeast Asia

The four themes are briefly introduced in the following subsections.

Water management

[2] Marine ecosystems and resources, biodiversity, waste management, and other issues are also important and close to climate change, but they are covered in detail in other papers commissioned for this study and, in our judgement, the four areas above present the most pressing challenges to ASEAN's economic integration over the next two decades.

Fresh water is essential to agricultural and industrial production. It is a basic requirement for human life, other organisms, and biological processes. Water resources generally have multiple uses and users, and inadequate management of their competitive use has frequently facilitated over-exploitation and degradation. The depletion and contamination of these resources generate large economic costs through an increase in the cost of obtaining a direct input to production, and damaging impacts to environmental systems and human health. Water management is viewed not only as an environmental issue but a major challenge to economic development, particularly in AMS (ADB, 2007a).

Excessive groundwater extraction, pollution from human waste and industry, poor infrastructure, and dam-building are factors contributing to degradation of the region's fresh water sources. Major improvements have been made with regards to water access and sanitation in AMS over the last two decades, but large numbers still have inadequate facilities (Table 1). Supply-side issues such as these are compounded by altered rainfall patterns due to climate change, particularly with respect to weakening of the Indian and East Asian monsoons (IPCC, 2007). Within the next three decades, increasing glacial melt during the dry season is likely to reverse and transform the major rivers originating in the Himalayas, such as the Mekong and Citrum in Indonesia, into seasonal rivers (Asia Society, 2009; Immerzeel *et al.*, 2010).

On the demand side, the United Nations' projections to 2030 estimate that the total population of ASEAN, currently comprising 8 percent of the world's total population, will rise to 736 million (UN, 2010). The attendant rises in agricultural, industrial, and urban usage will place even greater strain on dwindling supplies throughout these economies. The scale of this challenge is emphasised by the estimate that by 2030, under current management policies, water demand will exceed supply by 25 percent (WRG, 2009).

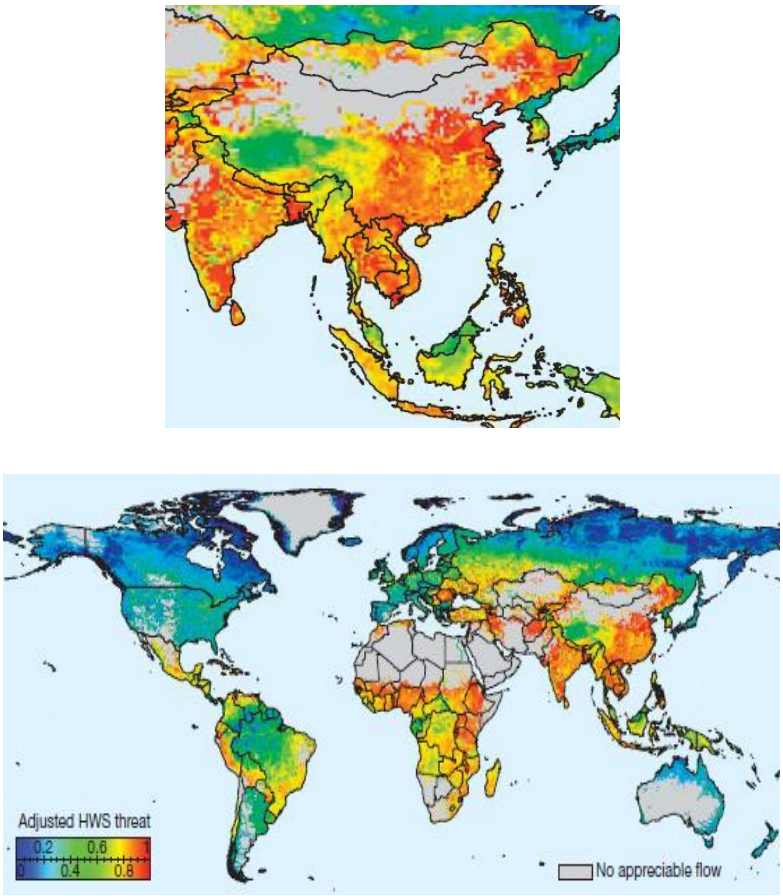
Although access to secure and clean freshwater resources will be a common challenge across ASEAN, the nature of this issue will vary across different settings. Increased demand may play a large role in some locations, in growing mega-cities like Jakarta, Bangkok, Kuala Lumpur, and Singapore, for instance, while supply-side concerns, such as lower dry-season rainfall or polluted water sources, may dominate in other locations. In most settings, some combinations of both demand and supply

factors will be present. Consequently, the term ‘water management’ used here encompasses a broad mix of water-related issues which also includes efficiency of water usage; degradation of water resources through pollution or over-use; allocation between competing uses such as agriculture, drinking-water, natural ecosystems, and industry; flood control; coordination between users at a local, national, and international level; treatment of waste water; and water storage, among many others.

The welfare implications of degraded water resources in ASEAN are substantial. As approximately 70 percent of water is currently used in agriculture (ADB, 2007b), water shortages undercut food security and the incomes of farmers. Illnesses associated with contaminated water reduce labour productivity and cause other health-related costs. If supplies continue to deteriorate as demand rises, the costs of attaining usable water, such as drilling for groundwater, will rise accordingly. Without improved management of pollution, expansion of industrial water usage, particularly in China (WRG, 2009), may diminish availability for human consumption and other uses. Furthermore, conflict over access to this increasingly scarce resource could arise between and within states (Asia Society, 2009); plans for several Chinese dams on the Tsangpo-Brahmaputra River upstream are perceived as a key threat to the stability of relationship among Mekong countries (Morton 2011).

Figure 1 is a map of human water insecurity which demonstrates from a global perspective the extent of ASEAN’s current water scarcity problems. Table 2 presents statistics highlighting the importance and scale of water management issues in ASEAN.

Figure 1: Water Security in Asia and the World



Note: Human water security threat index (on a scale of 0 to 1) adjusted for the level of existing technology investment in water infrastructure. For further details see Vorosmarty *et al.* (2010).
Source: Vorosmarty *et al.* (2010).

Table 2: Selected Water Management Statistics for ASEAN

Issue/Variable	Country	Value	Source
Water resources per capita[a] (m^3/inhabitant/year)	China	2,112	FAO (2011b)
	Beijing, China	230	World Bank (2009)
	India	1,618	FAO (2011b)
	ASEAN	11,117	FAO (2011b)
	Global Median	4,042	FAO (2011b)
Population gaining access to improved water source[b] (1990–2008)	China	425 million	WHO/UNICEF (2008)
	India	419 million	
	ASEAN	173.5 million	
Population without access to improved water source[b] (2008)	China	147 million	WHO/UNICEF (2008)
	India	142 million	
	ASEAN	80.2 million	
Deaths/year of children < 5 years attributable to water source, poor sanitation.	China	49,200	WHO (2011)[c]
	India	403,500	
	ASEAN	74,600.	
Excess water demand by 2030 (as % of demand)	China	25% (199 billion m^3)	WRG (2009)
	India	50% (754 billion m^3)	WRG (2009)

FAO = Food and Agriculture Organization, WHO = World Health Organization, UNICEF = United Nations Children's Fund.

Notes:

[a] The Food and Agriculture Organization (FAO) standard for water scarcity is 1,000 m^3 (FAO, 2011b). National or broad-scale aggregates can conceal local or seasonal shortages. For example, ASEAN overall has a relatively high level of per capita water resources, but some cities, such as Manila, or particular areas commonly experience shortages.

[b] 'Improved water source' refers to: household connections, public standpipes, boreholes, protected dug wells, protected springs, and rainwater collection (WHO/UNICEF, 2008). Although the implication is access to a safer water source, this measure does not involve a direct assessment of water quality.

[c] Refers to data from 2004.

Deforestation and Land Degradation

Widespread deforestation and land degradation are highly visible examples of the unsustainable use of natural resources in ASEAN. These issues are intrinsically linked. Unsustainable tree-removal practices, such as clear-felling, prompt erosion and soil salinity, as well as disturbance of the groundwater table. In dry-lands, deforestation

facilitates the transformation of fertile areas into barren land, a process known as desertification[3]. Once land is sufficiently degraded, it may be unable to support forests again, or even the agricultural use that often drives deforestation in the first place.

Deforestation and land degradation throughout ASEAN are caused by various factors, including demand for timber products and palm oil, intensive farming, and urban sprawl. Poor regulations and, in some cases, corruption have commonly allowed unsustainable practices. However, it has become increasingly apparent throughout the region that the enduring economic costs from unsustainable land-use ultimately overwhelm the more immediate gains. Once sufficiently degraded, woodland ecosystems require time and large expense to recover, effectively eliminating future sources of wood and causing other problems that curb the productivity of the natural resource base. Over-cultivation of agricultural land increasingly leads to declining soil productivity and, consequently, lower output and, in some areas, food insecurity.

At a regional level, the situation with regards to deforestation is clearly improving. This is due, in large part, to concerted afforestation and forest-protection efforts in countries like Viet Nam. ASEAN now has the largest area of planted forests in the world and, if anything, the governments of the region are elevating its level of ambition in this area. Yet these promising trends are at odds with those in Indonesia, Malaysia, Myanmar, and Cambodia, where deforestation continues on a massive scale (Table 2). In fact, it would seem that improved regulations elsewhere in Asia, particularly China, are contributing to continuing deforestation in the latter ASEAN countries (Demurger *et al.*, 2007). For example, the expansion of palm oil plantations is a major driver of deforestation in Indonesia and Malaysia (Fitzherbert *et al.*, 2008), and these two countries alone produce over 85 percent of global palm oil exports. China and India account for 45 percent of global imports (FAO, 2011b). Limits to expansion of agricultural land in the latter are, to some degree, 'exporting' former deforestation problems. Similar trends in the Asian timber trade have also emerged from recent analysis (Meyfroidt *et al.*, 2010).

Land degradation is a major economic issue primarily because, like sufficient water, productive land is a necessary determinant of food security. Access to food not

[3] Other drivers of desertification include climate change, natural weather variability, and unsustainable farming practices such as intensive cropping and excessive irrigation in lands with poor drainage.

only supports labour participation, well-being and, hence, development and economic growth, but also other factors such as political stability. At present, the quality and quantity of arable lands across Asia continue to deteriorate, affecting large swathes of the population (Bai *et al.*, 2008).

Throughout Southeast Asia, draining of peat lands, usually intended for agricultural purposes, has caused lands to subside, become highly acidic, and, hence, be unfit for any use (ASEAN, 2011). Beyond peat lands, an array of problems, including intensive farming, has contributed to high rates of decline in agricultural soil quality, particularly in Viet Nam and Thailand (Coxhead, 2003). The Food and Agriculture Organization estimates that in two-thirds of ASEAN nations (excluding Singapore) 40 percent of lands is suffering either severe or very severe degradation due to human activities (FAO, 2011b).

Table 3: Deforestation and Land Use Changes in ASEAN and its Neighbours

Variable	Location	Description/Value	Source
Annual rate of change in forest area (2000–2010)	China India Indonesia Malaysia Cambodia Myanmar	1.6% (2,986,000 ha) 0.5% (304,000 ha) -0.5% (-498,000 ha) -0.5% (-114,000 ha) -1.3% (-145,000 ha) -0.9% (-310,000 ha)	FAO (2011a)
Percentage of national territory subject to land degradation (1981–2003)	China India Thailand Indonesia	22.86% 18.02% 60.16% 53.61%	Bai *et al.* (2008)
Percentage of territory subject to erosion	China India	37.2% 34%	MEP (2010) GoI (2009)
Percentage decline in area of arable land (1990–2008)	China India Thailand	14% (~15 million ha) 2.9% (~4.6 million ha) 15% (~2.2 million ha)	FAO (2011b)

FAO = Food and Agriculture Organization, GoI = Government of India, MEP = Ministry of Environmental Protection.

Air pollution

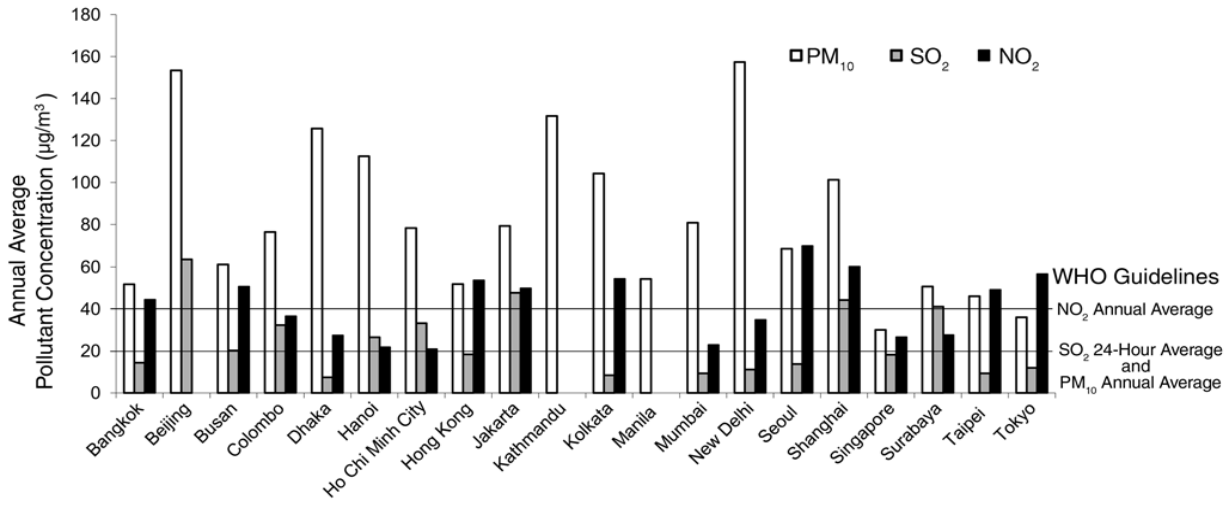
Access to clean air is a principal determinant of human health, as well as the overall condition of other organisms and environmental processes. Outdoor air pollution is a common by-product of industrial production, motorised transport, and, in fact, the central processes underpinning global economic growth over the last century or so. On the other hand, indoor air pollution is often associated with lack of development. Absence of affordable alternatives encourages burning of solid fuels such as dung and timber for energy, despite its harmful effects. Consequently, air pollution is a primary cause of illnesses and deaths in both the growing cities and the poorer rural areas of ASEAN. The widespread nature of this problem undermines the productivity and income of the labour force, exacting a heavy economic toll. For example, a recent study estimates that in 2005 the annual welfare loss associated with air pollution in China amounted to US$151 billion (2010 dollars) (Matus *et al.*, 2011).

Air pollution commonly exceeds safe levels across the cities of AMS (Figure 2). Emission of noxious gases and particulate matter from motor vehicles, industry, and other sources—plus the rising urban population exposed to them— are increasing the regional burden of respiratory illnesses and cancer (HEI, 2010). On a global basis, about 65 percent of urban air pollution mortality occurs in ASEAN, China, and South Asia (Cohen *et al.*, 2005). At an aggregate level, there have been significant improvements in recent times (CAI, 2010), but without renewed mitigation efforts, such as tighter emissions standards and stronger monitoring programmes, the situation across the region could deteriorate substantially. The urban population of ASEAN is set to increase by 50 percent between 2010 and 2030 (UN, 2009). This rapid urbanisation and a growing middle class are causing an explosion in motor vehicle ownership in ASEAN. Higher incomes will also raise demand for energy-intensive consumer goods, such as air conditioners, and, where industrial and energy production occurs in proximity to cities, potential pollution from these sources increases accordingly.

Air pollution in large cities is not simply a localised or a health issue. Air transport of urban pollutants causes problems further afield. For example, acid rain originating from sulphur dioxide emissions in cities degrades farm land in regional areas and contaminates groundwater. Air pollution problems in one city may be compounded by

activities in others. Major incidents of air pollution in Hong Kong over the last two decades have coincided with northerly winds transporting pollutants from the major industrial areas in the mainland China (Huang *et al.*, 2008). Other activities or events outside cities, such as forest fires, can add to urban problems. At a regional level, air pollution from cities has mixed with that from other sources (including indoor air pollution) to form atmospheric brown clouds over Asia. These combinations of aerosols and partially combusted (or black) carbon have been shown to affect regional and global climate, crop production, as well as health (UNEP, 2008).

Figure 2: Air Pollutant Concentrations in Major Asian Cities (2000–2004)



Notes: PM_{10} = particulate matter <10 μm in diameter, SO_2 = sulphur dioxide, NO_2 = nitrogen dioxide.
WHO Guidelines for annual concentration averages is 20 $\mu g/m^3$ for PM_{10} and SO_2, and 40 $\mu g/m^3$ for NO_2. Data is a five-year average from 2000 to 2004.
Source: HEI (2010).

While atmospheric brown clouds are a shared outcome of urban and indoor air pollution, and both are a significant regional health risk, the latter is distinct as a symptom of under-development. Poverty causes over 600 million people in ASEAN to use solid fuels (including biomass and coal) for cooking and heating (IEA, 2010). Particulate matter, carbon monoxide, and other harmful airborne substances damage the lungs of householders, causing a variety of illnesses including cancer. Exposure to particulate matter has been estimated to be eight to over 100 times daily World Health

Organization (WHO) safe levels (Rehfuess *et al.*, 2011). As a consequence of such exposure levels, the WHO estimates that over one million deaths each year in China, India, and ASEAN are directly attributable to indoor air pollution (WHO, 2009).

The disproportionate impact upon women and children of this problem impedes the workforce participation of the former and limits the prospects for the latter. Although this problem has been long recognised, widespread change in ASEAN is yet to take place (IEA, 2010). Indoor air pollution is a major development issue because it not only affects the welfare of poor households in the present but their prospects for the future. While promising developments are on the horizon, particularly as the co-benefits of black carbon mitigation and improved cook stoves gain prominence (UNEP/WMO, 2011), indoor air pollution will continue to afflict a large proportion of poor households in Asia over the next two decades (IEA, 2010), despite regional economic growth.

Table 4: Selected Air Pollution Statistics for ASEAN

Variable	Location	Description/Value	Source
Average PM_{10} concentration	230 Asian cities	89.5 $\mu g/m^3$ (WHO standard is 20 $\mu g/m^3$)	CAI (2010)
Percentage of Asian cities exceeding WHO SO_2 concentration standards	230 Asian cities	24%	CAI (2010)
Proportion of population using solid fuels (2007)	Indonesia Lao PDR, Myanmar, Cambodia, Thailand, Viet Nam	79% (rural), 58% (total) >90% (total) >45% (rural)	WHO (2011)

CAI = [please supply entry], WHO = World Health Organization.
Notes: The 230 Asian cities referred to in rows 1 and 2 are from China, India, Indonesia, Thailand, Malaysia, Philippines, South Korea, and Chinese Taipei. See CAI (2010) for further details. PM_{10} refers to particulate matter <10 μm in diameter.

Climate change

ASEAN is highly vulnerable to the effects of climate change. With a large population in low-lying and coastal areas, widespread water insecurity, and around two-thirds of the world's poorest people, the region is likely to suffer extensive damages in the future (IPCC, 2007). While the full force of development impacts will not be realised for many decades, climate change adaptation is already a contemporary issue. Rising maximum temperatures and changing rainfall patterns are affecting agriculture and food security today, and the effect of these changes will escalate to 2030 (Lobell *et al.*, 2008). For example, it is estimated that yields of important crops will decline in parts of Asia by 2.5 percent to 10 percent by the 2020s (IPCC, 2007). Greater intensity of extreme weather events, incidence of flooding and tropical disease, and decline of marine ecosystems are also concerns for the proximate future (ADB, 2009a; IPCC, 2007).

Climate change will worsen the ill effects of ASEANs current environmental problems, such as water insecurity, but these problems also contribute to climate change. Deforestation and black carbon emissions in Asia drivers of global warming, both in terms of contribution and also because their mitigation could be a low-cost option with short-term benefits. Energy demand in ASEAN is expected to explode with ongoing economic expansion and, accordingly, so will coal use and greenhouse gas emissions. ASEAN is set to be the dominant source of expansion in global emissions. Recent projections of global emissions estimate that, under business as usual, China's share of global fossil fuel emissions will be 34 percent by 2030, and the figure for developing Asia as a whole will be 51.9 percent (Garnaut *et al.*, 2008). Unsurprisingly, the International Energy Agency projections indicate that China, India, and ASEAN, in particular, will have to shoulder a large share of the mitigation burden necessary to restrict global warming to 2°C (Table 5).

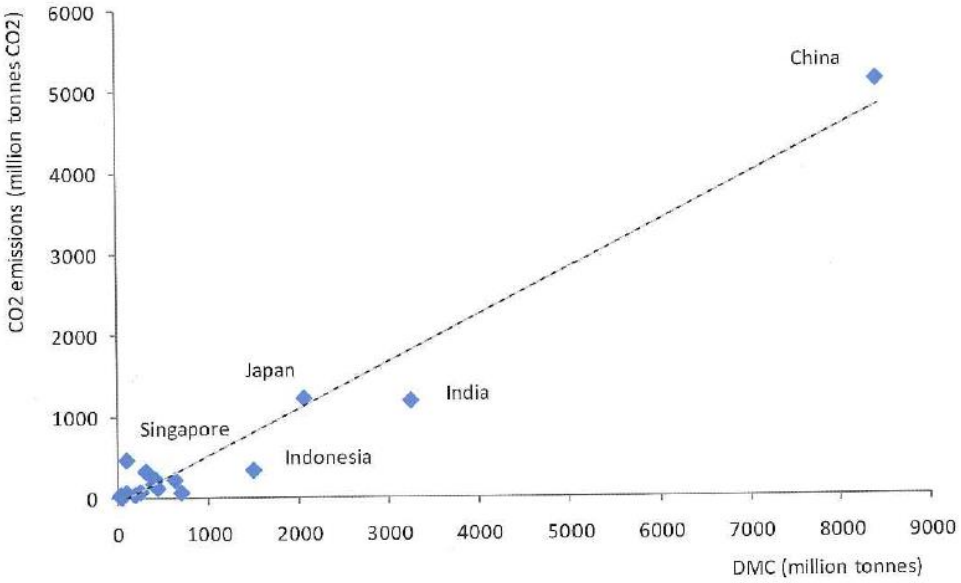
Table 5: Past and Projected Energy Demand (Reference Scenario) and CO_2 Emissions

Region/Country	Primary energy demand (Mtoe)			CO_2 emissions (Mt)		
	1990	2007	2030	1990	2007	2030
ASEAN	243	513	988.2	361	1013	2078.9
PRC	872	1970	4320	2244	6071	13290
India	318	595	1204	589	1327	2856

Mtoe = Million tonnes of oil equivalent, PRC = People's Republic of China.
Source: (i) 2007 data from World Energy Outlook (2009), (ii) 2030 data from Fan and Bhattacharyay (2011)*. * (i) A dynamic Computable General Equilibrium model based on China's economy is employed to forecast energy demand in China. IEA (2010) has predicted India's energy demand by its own World Energy Model, which is the main tool used to generate the projections. The energy demand predictions for ASEAN and its members come from ADB (2009a) which predicted the energy demand for ASEAN in two different scenarios—the Reference Scenario and the 450 Scenario.

Figure 3 shows the direct correlation of material consumption and carbon emissions that contribute for climate change. While the scale of climate change damages to 2030 alone may not warrant the substantial mitigation investment required in ASEAN over the next two decades, they will be in the long run. At a regional level, ASEAN is both highly vulnerable to climate change and will play a decisive role in its limitation. Therefore, extensive climate change mitigation activities are a matter of self-interest. It is clear today that the process of lifting the standard of living throughout ASEAN cannot follow the carbon-intensive trajectory laid out by today's high-income economies; the limits of the climate system render such repetition infeasible. Switching to a 'green growth' development pathway will reduce the impact of potentially major stumbling blocks arising from climate change, such as food and water insecurity, environmental refugees and conflict, among others. Not only does avoidance of major climate damages provide a firmer base for growth beyond 2030, but there are significant economic opportunities in the short-term from leading the way in, for example, renewable energy generation, and also increasing energy security. Indeed, ASEAN countries are moving towards exploiting these opportunities.

Figure 3: CO_2 Emission and Material Consumption in ASEAN



The main determinants of carbon emissions and thus the cause of climate change in ACI shall be summarised as follows.

(i) Economic structure: Different economic sectors generate very different amounts of value added per tonne of energy and resource input. Carbon/energy/material productivity in terms of value added per resource input is low in primary resource extraction and processing sectors and this value improves with an increasing contribution of higher manufacturing industries and service sectors to GDP (Howes and Wyroll, 2012). However, due to specialisation of countries within an international division of labour, comparisons of material productivity should consider the role of the countries within these specialisation patterns.

(ii) Resource endowment: Countries that have limited endowments of raw materials such as coal within their own border tend to be more resource efficient than countries with resource abundance. Relative resource scarcities support the implementation of policies to increase resource efficiency (SERI, 2010). In contrast, small and rich countries with large reserves and extraction of key resources with high global demand tend to

have the highest per capita consumption numbers and have less incentive to increase resource efficiency.

(iii) International trade: A factor closely related to emission and resource endowments is international trade. Countries that import high shares of their raw materials and products have higher material productivities than countries that extract and process raw materials within their borders. This calls for application of more comprehensive indicators to measure material consumption and evaluate material productivity, including the up-stream indirect flows of trade (Kalirajan, 2012).

3. Case Studies of Environmental Problems in Asia

This section presents five case studies of environmental issues affecting the economies of ASEAN.

3.1. Regional Management of Hydropower Development on the Mekong River

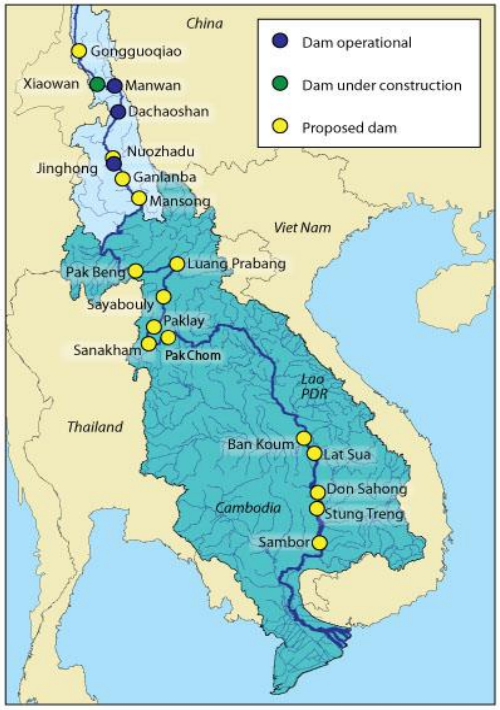
The Mekong is one of the world's few major rivers whose hydropower potential remains largely unexploited. This relative absence of dams is set to change at a rapid pace. Eleven mainstream dams are planned in the Lower Mekong Basin (LMB), an area encompassing Lao PDR, Thailand, Cambodia, and Viet Nam.[4] The environmental and social impacts of the proposed dams will endure for decades, yet, due to the complex processes involved, any prior assessment of costs and benefits is riddled with great uncertainty.[5] Outcomes will be broadly and unevenly distributed across stakeholders, time, and countries. In recognition of the scale of potential transnational impacts, a regional forum, the Mekong River Commission (MRC), was created during the 1990s to facilitate collective and mutually beneficial management. However, meeting this fundamental objective, whether through the MRC or otherwise, is likely

[4] Away from the mainstream, a further 56 tributary dams are in various stages of design or construction through the LMB, mainly in Lao PDR (MRC, 2011b). Although tributary dams can have a major impact on the mainstream river, they are outside the auspices of the MRC.

[5] A recent study by Costanza *et al.* (2011) demonstrates that cost-benefit analysis of Mekong mainstream dams can produce highly variable results across a credible range of values for economic and environmental parameters.

to be a major challenge during both planning and operation of these projects, should they proceed.

Figure 4:



Planned Mekong River dams
Source: MRC (2011b).
Lower Mekong Basin
Upper Mekong Basin

Dam construction on the Mekong addresses two important economic issues in the LMB: the need for an abundant and cheap supply of electricity to meet the burgeoning demands of the Thailand and Viet Nam economies (Middleton *et al.*, 2009), and enduring poverty in Lao PDR and Cambodia. Proponents claim that the dams represent a major opportunity for the host countries: the nine mainstream projects in Lao PDR and two in Cambodia are expected to increase annual state revenues by 18 percent and 4 percent above 2009 levels respectively (Grumbine and Xu, 2011). In fact, the Government of Lao PDR aims to become the 'battery of ASEAN' and views hydropower as the key driver of poverty alleviation in the country (Powering Progress, 2011). In the context of climate change, hydropower is often presented as a clean alternative to fossil-fuel-intensive energy generation, and this attribute is also commonly invoked by the Lao PDR government.[6]

On the other hand, dams also pose major environmental degradation that would have a disproportionate impact upon low-income rural communities (MRC, 2010). While benefits will be distributed between countries in the LMB, the transboundary course of the river ensures that the costs will be as well. Among the most prominent of these is the barrier created for upstream migration of species belonging to what is presently the world's largest inland fishery (Sarkkula *et al.*, 2009). The MRC commissioned a strategic environmental assessment of all mainstream proposals that

[6] Mitigation of carbon emissions through hydropower expansion is however debatable. Dam projects may involve road construction that provides access to areas previously inaccessible for logging, and dam reservoirs are significant sources of methane.

estimated an annual loss of 340,000 tonnes of fish by 2030, equating to US$476 million per year (MRC, 2010). As fish account for 47-80 percent of animal protein consumed within the LMB (Hortle, 2007), and is a major source of rural income (Dugan *et al.*, 2010), this factor alone could have a major impact on food security and poverty (MRC, 2010). In addition, substantial blockage of sediment transfer would cause significant downstream erosion and undermine the productivity of riverside and flood-plain agriculture (Kummu *et al.*, 2010). Although prior assessment of the damages caused by LMB mainstream dams are unavoidably estimates, disastrous experiences in China (Economy, 2010) and on Mekong tributaries (Amornsakchai *et al.*, 2000) indicate their potential scale.

The major recommendation of the MRC-commissioned strategic environmental assessment was a 10-year moratorium on any construction decisions, pending further scientific study into uncertainty over large environmental and social costs (MRC, 2010). This and other MRC technical reports (MRC, 2011c), as well as associated planning processes (MRC, 2011a; 2011d), have significantly contributed to dissemination of information on the mainstream proposals. However, the future effectiveness of the MRC as a forum for LMB countries to collectively pursue hydropower development sustainably is an open question (Grumbine and Xu, 2011). The MRC has frequently been marginalised in states' decision making (Dore and Lazarus, 2009; Campbell, 2009). Despite the recommended delay, the Lao PDR government has consistently demonstrated a determination to proceed in a much shorter time frame (Hirsch, 2010). Although other member countries— particularly Viet Nam— have recently used the MRC framework to voice objections to progress in the first mainstream project at Xayaburi (near Luang Prabang in Lao PDR) (MRC, 2011d), and subsequently secured a temporary suspension on the sidelines of the ASEAN summit, the MRC remains in principle a consultative body which affords no veto power for members to prevent construction of a mainstream dam in another country. This lack of oversight was demonstrated during the MRC consultation process for the Xayaburi dam, when construction activities were already taking place (*Bangkok Post*, 2011), and also during the supposed suspension, when the Lao PDR Ministry of Energy notified the dam developer that it was authorised to proceed (Reuters, 2011).

It is important to note that regional management is not simply a case of deciding whether the mainstream projects are built or not, but also minimising their negative impacts should they proceed. Planning tools such as those pursued by the MRC inform the need for dam design measures that incorporate environmental river flows. The latter include variable water outlet capacity, sediment bypasses and flushing outlets, re-regulation reservoirs, and fish passages (Krchnak *et al.*, 2009). However, such measures can entail significant additional costs to dam developers across all phases of the project, including operation. What's more, their utility will always be site-specific; for example, there is no scientific evidence to suggest that fish ladders will work for most species in the Mekong mainstream (Dugan *et al.*, 2010). Minimising environmental and social damage entails significant financial investment and a lengthy planning period to allow sufficient scientific study, yet dam developers are unlikely to meet such requirements if they impinge on short-term profits.

Outside of the MRC, other means for managing environmental risks exist, but appear limited. Where domestic environmental regulations exist on paper in Lao PDR and Cambodia, the institutional capacity or willingness to enforce them is often deficient (Foran *et al.*, 2010). Similarly, the prospects for regulation through corporate social responsibility standards (such as the World Commission on Dams principles [WCD, 2000]) are constrained by the primacy of profit to private-sector financiers and developers from Thailand, Viet Nam, China, and Malaysia (Foran *et al.*, 2010; Middleton *et al.*, 2009). These sources of new finance have supplanted the prospect of direct involvement, and hence significant oversight, by multilateral institutions such as the World Bank in the mainstream projects.

The task facing LMB governments within the MRC framework is complicated by the existence of competing domestic interests. Aside from the importance of electricity imports to growth of the Thailand and Viet Nam economies, dam developers and financiers from these countries stand to make large profits from mainstream dams (Foran *et al.*, 2010). However, substantial community opposition exists both in Thailand, where NGOs have effectively harnessed anti-dam sentiment from previous domestic projects, and in Viet Nam, where farming productivity and food security in the Mekong Delta are likely to suffer. From the perspective of the Cambodia and Lao PDR governments, elite groups stand to gain personally if the dams proceed, yet the

broader development impacts for many of their citizens from, for example, resettlement and lower fish catches could potentially be overwhelmingly negative, especially in the short-term. While the Cambodian government seeks to mitigate detrimental impacts from dams upstream in Lao PDR, it does not oppose mainstream dam construction more generally due to plans within its own territory (MRC, 2011d).

Although China has only loose affiliation with the MRC, it is playing a major role in the mainstream projects. Dams on the upper reaches in China provide not only a moral case for Lao PDR (i.e. dams are already having impacts in the LMB), but have changed the river's hydrology so that the run-of-river projects planned in Lao PDR are commercially viable (Hirsch, 2011)[7]. Aside from the four mainstream projects led by Chinese interests (MRC, 2010), up to about 40 percent of all hydropower development in the LMB (including tributary dams) will be undertaken by Chinese companies in the coming decades (Hirsch, 2011). More broadly, China has been heavily expanding economic investment in both Cambodia and Lao PDR, such as the forthcoming high-speed rail link between China's Yunnan Province and Vientiane.

Regional governance through a purpose-built institution like the MRC is essential because mainstream dams are such a multi-faceted issue with wide ranging impacts (Grumbine and Xu, 2011; Campbell 2009). In addition to the issues discussed above, future transboundary damages have the potential to undermine long-term cooperation and security in the region (Cronin, 2009). Even if the current plans do not proceed in the near future, the prospective financial gains for some stakeholders ensure that demand for dams will always be present. If they do proceed, strong mechanisms will have to be developed within the MRC framework to ensure that they are operated to the benefit of the region's inhabitants. The perpetual yet dynamic nature of the issue, as well as the great risks involved, will require adaptive and strong regional governance in the years ahead.

3.2. Afforestation and Land Restoration in China

[7] Run-of-river dams typically have small reservoirs and require a steady flow to operate year-round. The high fluctuation of the Mekong's flow across the seasons in northern Lao PDR, site of several proposed run-of-river dams, is now regulated by the mainstream dams in China increasing flows outside of the monsoon and vice versa.

Although deforestation and land degradation have been common throughout China's history, the unsustainable use of the country's land-based resources has become most apparent in the last two decades of rapid economic growth. By the late 1990s, soil erosion was degrading 20 percent of the country's landmass, the area of cropland and forested land per person had declined to one half and one-sixth of the global average, and desertification affected 25 percent of China (Liu and Diamond, 2005). In addition to the pressures of population growth and urban development, these problems were symptomatic of the national government's earlier willingness to pursue economic expansion at the expense of the environment. However, multiple factors prompted the government to initiate urgent action during the late 1990s, including major flooding; dust storms affecting urban areas, particularly Beijing; and concerns over food security, as well as the future of the nation's forest resources.

The government response was to design and implement several land-based ecological restoration programmes (ERPs) which have, since 2000, entailed an unprecedented financial investment in China's forestry resources of approximately US$100 billion (Wang, G. *et al.*, 2008).[8] Key focus areas include forest conservation (including wholesale logging bans in many areas), prevention of slope erosion and desertification, afforestation of degraded land, and re-vegetation of agricultural land. The primary mechanism of these programmes has been an extraordinary rise in afforestation activities[9]. The official statistics are impressive to say the least. Chinese government figures indicate that forest coverage has been increasing at 1.6 percent per year since 2000, or approximately three million hectares annually (FAO, 2011a). It has been estimated that within the first eight years of the ERPs: 8.8 million hectares of cropland was converted to forest; soil erosion and desertification of land had been reversed, and were declining annually by 4.1 percent and 1283 km^2 respectively; and 98 million hectares of natural forest were placed under effective protection (Wang *et al.*, 2007).

Aside from the finances dedicated to the ERPs, contributing factors to their success have included payments to local communities, particularly for farmers through

[8] See Wang et al (2007b, Table 2) for a detailed description of each programme.
[9] Formally, afforestation refers to tree-planting on land that did not previously support forests and reforestation applies to planting that occurs on land where forests did exist but were removed or degraded. For simplicity, we use the term afforestation to describe tree-planting in both cases.

the Sloping Land Conversion Program (Yin and Yin, 2010); ownership and tax reform at a state level that has encouraged the growth of commercial plantations (Wang *et al.*, 2007); and national government programmes that have resettled or retrained workers previously engaged in logging (Wang *et al.*, 2007).

There are, however, a number of caveats to this success story. The term 'forest' in China has changed over the last decade, and can now describe scrub and grass land, as well as orchards and other types of 'economic forests' (Demurger *et al.*, 2007; Si, 2011). Thus, definitional alterations may account for some of the statistical expansion. Monitoring and assessment are a major challenge; the political system ensures that regional governments and the bureaucracy at all levels have a strong incentive to state that central government targets are being met, even if that is not the case (Guan *et al.*, 2011; Yin and Yin, 2010). A field study of afforestation programmes in a small township of Sichuan province demonstrated this problem, finding that local government statistics had grossly misrepresented reports of success (Trac *et al.*, 2007).

Another issue pertains to the desirability and permanence of tree plantations, particularly in the arid and semi-arid lands of China. Large-scale afforestation in these areas, particularly of non-local tree species, has frequently lowered the water table and actually advanced land degradation (Cao, 2008; Jiao *et al.*, 2011, Sun *et al.*, 2006). As they are simply not suited to the environment in these regions, survival rates of planted trees in China's dry northern provinces have been as little as 15 percent in some cases (Cao, 2011). Although re-vegetation of local grasses and shrubbery would produce better long-term results (Jiao *et al.*, 2011), the 'top-down' nature of ERP design and implementation means that the central government has been slow to recognise that afforestation alone will not produce favourable outcomes (Cao *et al.*, 2010). Across a wider range of geographic areas, forestry management practices that encourage higher survival rates and better quality of plantation forests (such as thinning and tending of branches, as well as site selection) have been insufficiently incorporated into afforestation programmes to date (Yin and Yin, 2010).

A further component of the permanence issue is the long-term maintenance of reforested land by private land owners. Uncertainty over the duration of compensatory funding— five to eight-year periods are typical— provides a disincentive to quality stewardship and, in the case of the Sloping Land Conservation Project (SLCP),

analysis of surveyed participants responses indicated that a large proportion will simply return forested land to cropping once funding ends (Bennett, 2008). Moreover, the level of support and resources available for implementation of ERPs on the ground has often been lacking (Wang *et al.*, 2007; Bennett, 2008).

A common thread to critiques of the ERPs is the inefficiency of their 'top-down' design and the multiple levels of bureaucracy required for implementation (Demurger *et al.*, 2007; Cao, 2011; Yin and Yin, 2010). Obviously this is not a problem specific just to forestry and environmental management, but a wider issue pertaining to governance in China as a whole. Although vast resources have been dedicated to afforestation and mitigation of land degradation since the turn of the century, it would appear that these efforts have been hindered by China's political system. Official estimates of China's forest coverage and related statistics have improved, but they are rarely corroborated by independent evidence (Yin and Yin, 2010).

The Chinese government has stated plans to further increase official forest cover to 23 percent by 2020 and 26 percent by 2050 (up from 22 percent in 2011); hence, large-scale afforestation activities are set to continue. A major component of this increase will be plantations to fulfil the growing demands of China's economy, particularly the manufacture of timber products. In light of the issues outlined above, actual future increases in domestic supply are unlikely to meet burgeoning domestic demand (White *et al.*, 2006). Another pressure on China's forestry resources will be conversion to agricultural land as the population and incomes grow. However, given the central government's commitment to reversing deforestation rather than a widespread return to unsustainable domestic practices, it is more probable that the recent 'exportation' of China's deforestation problems to its neighbours will escalate (Liu and Diamond, 2005; Demurger *et al.*, 2009).

3.3. Deforestation in Indonesia and Transboundary Haze Pollution

Although various estimates differ over the precise scale of deforestation in Indonesia, they all tell the same story: the country's forestry resources are being degraded at a massive rate[10]. Satellite-based observations between 2000 and 2008 of

[10] For example, Verchot *et al.* (2010) quote government statistics of 1.2 million hectares per year. The FAO (2011a) report 498,000 hectares per year. Such discrepancies are common and arise from the difficulties of measuring such a dynamic and geographically disperse issue.

Indonesia's largest land masses, Sumatra and Kalimantan, have revealed 5.39 million hectares of deforestation, comprising 5.3 percent of the land area and 9.2 percent of forest cover in 2000 (Broich *et al.*, 2011). Deforestation in Indonesia is driven primarily by demand for timber and conversion of land into palm oil plantations (mostly for export), as well as the expansion of subsistence farming which also plays a lesser, though still significant, role (Verchot *et al.*, 2010).

Central to the problem is that weak institutional capacity and corruption at a local level limit the strength of national laws aimed at reducing deforestation; illegal logging in government- managed areas is common.[11] Further drivers include the short-term financial gain in regional income and employment associated with deforestation activities, particularly given that Indonesia exhibits relatively low-income levels (Tacconi *et al.*, 2008); government policies in the 1980s that encouraged land-use change (Herawati and Santoso, 2011); and the move to decentralisation of governance after the fall of the Suharto regime (Arnold, 2008). More broadly, however, much of the demand for timber and palm oil originates from overseas, where surging economic growth and more stringent domestic regulations in countries such as China have caused Indonesia to 'import' some of its deforestation problems from elsewhere (see previous section of the present study).

While deforestation in itself is a major environmental issue—Indonesia's remaining forests support extensive animal and plant biodiversity, as well as providing vital ecosystem services to rural communities—the manner in which it occurs greatly accentuates its ill effects. Land-clearing for logging and agricultural purposes is commonly pursued by means of fire simply because this is the cheapest method available (Tacconi *et al.*, 2008). The smoke and air pollution associated with fire clearing is exacerbated by its frequent occurrence on Indonesia's vast expanse of tropical peat lands; peat is organically rich and highly combustible, thus fire clearing, combined with the accompanying practice of draining peat lands, causes the land itself to burn. The consequent haze is transported by monsoonal winds over to Indonesia's neighbours, of which Malaysia and Singapore are among the worst affected. In 1997 a major incidence of regional transboundary haze pollution (THP) from forest fires in

[11] For example, the Broich *et al.* (2011) study found that 20 percent of deforestation occurred in legally protected areas.

Indonesia exacted a short-term economic impact across the three countries of around US$4.5 billion, including US$1.4 billion from air-pollution-related health costs (EEPSEA/WWF, 2003).

Once again, THP and deforestation are not just an important issue in terms of their regional impacts, but also because of their direct link to the greatest environmental challenge at a global scale: climate change. The drainage and burning of peat lands release large volumes of carbon dioxide trapped in soil. Forest clearing eliminates a major carbon sink. The combination of these two factors, plus the scale at which they are occurring, renders deforestation in Indonesia an issue of global importance. The forest fires causing the aforementioned THP incidence in 1997 have been estimated to account for 13–40 percent of global carbon emissions in that year (Page *et al.*, 2002). In fact, Indonesia is considered the third highest source of carbon emissions by country, though 80 percent are caused by the land-use change discussed here, and not the energy and industrial production that are major emissions sources elsewhere.

From a domestic perspective, the Indonesian government has to weigh up many competing interests within the country. Deforestation represents a short-term economic opportunity locally, particularly in peat land areas where there is a high incidence of poverty (Harrison *et al.*, 2009), but it adversely affects national health and unsustainably degrades Indonesia's natural resources; 41 percent of Indonesia's remaining forest land is considered to be degraded (Verchot *et al.*, 2010). Decision-making in the interests of long-term sustainability is made more difficult by logging and palm oil companies, both domestically and foreign owned, that use their influence over regional economies to extract favourable treatment from politicians.

Within Malaysia, Singapore, and other neighbours affected by THP, costs are borne from air pollution but benefits also accrue from deforestation, such as a ready supply of cheap timber to manufacture wood-based furniture. Further afield, consumers and companies in countries not affected by THP, such as China, suffer in the long-term if Indonesia's land-based resources are degraded to the point where they are no longer available.

The twin issues of deforestation and THP have been, and continue to be, the focus of potential solutions at a domestic and international level. Numerous legislation and other regulations have been devised, but largely failed due to the incapacity or

unwillingness of local authorities to enforce them (Herawati and Santoso, 2011); corruption has commonly exacerbated the difficulties of enforcement (Palmer, 2001). As a response to THP, a regional haze agreement was formulated under the auspices of ASEAN in 2002. However, the Indonesian parliament has not ratified it, partly as Indonesia would have to foot the majority of the cost of compliance (Tacconi *et al.*, 2008), but also because poor air quality in Singapore lies well outside the political compass of a politician representing a region where there are many pressures for land clearing.

More recently (2010), the Norwegian and Indonesian governments signed an agreement whereby the latter would institute a two-year moratorium on the issuance of new permits to log or set up palm oil plantations in government-managed forest and peat lands. As part of this agreement, Norway will help build institutional capacity for improved forest management and, if deforestation rates decrease, Indonesia will receive up to US$1 billion. In May 2011 a presidential instruction to regional authorities brought the moratorium into effect. However, it contained numerous exemptions as a result of lobbying by business entities. For example, projects where the application was received prior to the presidential instruction can still proceed, as can those which are up for renewal and also those related to mining (Wells and Paoli, 2011). The Norwegian funding is seen as laying the groundwork for future expansion of REDD (Reducing Emissions from Deforestation and Forest Degradation) in Indonesia as part of international climate mitigation policy. If successful, the two-year freeze in the increasing rate of deforestation will enable data collection and other activities that aid successful implementation of REDD. Despite the potentially large sums involved in future REDD-based activities in Indonesia (up to US$5.6 billion (Clements *et al.*, 2010), they will only be effective if they address the key impediments to previous attempts at stopping deforestation: local-level incentives and a deficient institutional capacity for effective monitoring and enforcement.

3.4. Regulation of Air Pollution in India

In the 50 years to the end of the 20th century, the population of Delhi, the national capital region, increased from less than two million to around 13 million people (Firdaus and Ahmad, 2011). Rapid population growth, urban sprawl, and rising

incomes in one of India's major economic hubs have come however at a major environmental cost. By the 1990s, air pollution from a burgeoning vehicular fleet—registered vehicles doubled to four million between 1991 and 2001 (World Bank, 2005)—and industrial activity suffocated Delhi with the highest level of suspended particulate matter in Asia (World Bank, 2005). Unsurprisingly, the health impacts were substantial. Given that up to 25 percent of non-trauma deaths were associated with air pollution in the earlier 1990s, and the peak impact was on Delhi residents between the ages of 15 and 44, Cropper *et al.,* (1997) found that there would be major benefits to stronger air quality regulation.

Intervention by the Indian Supreme Court beginning in 1996 compelled the government to reform the state government's existing suite of poorly targeted and even more poorly enforced air quality regulations.[12] As vehicular emissions were the major cause of air pollution (approximately 60–70 percent during the 1990s (Foster and Kumar, 2011), they were the primary target of the new regulations, although forced closure or relocation of polluting industries also occurred. The central component of the reform was the conversion of all commercial vehicles (including buses, taxis, and motorised rickshaws or 'three-wheelers') to using compressed natural gas, a much cleaner fuel than diesel or gasoline. Other measures included retirement of old commercial vehicles, reduction of sulphur content in diesel and gasoline fuels, emissions standards for private vehicles, and enhancement of the public transport system.[13]

Despite the challenges of broad reform involving so many road users, the programme has been a major success. Statistical analyses of air quality measurement have indicated that the results of these policies have been highly beneficial, significantly reducing, or at least arresting, the rapid rise in concentrations of particulate matter, sulphur dioxide, carbon monoxide, and other pollutants (Firdaus and Ahmad, 2011; Narain and Krupnik, 2007; World Bank, 2005). Similarly, the respiratory function of Delhi's inner city residents has substantially improved, particularly among low-income households (Foster and Kumar, 2011). As a direct

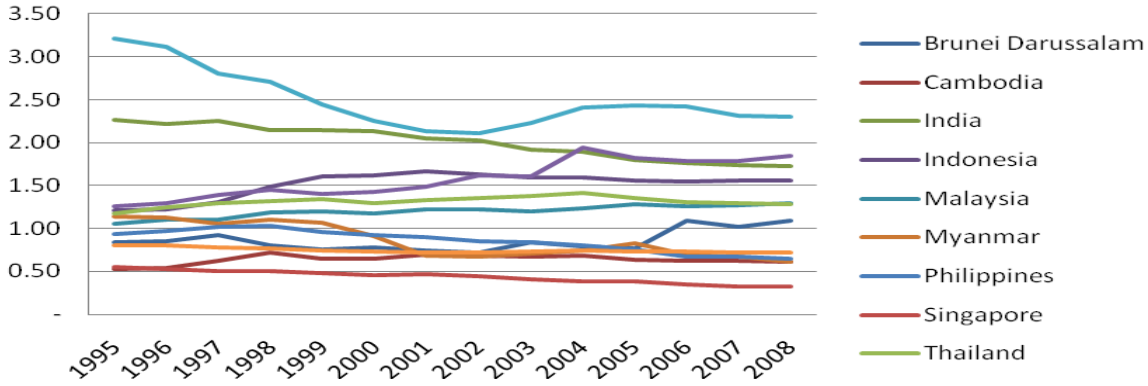
[12] Bell *et al.* (2004) for a comprehensive exposition of the judiciary's role in the reform process.
[13] Government of NCT of Delhi (2010, Table 2.5) for a timeline of state government air pollution reduction measures.

result of the reforms, it has been estimated that nearly 4,000 deaths each year in Delhi have since been averted (World Bank, 2005).

3.5. Climate Change Mitigation in ASEAN

In ASEAN, CO_2 emissions grew slowly since 2000 and reached 1060.1 million tonnes in 2008, accounting for 3.5 percent of the global emissions. Indonesia, Thailand, and Malaysia are the top three CO_2 emitters in ASEAN.

Figure 5: Change of ASEAN's CO_2 Emissions/GDP ($kgC0_2$/US$ (2000 Prices)



Source: Fan and Bhattacharyay (2011).

Of course, in per capita or cumulative terms, ASEAN's emissions still greatly lag those of the EU and US. However, one can safely say that there can be no satisfactory global response to climate change without the active participation of ASEAN.

In 2009, Malaysia, Indonesia, and Thailand announced that they would, for the first time, subject themselves to emissions constraint. Their aim is to reduce CO_2 emissions intensity in 2020 by 20–25 percent compared to 2005, with and without international support. This is an ambitious target which will not be met without considerable policy effort.

AMS already have a large range of policy instruments in place to achieve their new emissions target (Table 6). Climate-change mitigation policy instrument can be divided into market-based instruments such as energy pricing and taxes can be an efficient means of stimulating resource conservation and controlling emissions as well as technology-based policies. In the past and at present, countries have used a variety of mechanisms to promote renewable energy, including direct public investment, investment incentives (e.g. low interest rates, tax write-offs, accelerated depreciation), portfolio obligations, and feed-in tariffs. While all policy mechanisms have had their share of success, the most dramatic expansion in renewable energy capacity was witnessed under the feed-in tariff programmes. 'Feed-in tariffs' obligate electricity grids to purchase renewable energy as it becomes available (to 'feed it in'), and offer potential providers of renewable energy a guaranteed price (the 'tariff,' or rate paid for the electricity). The tariffs are generally fixed for a given period, between 10 and 20 years, at levels that ensure the profitability of the investment. The existence of a guarantee that successful development of a solar or wind energy installation will be rewarded with customers as well as a subsidised price essentially levels the playing field, removing the cost barrier to renewable energy development in comparison to fossil fuel–based technologies.

Table 6: Classification of Climate-Change Mitigation Instruments

Carbon pricing	**Technology-based**	
Fiscal	Fiscal	Regulatory
Emission trading Carbon tax Hybrid trading-tax schemes	Feed-in tariffs Tax credits Public procurement Renewable energy certificate trading Subsidies for energy-efficiency purchases Demonstration grants Public R&D Investment subsidies Preferential tax treatment Government investment in venture capital Public investment vehicles	Technology performance standards Renewable fuel/energy standards Building regulations Automobile regulations Information standards

R&D = research and development.

Of the different options to support renewable energy, the feed-in tariff is seen as the 'policy of choice' that provides the most benefit at least cost (Tian, 2011). It can be applied consistently and transparently while being readily adapted to different specific conditions in different countries. Where feed-in tariffs have been employed in ASEAN countries, they often have to be accompanied by government budgetary allocations to cover the differential between the guaranteed price that the utility pays to the renewable energy suppliers, and the average rate that it is allowed to charge consumers for each kilowatt hour of electricity. This dependence on national budgets to cover the difference places a cap on the total expansion of renewable energy that can take place in a developing country, and thus creates a disincentive for expanded renewable energy investment. Regional financing to support the tariff, or price guarantee, will remove this constraint and create highly favourable conditions for accelerating renewable energy investment and development.

As the phrase itself indicates, feed-in tariff policies have been employed exclusively in regard to grid connections. Given the current level of grid development in ASEAN, the policy framework would need to be amended to be able to include off-grid areas as well. In practical terms, future paradigm involves linking the demonstrated favourability and effectiveness of feed-in tariff policies with the rapidly

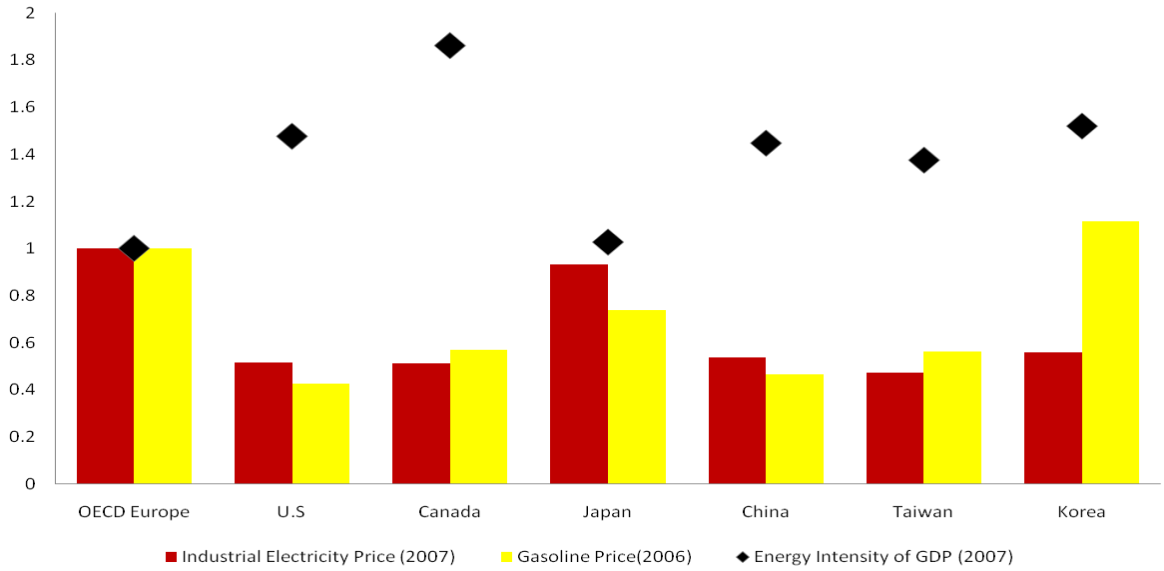
growing energy needs of ASEAN countries, offering suitable mechanisms for finance, policy, and technical support for rapid scale up. It delivers the right mix of policy and market stability that, according to recent research summarised by Kim *et al.* (2011), can create the highest possible leverage for public financing, mobilising up to 15 times the original investment in additional, follow-on funding (Hongo, 2012).

A new regional investment fund needs to be established to contribute the global share of the subsidy for renewable energy services and supplement the national guarantees offered by each country. As such, the fund will reduce uncertainty and ensure predictability in the renewable energy industry. Once it is in place and adequately resourced, it would help stimulate a rapid and massive expansion in the market for solar, wind, and other renewable technologies— and speed them toward an economic tipping point, after which they would be on track to become the dominant energy option on the planet. The price support mechanisms need to be structured in such a way as to reward the most efficient renewable energy suppliers and to give them an incentive to reduce costs as rapidly as possible. The concept of a declining tariff schedule seeks to ensure this by stipulating that price supports decline and disappear within a defined period of time. Producers would race to enter the market ahead of the declining subsidy and establish their competitive position in the marketplace. Where appropriate, countries could choose additional policies (such as renewable portfolio standards and innovative financing of upfront costs) that would encourage utilities and local governments to be more proactive in cooperating with renewable energy suppliers. If implemented, the economics and the technologies of the world energy sector could be transformed by 2030. With renewable energy costs becoming competitive with fossil fuels, subsidies could soon be discontinued. The majority of ASEAN's poor would have access to energy from affordable, renewable sources—the new default option.

What we have not seen so far in ASEAN is the introduction of a carbon price. Carbon pricing would certainly seem to be a critical part of the mitigation challenge. Figure 5 compares China (and Chinese Taipei and Korea) to two sets of developed economies: the US and Canada on the one hand, and the EU and Japan on the other. The US and Canada have cheap energy (low electricity and petroleum prices) and a high energy/GDP ratio. By comparison, the EU and Japan have expensive energy and

a low energy/GDP ratio. China, with relatively low energy prices and high energy intensity, currently looks much more similar to the US and Canada than it does to Europe and Japan. But China's mitigation objective requires that it ends up looking more like the Europe and Japan in terms of its energy to GDP ratio. It will not get there without higher energy prices.

Figure 6: Cross-country Comparison of Electricity Prices, Gasoline Prices, and Energy Intensity (Ratio of Energy Use to GDP)



Notes: Energy prices measured in current US dollars, using market exchange rates. Energy intensity is the ratio of energy consumption to GDP measured using PPPs. All OECD (Organisation for Economic Co-operation and Development) Europe values are normalised to one.
Sources: IEA (2009, 2010).

Introducing an effective system of carbon pricing into ASEAN would, however, be a major and difficult economic reform. Say ASEAN did introduce a carbon price. What impact would it have? Would it actually lead to higher energy prices and lower emissions? Clearly, a carbon price would send a signal, the strength of which would depend on the level of carbon price, to commercial consumers of coal, such as steel manufacturers that they should use coal less and more efficiently. But much of the energy sector in ASEAN is regulated, and here matters are more complex.

One key problem is that cost pass-through mechanisms in the electricity and petroleum fuel sectors need further strengthening. Coal is the dominant fuel for electricity in AMS like Indonesia, Malaysia, and Viet Nam. In recent years, the price of coal in Indonesia has risen sharply. Through a series of electricity tariff increases, Indonesia greatly reduced electricity subsidies over the past years. However, Indonesia has found it difficult to pass on the increase in coal costs it has recently experienced.

A good illustration that effective carbon pricing requires pricing reform comes from attempts already made to try to influence the fuel mix, or dispatch order, in the electricity sector. Under the Energy Saving and Emissions Reduction in Power Generation or ESERD that China introduced in five pilot provinces, provinces have been instructed to dispatch generators, not on an across-the-board basis as in the past, but rather according to a mix of economic and environmental criteria. To simplify, the dispatch order is: renewable, nuclear, gas, and then coal, with coal plants ordered by their thermal efficiency, from highest to lowest. Note that this is roughly the order that one would expect with a high-enough carbon price, and, indeed, simulations show implementing ESERD would cut emissions by 10 percent. However, the pilot provinces have only been able to partially implement this reform, because of the negative financial implications full implementation would have for less-efficient coal-fired units. These units are still valuable as reserve capacity, but, under the Chinese on-grid tariff system, plants only receive a payment if they are dispatched, and so have no incentive to provide stand-by capacity. Instead, if not regularly dispatched, they would simply shut down, thereby depriving the system of valuable spare capacity, in case of an emergency or a spike in demand. Or, put differently, the policy-induced lack of flexibility in dispatch has undermined the impact of the introduction of a carbon price (or, in this case, a carbon price equivalent).

Carrying out the reforms needed in the power sector in ASEAN to make carbon pricing effective will not be easy. Power sector reforms in developing economies are generally difficult. While there are some success stories, a World Bank (Besant-Jones, 2006) review of power sector reforms concludes that overall ‘political forces are difficult to align for reform’ (Besant-Jones, 2006), that interest groups ‘constitute a major impediment to reform’ (Besant-Jones, 2006), and that ‘successful reform requires sustained political commitment’ (Besant-Jones, 2006). Not surprisingly,

therefore, ‘Power market reforms in developing economies are generally tentative and incomplete, and are still works in progress’ (Besant-Jones, 2006).

China is no exception to this generalisation; it has made slow progress with electricity reform. In 2002, China split its single, vertically integrated utility into two grid companies (a large one covering most of the country, and a small one in the south) and a number of generation companies (including five large ones). It experimented with wholesale electricity markets in 2002, but that was short-lived and generators no longer bid for dispatch, but sell at centrally-fixed prices. Countries like Malaysia also established in 2008 Sustainable Energy Development Authority that focuses on technical rather than economic regulation. Prices are still set by government and, as noted earlier, mechanisms for cost pass-through have been established but are not used. The IEA’s conclusion that in the energy sector ‘ASEAN is caught between the old planning mechanisms and a new approach’ (2006) is probably as relevant today as when it was written.

It also has to be admitted that the direct impact of power sector reforms might be to increase emissions. Though it is often claimed that such reforms are ‘win-win’ (IEG of the World Bank, 2009), in fact this will vary from country to country. The efforts of Indonesia and Malaysia to eliminate subsidies laid the groundwork for their rapid electricity growth last decade. If China does allow for greater cost pass-through in the electricity sector, this will put upward pressure on electricity prices. But it will also remove one of the underlying forces which is currently leading to electricity shortages, namely, the unwillingness of coal producers to supply the electricity sector.

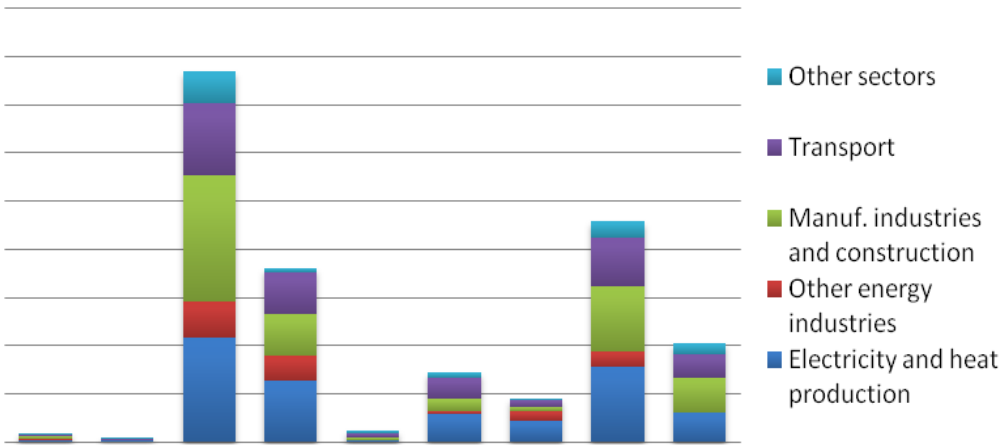
Reforms to support climate change mitigation need to go beyond the energy sector to the economy as a whole. It is not cheap energy that is driving ASEAN’s massive expansion of its energy-intensive sectors. Energy prices are low in ASEAN compared to Europe and Japan but not compared to the US (Figure 4). The search for what Rosen and Houser call ‘the root causes of structural over-allocation into energy-intensive industry (2007) must extend beyond the energy sector. As they argue: ‘the pervasive revealed comparative advantage of heavy industry manufactured goods from China is generally rooted in distortions other than energy inputs (Rosen and Houser, 2007).

ASEAN is characterised by both an exceptionally high investment rate (some 25 percent of GDP) and an exceptionally high share of industry in value added (about 50

percent). The reasons for this are complex, but include, as argued by Huang (2010), limited liberalisation of markets. Low interest rates, high re-investment rates by state-owned enterprises, and low land prices in particular have all encouraged capital-intensive industrial production.

Rebalancing the economy should not only lift economic welfare but also reduce emissions. The electricity and heat-generation sector emitted the largest in most countries, while manufacturing industries and construction sector produced largest emissions in Viet Nam. Carbon intensity, a ratio of CO_2 emissions per GDP, showed a decreasing trend in Singapore**,** Philippines**,** Indonesia, and Thailand, while Singapore has the smallest emission intensity. Carbon intensity showed a slowly ascendant in Malaysia and Viet Nam. A large share of emissions was produced by electricity and heat generation sector, accounting for 56 percent (Figure 7). Manufacturing industry and construction sector accounted for 29 percent while 22 percent came from transport sector.

Figure 7: ASEAN Carbon Dioxide Emissions by Sector, 2008
(million tonnes of CO_2)



Source: Fan and Bhattacharyay (2011).

Rebalancing implies, among other things, faster growth in services than industry. A 10 percentage point switch in GDP composition away from industry towards services (the tertiary sector) would, everything else being equal, result in a 14 percent reduction in energy intensity.

Slower economic growth would also help reduce the growth in ASEAN's emissions. ASEAN's average economic growth between 2001 and 2010 was 5.6 percent. This is a remarkable result considering that the period encompasses the global financial crisis. It seems heretical to suggest that ASEAN would do better by growing more green way, but it is possible such growth would actually improve welfare. For example, a switch in government spending from fossil fuel subsidies to incentives for renewable and green infrastructure could generate green growth but still be welfare-enhancing as well as emissions-reducing. Whether ASEAN will be able to, green growth remains to be seen.

As with energy reform, rebalancing will not be undertaken to reduce emissions. Its primary motivation will be economic. But emissions reductions efforts will be more successful if rebalancing occurs.

Of course, the measures already in place, such as support for research and development, and other regulatory and technology-specific-promotion measures, are also important. But these are already at the heart of ASEAN's mitigation efforts. What is now needed is a broader response to the mitigation challenge, one which embraces pricing reform, energy sector reform, and structural economy-wide reforms. Neither the importance nor the difficulty of the path ahead should be underestimated.

4. ASEAN's Wicked Environmental Problems

Initially conceived in the context of social planning in the United States (Rittel and Webber, 1973), the concept of 'wicked problems' has since been applied to a diverse range of fields, including health sciences (Kreuter *et al.*, 2004), business strategy (Camillus, 2008), art design (Buchanan, 1992), and forestry management (Allen and Gould, 1986). The term 'wicked' is not used in this instance to reflect awfulness and immensity of consequences. Rather, wicked problems are complex, multidimensional, hard to solve, and often harder to define.

Rittel and Webber (1973) contrasted these difficult challenges to ‘tame problems’, for which the task is more straightforward, even though the impacts may be considerable. Initial contrasts involved (wicked) problems like building a freeway or setting a tax rate with (tame) problems such as solving a mathematical equation or identifying a chemical compound. The latter type have definable right and wrong answers, with clear criteria for distinguishing between them, both of which the former lack. In particular, different stakeholders will hold wildly different and often irreconcilable views on the best highway routes or tax rate.

From an environmental perspective, consider the contrast between international action to prevent ozone depletion and climate change. In the former case, the primary cause is the emission of chlorofluorocarbon gases from refrigeration. This can be reduced at low cost, and through the engagement of a small number of players, namely the producers and users of refrigerants. The definite source, low mitigation cost, and small number of stakeholders involved facilitated the implementation of a successful solution, the Montreal Protocol.

On the other hand, greenhouse gas emissions arise from a wide variety of sources, such as electricity generation, transport, manufacturing, and, in fact, the fundamental processes of industrialised society. Traditional sectors are also involved, namely agriculture and forestry. Therefore, devising a solution is a much more complex task involving a much larger number of inter-connected issues, much larger costs, and greater uncertainties. Not surprisingly, the world has made much less progress in responding to climate change than ozone depletion.

There are various characterisations of a wicked problem. By way of introduction to the approach in the present study, Table 7 summarises the characteristics of wicked problems in contrast to tame problems. We illustrate them in the following sub-sections using three overlapping themes: problem formulation, interdependency, and solution set. The applicability of this framework to ASEAN’s environmental concerns is demonstrated by its description in terms of examples from the case studies, whilst also referring to the four broad environmental challenges.

Table 7: Comparison of Wicked and Tame Environment Problems

Problem formulation	A clear and objective definition is readily available. The sources and underlying processes are simple and widely understood.	No definitive formulation due to extreme complexity. The problem is perceived through personal judgement and/or preconceived notion of solution.
	The nature of the problem does not change significantly over time. Problem is terminated by applying solution(s).	The problem is constantly evolving and is never completely resolved. Any solution(s) may only be temporary.
Interdependency	The problem is composed of a small number of constituent parts without extensive linkages between them.	The problem is composed of and related to many different problems. All of these different elements affect each other through a network of linkages.
	A narrow range of stakeholders are involved whom all view the problem in a similar manner.	Many, diverse groups and stakeholders with competing interests are affected by the problem and solution.
Solution set	The effects of solutions are isolated to specific targets.	Any solution causes feedback effects. The linkage between constituent elements means that the total effect is difficult to ascertain.
	A clear and finite solution set exists. Solutions are developed from objective analysis.	A potentially infinite solution set exists. The merits of different solutions are determined by the judgement of different stakeholders.
	Outcomes are 'true-or-false'	Outcomes are 'better-or-worse'.

Notes: Kreuter *et al.*, (2004) provide a similar presentation of the difference between tame and wicked problems using four of the characteristics formulated by Rittel and Webber (1973). Batie (2008) adapts this approach, although using a broader set of characteristics.

5. How Can ASEAN Harness Available Economic Opportunities with Environmentally Sustainable Growth?

Over the last three decades, China's economy grew at about 10 percent a year, progressing from being a poor country to having the world's second-largest economy. Yet, the Chinese government is now reconsidering the strategy that permitted this economic miracle, in an effort to green its development process (World Bank and DRC, 2012). Brazil, India, Mexico, Morocco, and Tunisia are also acting to green their growth or using green industries as sources of growth. Ethiopia is developing a green-

growth strategy. Kenya is investing heavily in geothermal power. And many other countries are hoping to leapfrog and better balance the environment and the economic imperative of rapid growth.

Why such efforts, when many have argued that environmental issues will 'solve themselves' with economic development, and that early action in developing countries would be detrimental (Grossman and Krueger, 1995)? There are serious flaws in this argument. First, a distinction needs to be made between wicked environmental problems that affect welfare through income and those that affect welfare through amenities. Poor households that struggle to feed and house themselves will indeed place a lower priority on the amenities provided by a park than wealthier households might. However, they care deeply about soil degradation that reduces agricultural yields and about the absence of solid-waste management that lead to dengue epidemics and to clogged urban drains and floods.

Making the 'grow dirty now and clean up later' argument even less palatable is the fact that it may simply be too costly to do so. Acting early is critical when the choice of technology and infrastructure can 'lock in' high-carbon or polluting lifestyles or economic structures. This is particularly the case of urban forms, which are almost impossible to modify when cities are built. This issue is particularly relevant in ASEAN countries, where most of the infrastructure and cities will be built in the next few decades. Even worse, some damages cannot be reversed

What can be done to combine the need for growth with environmental constraints? In Hallegatte *et al.* (2011), it was argued that what is needed is to reconcile developing countries' urgent need for rapid growth and poverty alleviation with the need to avoid irreversible and costly environmental damage. As such, efforts to foster green growth must focus on what is required in the next five to ten years to sustain robust growth, while avoiding locking economies into unsustainable patterns, preventing irreversible environmental damage, and reducing the potential for regret. This can be done with growth that is efficient in its use of natural resources, clean in that it minimises pollution and environmental impacts, and resilient in that it accounts for natural hazards— the definition of what we call 'green growth'.

5.1. Is Green Growth Possible for ASEAN?

In 1956, Robert Solow put forward a formal model that suggested that GDP growth comes from increases in physical capital, labour (or human capital), and productivity. In this model, physical capital increases thanks to investment. Labour increases as a result of population growth, greater labour force participation, and better health and education. And productivity increases thanks to technological change— which can stem from investments in education and research and development, economies of scale, and learning by doing.

What is missing in this model, however, is the notion that economic production depends on the stock of natural resources and the quality of the environment— that is, that the environment is a factor in the production function. This notion has been around at least since Malthus (1798), but it was not until the early 1970s that classical growth theory was modified to embrace the environment— referred to as 'natural capital'— as a factor of production (Dasgupta and Heal, 1974; Nordhaus, 1974; Solow, 1974; Bovenberg and Smulders, 1996). If the environment is considered as productive capital, it makes sense to invest in it, and environmental policies can be considered as investment.

In this 'green growth' framework, environmental policies increase economic output directly by improving environmental conditions. But green policies can also contribute to economic growth indirectly, because the world's economies are highly inefficient. Indeed, many market failures hurt both the environment and the economy. Correcting these market failures can increase efficiency and yield benefits that go beyond the environment. Environmental policies can theoretically increase conventionally measured GDP through four channels:

Input effect: The input channel works by increasing the quantity of natural capital, labour, and physical capital, which allows for more economic production. Individual transferable fishing quotas, for example, help maintain and even increase fish stocks and thus the economic activity that depends on them (Heal and Schlenker, 2008). The ecological restoration of the Loess plateau in China led to a near doubling in farmer incomes, and a significant reduction in floods. Environmental policies can also increase labour by improving population health, and they increase physical capital by

better managing natural risks. Protecting mangroves, for instance, not only protects biodiversity, it also improves the resilience of coastal zones to hurricanes and floods.

Efficiency effect: The efficiency channel works by increasing productivity by correcting market failures and enhancing the efficiency of resource use. One example is energy efficiency. Many firms and households fail to make cost-effective energy-efficiency investments— because of market failures and behavioural biases (Gillingham *et al.,* 2009). Environmental policies that aim to reduce energy consumption may correct these market failures or influence these behaviours, leading to less environmental damage and a more efficient economy, with a higher growth potential.

Stimulus effect: The stimulus channel can occur during an economic recession, when capacity utilisation and employment are low. Green investments increase demand, potentially increasing employment (Zenghelis, 2011). Underemployment is not always related to demand, however; it can be structural, especially in developing countries. In this case, a stimulus may prove costly and do little to increase employment.

Innovation effect: There is clear evidence that environmental policies (e.g. European fuel taxes or SO_2 tradeable permits in the US) can shift the production frontier (increasing the potential output the economy can produce) by accelerating the development and dissemination of innovation and creating knowledge spillovers. Given that investments in knowledge tend to be lower than desirable in the absence of public intervention, policies that encourage green technologies can thus usefully increase them (Porter and van der Linde, 1995; Fischer and Newell 2008). The innovation effect is illustrated by investments in research and development on photovoltaic power motivated by the desire to mitigate greenhouse gas emissions. Success could make photovoltaics competitive with fossil fuels, increase the supply of electric power, and reduce the cost of providing electric power, especially to remote off-grid communities.

Environmental policies may also improve welfare through distributional impacts. For instance, subsidies that incentivise the use of energy (e.g. fuel subsidies) are bad for the environment, and mainly benefit the wealthiest. According to a study by Arze del Granado *et al.* (2010) in 20 developing countries, the 20 percent richest households

capture 43 percent of such subsidies. Replacing them by targeted cash transfers can thus free resources for public investment (in schools or infrastructure) and benefit the poor and the environment. Environmental policies can also reduce potential risks to growth by increasing resilience to environmental shocks (such as natural disasters), (Hallegatte, 2011) or economic shocks (such as oil shocks or spikes in commodity prices), (Rozenberg *et al.*, 2010).

5.2. Trade-offs and Synergies between Green Growth and Conventional Economic Growth Policies

Green growth efforts may also reduce productivity and growth, by causing producers to use more expensive technologies, by crowding out research and development in non-environmental domains, or by forcing the replacement of productive capital based on polluting technologies. Policymakers need thus to weigh the trade-offs between the costs and benefits of environmental policies.

The balance between costs and benefits will be affected by how they are defined. In a narrow economic framework, a policy to protect a mangrove forest has an economic opportunity cost (because it prevents shrimp farming, for example) and no direct benefit. In contrast, in a framework that includes the valuation of ecosystem services (Heal and Kriström, 2005), the policy also has economic benefits, including protection against coastal storms.

In sum, although many observers fear that green policies require incurring large costs now for benefits that will materialise only in the long term, the reality is that many of the benefits can occur in the short and medium term. And action needs to be taken now on issues that carry a risk of lock-in and irreversibility to minimise regret and avoid costly policy reversals.

A start is classifying the potential green-growth policies as a function of the co-benefits they create and of the urgency in implementing them, as done in Table 8. Low-income AMS such as Cambodia, Lao PDR, Myanmar, and Viet Nam should focus on environmental policies that have a negative or zero economic cost thanks to synergies with development (such as implementing specific urban plans); have a positive economic cost but large direct welfare impacts (i.e. when they target local environment

goods such as local air pollution or natural risks); and whose cost can be offset with external resources (such as carbon trading).

Table 8: Prioritising Green-Growth Strategies for ASEAN

		Local and immediate benefits	
		LOWER (Trade-offs exist between short and long term or local and global benefits)	**HIGHER** (Policies provide local and immediate benefits)
Inertia and/or risk of lock-in and irreversibility	**LOWER** (action is less urgent)	• Lower-carbon, higher-cost energy supply • Carbon pricing • Stricter wastewater regulation	• Drinking water and sanitation, solid waste management • Lower-carbon, lower-cost energy supply (e.g., hydro) • Loss reduction in electricity supply • Energy demand management • Small-scale multipurpose water reservoirs
	HIGHER (action is urgent)	• Reduced deforestation • Coastal zone and natural area protection • Fisheries catch management	• Land use planning • Public urban transport • Family planning • Sustainable intensification in agriculture • Large-scale multipurpose water reservoirs

Note: The examples provided in this table are illustrative, and the extent of trade-offs, synergies, and inertia is highly context dependent at individual country level.
Source: Authors.

6. Managing Wicked Environment Problems through Green Growth in ASEAN

The present analysis of interrelated characteristics of environmental problems and green growth in ASEAN indicates that they are going to be very difficult to manage. But that does not mean that these issues will not be or that they cannot be addressed. Environmental resources are a critical component of human welfare and economic activity, and, consequently, their degradation will compel responses at some stage. The key question is not whether these responses occur in ASEAN, but how? Pre-emptive

measures avoid the far greater economic burden associated with reactive or emergency responses, such as migration from areas of extreme water scarcity or government imports of food due to failed harvests. Prior mitigation necessarily avoids some of the costs from adaptation and damages. Therefore, the degree to which these problems act as a brake on regional economic integration will depend largely upon the pre-emptive steps taken towards controlling them.

A major corollary of the discussion in the previous section is that wicked problems defy simplistic, pre-packaged solutions. A more modest and useful goal is to suggest a set of more general policy objectives that will serve as a platform from which to address all these problems, at both the regional and local level. We offer below seven areas of strategic focus whose engagement will facilitate management of ASEAN environmental problems beyond 2015.

6.1. Co-benefits and Issue Linkage

One of the principal characteristics of wicked problems is that they are composed of and related to many problems. This presents complexity but also opportunity. The links between AMS's environmental problems, as well as to development and other issues, allow a single measure to address more than one negative outcome, or achieve co-benefits. Such a situation has many advantages. The value for money in terms of welfare and economic benefits from finance dedicated to attempted solutions is likely to be higher. 'No-regrets' policies may be available; even if one goal is not achieved satisfactorily by a multi-objective solution, another is likely to be. Finance and resources available for one issue can be used to address another where the wherewithal is less prevalent. Regional policymakers should divert some resources towards identifying where these opportunities may exist and how they can be best exploited.

Opportunities to realise these co-benefits are most conspicuous where climate change is involved. For example, future REDD arrangements may enable the Singapore and Malaysia governments to prevent the health impacts of THP in their countries. Similarly, the distribution of improved cook stoves in the interest of climate change mitigation also addresses the health impacts of indoor air pollution on low-income communities. Energy sector reform and a shift to renewable technology can be pursued in the joint interest of energy security, sustainable economic growth, and

climate change mitigation. Indeed, the development co-benefits of climate change mitigation have been a principal focus for climate policy in Asia and developing countries more generally. Beyond 2015, the international architecture is likely to present many more opportunities similar to the Clean Development Mechanism and REDD. These should be embraced by the governments of Asia's emerging economies, even where there are up-front costs, such as imposition of outside oversight or structural reform.

Away from climate change, a fundamental issue for AMS policymakers beyond 2015 is that environmental problems are also problems of development and economic growth. Environmental sustainability is not an end in itself, but a key determinant of future prosperity. Certainly, some trade-offs will still occur in the short-term, but not later or even in the proximate future. ASEAN's shift towards greater environmental protection reflects the economic downside of the 'development first-environment later' mindset, even over just a decade or so of major expansion. Other economies in the region have the opportunity to avoid undergoing this correction. This is why problems such as water and air pollution, farmland degradation, deforestation, and the like are economic issues first and foremost. Hence, their engagement by definition produces 'win-win' situations.

A further relevant point here is that the economist adage of 'one problem, one instrument' is unlikely to work for these wicked problems. More complex responses operating across multiple issues will be required. In the energy-environment space, for example, a mix of policies will be required to reduce emissions, improve energy security, tackle air pollution, and extend energy access.

6.2. Bottom-up Management Processes and Stakeholder Participation

Many of ASEAN's environmental issues involve diffuse groups whose actions are difficult to control by centralised, one-size-fits-all regulation. The nature of an environmental problem is likely to differ across locations in the same country, state, or neighbouring communities. Without the participation of local-level stakeholders in their formulation, attempted solutions will not be effective, especially where the incentive structure to change behaviour is not addressed. Where possible, participation of stakeholders in both the decision-making process and adaptive management should

be encouraged. Stakeholders will generally have the best idea of how problems and their solutions work and affect them. Even where broad-scale strategies are required, the design of centralised measures should place a heavy emphasis on information gleaned from 'bottom-up' consultative processes.

The advantages of this approach are apparent from our earlier examples. The short-term financial incentives for communities to be engaged in logging would need to be overcome to achieve a lasting halt to deforestation in Indonesia. Similarly, improved groundwater management in rural Cambodia would require some form of cooperation between groundwater users, perhaps through community management. Rural households are unlikely to adopt improved cook stoves unless they consider them to be viable and improved alternatives to traditional methods. Impacts of dams on riparian communities in the Mekong, and the choice of afforestation activities in Indonesia are all issues that will have improved environmental outcomes by the direct engagement of local stakeholders.

6.3. Scientific and Technological Research

Comprehension of the dynamics and impacts of problems and potential solutions are essential inputs into effective management of environmental issues. The process of prioritising certain measures from within an infinite solution set has to be informed by the best possible information. For example, a critical determinant of the welfare impacts of Mekong dams will be the effectiveness of fish ladders for migratory species. Without prior research into this issue, informed decisions on construction are impossible. Likewise, scientific assessment prior to the establishment of large-scale plantations would have avoided the negative impacts on soil hydrology that have since occurred. Ongoing support of scientific research facilitates adaptive management as problems evolve and solutions are attempted. Increased linkages between research institutions across Asia will support knowledge dissemination on related issues.

6.4. Planning for Green Growth

As indicated at the start of this section, planning rather than reaction will be crucial to effective management. For example, measures addressing air pollution in major cities must account for continuing urban sprawl and a richer population in the future and, consequently, rising demand for vehicles. Planning for rising water demand will also be crucial over the next two decades. Policies that address only the current state of an environmental issue will likely be ineffective if and when the problem expands in the future.

The importance of green growth is particularly significant to climate change. Steps taken towards a low-carbon economy in ASEAN to 2030 will have a great bearing on the future extent of climate change globally. Measures in the near-term, such as energy pricing reform, will reduce the level of restructuring required once these economies have grown much larger. Moreover, climate change will render water security a much bigger challenge in the future, particularly in India and China. Planning for such events ahead of time and addressing issues before they get worse will avoid the full scale of negative impacts.

6.6. Pricing of Environmental Services

Most environmental problems are an example of ‘market failure’. This failure usually pertains to environmental costs being unrepresented in the price of goods, services, and access to resources. Raise the price to reflect these costs and invariably there will be less ‘demand’ for environmental degradation. Throughout ASEAN, examples abound of large discrepancies between prices, or private costs, and social cost. In our case-studies, the link was particularly clear in the case of excessive ground-water degradation, and climate change mitigation. Indeed, when it comes to energy and water, prices often fail to reflect economic let alone environmental costs. Of course, one reason ASEAN’s environmental problems are wicked is because the pricing reforms needed to solve them are very difficult to implement. Energy pricing reform can be one of the most sensitive reforms a government can attempt to undertake. Nevertheless, if one is looking for solutions, opportunities to rectify major discrepancies between private and social cost need to be taken.

The flipside of this argument is that environmentally beneficial activities should be supported through subsidies and other price-based mechanisms. Governments throughout the region are already investing heavily in the development and deployment of renewable energy. In other areas, such as deforestation, ecosystem services are beginning to be valued and economic mechanisms developed to sustain them. Such activities should broaden. The prospects for this happening will increase with international and regional support in the provision of funds, expertise, technology, and other resources.

6.7. Improving Institutional Capacity

A key determinant of effective environmental regulation is, of course, the quality of the regulator. Implementation remains a pervasive hindrance to improved environmental protection. Whether it be high-level sanction of forest 'land-grabs', misreporting of environmental statistics, or bribes for local officials not to enforce national laws, insufficient institutional capacity facilitates unsustainable resource use across many parts of Asia. Institutional capacity is a wicked problem in itself, but attention to this single issue will strengthen the effectiveness of all the other management strategies outlined here. Establishment of independent regulators, cooperation with unrestricted NGO sector, greater transparency, and institutional democratization at all levels are important objectives. Still, uncorrupted regulatory bodies can be under-resourced or have poorly trained staff. Allocating central budget resources to environmental regulation should increasingly be viewed as part of the economic growth and development agenda.

6.8. Cooperative Management, Regional Institutions, and International Cooperation

Cooperative management mechanisms will be important to avoid any conflict over use of shared resources, particularly between states. Forums such as the Mekong River Commission and others like it must serve as an important meeting place for states to share information and negotiate. The creation of shared institutions or agreements prior to the full materialisation of potential flashpoints will assist adaptive and mutually beneficial management. At a community level, cooperative management of a shared

resource, such as groundwater, could help to break 'public good' characteristics wherein individual users have no self-interest in personally pursuing sustainable usage patterns. Cooperative management between government departments or national governments in the pursuit of the co-benefits mentioned above will be critical to the results of a multi-objective approach.

An important component of cooperative management will be a central role for regional institutions. Batie (2008) emphasises the importance of 'boundary institutions' in addressing wicked problems. Such institutions act as a conduit between knowledge providers (e.g. scientific researchers) and knowledge users (e.g. policymakers, resource managers, and the public). In ERIA, the region already has a major institution that fulfils this role. As Asia's environmental problems grow, the ERIA, ASEAN Secretariat and Asian Development Bank should expand their activities to further engage with the management strategies outlined in Appendix A-2. Political and economic institutions such as ASEAN and Asia-Pacific Economic Cooperation will increasingly have to incorporate environmental issues within their agenda, not just in words but in actions that reflect the significance of these problems to regional growth and stability.

Looking beyond the region, international cooperation has a critical role to play. This century may belong to Asia, but, at this particular juncture, this region will need considerable assistance if it is to find the resources and expertise required to address its environmental problems. This is particularly true for Cambodia, Lao PDR, Myanmar, and Viet Nam. Broadly, the developed countries of the region would also play a crucial leadership role on global issues such as climate change. Without effective action to reduce emissions being taken by OECD (Organisation for Economic Co-operation and Development) countries, one can hardly expect tough decisions to be made in ASEAN.

7. Conclusion and Recommendations

The current trajectory of environmental degradation in ASEAN is clearly unsustainable. Policymakers around the region acknowledge the importance of

environmentally sustainable growth and are already addressing it, but much more will need to be done. A prosperous, growing, and safe ASEAN needs water, clean air, forests, and arable lands. Under current trends, these components of the natural resource base threaten to decline substantially as population and per capita incomes rise. Food security, human health, and regional cooperation are all likely to weaken if natural resources are not protected. Action on climate change mitigation in the region over the next two decades will, by and large, shape the scale of damages from global warming. Both the region and the globe cannot afford for ASEAN as a whole to retain any vestiges of a 'development first–environment later' mindset.

At the same time, there are no easy answers. In this paper, based on the fact and progress made, we have argued that ASEAN's diverse environmental problems share the characteristic of being 'wicked'. That is, they are dynamic and complex, they encompass many issues and stakeholders, and they evade straightforward, lasting solutions. Greening the growth will help make resources available to direct towards solutions, but they will also deepen the impact of the divergence between social and private cost which underlies so many of these problems.

Prescriptive, simplistic solutions will not be effective, and may make matters worse. The best one can hope to articulate at a general level is a set of principles for accelerating green growth that may be useful in dealing with a number of these problems. Broadly, the factors that need to be considered to facilitate the transition toward environmentally sustainable green growth are:

- Recognising that development is the main priority in ASEAN, an environmentally efficient development path provides an opportunity to contribute towards this objective in a more sustainable manner. The policy framework to promote a resource- efficient development path needs to clearly demonstrate the benefits of both co-benefits and strategies for removing barriers to reap the co-benefits. Pursuing the low-carbon development path will benefit ASEAN from more analysis based on existing policies, with a clearer analysis of co-benefits, in particular, the benefits for development;
- To promote a better understanding of the co-benefit approach towards a low-carbon green growth, it would also be necessary to enable ASEAN to quantify clearly the developmental challenges and other international agreements such as climate change, Montreal protocol;

- Translation of national goals to enable wider access to energy services and resource-efficient technologies needs to be strategised through innovative policies, financing schemes, and the participation of various stakeholders;
- It is important to quantify resource efficiency and renewable energy potential at the national level to assess the implications for (i) energy and water security; (ii) emission reduction; and (iii) a country's competitiveness;
- Application and utilisation of appropriate green technologies in developing these strategies would be essential to assess their financial implications. There is a need to better understand the long-term socio-economic and environmental costs and benefits in the choice of technologies. Technology transfer would be necessary to assist developing countries in accelerating the process;
- More innovative financing schemes at the micro- and macro-levels will be needed to implement strategies for access to water services, reduce land degradation, improve air quality, and foster energy efficiency. A mechanism to complement these strategies—closer links to the emerging carbon market and domestic financing schemes—needs to be developed at the national level.
- For ensuring water security and efficiency, ASEAN countries need to enhance their regional cooperation particularly in sharing cross-border water sources and meeting regional financing needs for water infrastructure.

The transition to the above state will involve coherent efforts by national and sub-national governments, private sector, international organisations, and knowledge institutes. Although such a transition involves many actors, the following concrete policy options could take advantage of the opportunities available:

- Employ market-based instruments such as eco-labelling programmes at regional level, to improve efficiency in resource use and promote innovations in renewable energy technology. Placing a price on emissions and pollutions has been found to stimulate innovation as firms and consumers seek out clean and green alternatives. Environmental and energy-related taxation on some levee has been successfully used by countries around the region since the 1970s and 1980s including Malaysia, the Philippines, and Thailand.
- Establish well designed regulatory frameworks that can define right conditions for market-based instruments and create incentives as well as remove barriers for investments in renewable energy resources. Adequate regulatory frameworks such as feed-in-tariffs reduce business risks and increase confidences.
- Prioritise government investments and spending in areas that stimulate energy and water resource conservations as well as pollution prevention. Green subsidies such as price support measures, tax incentives, direct grants, and loan support may be used to avoid lock-in effects as well as foster new industries in energy, water, and

emission- reduction sectors, as a part of combined ASEAN strategy to build comparative advantage and drive long-term employment growth.

- Limit government spending in areas that deplete resources. Artificially lowering the cost of using fossil fuels through subsidies deters consumers and industries from adopting resource efficiency measures that would otherwise be cost effective. Though subsidy reform is possible in ASEAN, it is challenging given the vested interest in their maintenance, but there are numerous examples such as conditional cash transfer schemes where aid is targeted to poor households.
- Invest in capacity building, training, and education. The capacity to seize the opportunities available with cross-border infrastructure projects varies from country to country. National circumstances often influence the readiness of ASEAN economies and population to cope with challenge. Training and skill enhancement programmes are needed to prepare the workforce for cross-border projects.
- Strengthen trade and governance systems through regional cooperation. The United Nations Framework Convention on Climate Change (UNFCC)'s Kyoto Protocol has already stimulated growth of trade and investment in a number of economic sectors of ASEAN. The cooperation among ASEAN, Japan, China, Korea, and India in establishing a regional market could be a significant factor in determining the speed and scale of the new green growth projects.

It is unquestionable that the challenge is vast and the urgency mounting. AMS's continued economic expansion and rising standard of living are being increasingly exposed to declining environmental conditions. The degree to which considered, pre-emptive action takes primacy over forced reaction will determine the burden of environmental degradation on ASEAN economic integration beyond 2015.

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Appendix A-1.
Shared Issues and Key Causes of Environmental Concerns in ASEAN

Country	Major Issues	Key Causes
Brunei Darussalam	Seasonal smoke and haze, solid wastes	Transboundary pollution from land and forest fires
Cambodia	Soil erosion, sedimentation, water pollution, deforestation, loss of biodiversity, and threats to natural fisheries	Unmanaged waste and effluent discharge into Tonle Sap lake; destruction of mangrove wetlands through extensive industrial and aquaculture development.
Indonesia	Deforestation, loss of biodiversity, water pollution, air pollution in urban areas, national and transboundary seasonal smoke and haze, land degradation, pollution of Malacca straits	Deficiencies in urban infrastructure—unmanaged industrial wastes and municipal effluents and waste, vehicular congestion and emissions, extensive land clearance and forest fires for pulp wood and oil palm production, extensive and unmanaged mining activities, national and transboundary industrial pollution, tourist developments in coastal regions beyond carrying capacity
Lao PDR	Deforestation, loss of biodiversity, soil erosion, limited access to potable water, waterborne diseases	Land clearance, shifting cultivation, inadequate water supply and sanitation infrastructure
Malaysia	Urban air pollution, water pollution, deforestation, loss of biodiversity, loss of mangrove habitats, national and transboundary smoke/haze	Vehicular congestion and emissions deficiencies in urban infrastructure industrial and municipal effluents, extensive land clearance and forest fires for pulp wood and oil palm production, unmanaged coastal developments, tourist developments in coastal regions beyond existing carrying capacity
Myanmar	Deforestation, loss of biodiversity, urban air pollution, soil erosion, water contamination and waterborne diseases	Land clearance, excessive mineral extraction, vehicular congestion and emissions, deficiencies in urban

		infrastructure—unmanaged industrial and municipal effluents
Philippines	Deforestation in watershed areas, loss of biodiversity, soil erosion, air and water pollution in Manila leading to waterborne disease, pollution of coastal mangrove habitats, natural disasters (earthquakes, floods)	Illegal forest cutting, land clearance, rapid urbanisation and deficiencies in urban infrastructure—unmanaged industrial and municipal effluents, inadequate water supply and sanitation, tourist developments in coastal regions beyond existing carrying capacity
Singapore	Industrial pollution, limited natural fresh water resources, waste disposal problems	Seasonal smoke/haze, limited land available for waste disposal.
Thailand	Deforestation, loss of biodiversity, land degradation, and soil erosion shortage of water resources in dry season and flooding in rainy season, conflict of water users, coastal degradation and loss of mangrove habitat, urban air pollution, pollution from solid waste, hazardous materials, and hazardous waste	Sporadic development and destruction of watersheds, unmanaged aquaculture, tourist growth exceeding growth in carrying capacity, deficiencies in urban and rural infrastructure, freshwater resources polluted by domestic/industrial wastes and sewage runoff
Viet Nam	Deforestation and soil degradation, loss of biodiversity, loss of mangrove habitat, water pollution and threats to marine life, groundwater contamination, limited potable water supply, natural disasters (e.g. floods)	Land clearance for industry, extensive aquaculture and overfishing, growing urbanisation and infrastructure deficiencies, inadequate water supply and sanitation (particularly in Hanoi and Ho Chi Minh City)

Source: ADBI (2014).

Appendix A-2.
Major Regional Programmes and Activities

In order to achieve meaningful and focused regional cooperation in line with national priorities and to contribute to addressing global environmental issues, the ASEAN Environment Ministers at their 7th Informal ASEAN Ministerial Meeting on the Environment (7th IAMME) in 2002 prioritised environmental cooperation in ten areas. The Ministers also agreed to each AMS spearheading programmes of specific interest to them in order to create better platforms for regional cooperation on the environment with the meaningful participation of all AMS. This arrangement of lead country/chairmanship is for a period of three years and is based on expression of interest, rather than by alphabetical rotation. The next review of this arrangement took place in 2010 during the 21st ASOEN Meeting. At the 10th IAMME in September 2007, the ASEAN Environment Ministers agreed to rationalise the priority areas of sustainable forest management and sustainable management of protected areas into one priority area, namely, sustainable management of biodiversity.

Lead Countries/Chairpersons for the Priority Areas of Cooperation on Environment

Priority Areas For Regional Cooperation	Lead Country/ Chairperson	Subsidiary Body of ASOEN
Addressing global environmental issues (focus on MEAs)	Thailand	AWGMEA
Promoting sustainable development through environmental education and public participation	Brunei Darussalam	AWGEE
Promoting environmentally sound technology	Malaysia	[ASEAN Secretariat]
Promoting quality living standards in ASEAN cities/urban areas	Indonesia	AWGESC
Harmonising environmental policies and databases	[ASEAN Secretariat]	[ASEAN Secretariat]
Promoting the sustainable use of coastal and marine environment	Viet Nam	AWGCME
Promoting sustainable management of natural resources and biodiversity	Thailand	AWGNCB
Promoting the sustainability of freshwater resources	Philippines	AWGWRM
Responding to climate change and addressing its impacts	Thailand	AWGCC

Source: Fourth ASEAN State of the Environment Report (2009).

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