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Asia's Sustainability Challenges and Future Earth

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29.1 Introduction

The notion that we have entered a new geological era, the Anthropocene, in which humanity has become the dominant driver of Earth system change (Crutzen, 2002; Steffen et al., 2007) is rapidly gaining currency. Asia's sheer size and dramatic development are increasingly making it a major contributor to this trend. About 60% of the global population lives in Asia, and its total GDP has exceeded one-third of the global GDP. The region is experiencing tremendous demographic change, rapid economic growth and urbanization. Associated with these trends of human activity, Asia has become a hotspot for greenhouse gas emissions and air and water pollution, which have begun to affect regional and even global hydro-climate change and air quality.

These changes are accelerating the decline of ecosystem services, with biodiversity loss in the terrestrial and marine ecosystems of Asia increasing most rapidly in the world. At the same time, economic development trends give rise to great disparities of wealth both within and between countries. Under these social and environmental conditions, the vulnerability of societies and ecosystems to the potential impacts of climate change is being aggravated.

On the other hand, the so-called Asian Green Belt, with its humid monsoon climate and rich biodiversity, has historically offered many examples of long-term social and ecological sustainability. Here, traditional systems of agriculture and livelihoods, with their own unique cultures, have supported large numbers of people through time. In meeting its formidable contemporary sustainability challenges, Asia will need to develop novel approaches in science, technology and governance, building on the wisdom embodied in traditional livelihoods and cultures. Designing sustainable interactions between humanity and nature in Asia is a global challenge, and the ultimate goal of Future Earth, global sustainability, cannot be achieved without sustainability in Asia (Yasunari et al., 2013; Manton et al., 2015).

In this chapter, we first provide an overview of the natural system of Asia, which underpins its burgeoning human society. We then document the current environmental issues, and some of the impacts on human health, caused by active and rapid industrial and urban development in recent decades, as indicated by selected literature. At the end of the chapter, we emphasize the importance and urgent necessity of interdisciplinary and transdisciplinary research and engagement in Asia as part of Future Earth in Asia (or "Future Asia"), to cope with the environmental issues and to achieve long-term sustainability.

29.2 Changes in Climate and Water

29.2.1 Geophysical and Climatic Conditions

The topography of Asia is characterized by an active tectonic zone with its center the Himalaya-Tibetan Plateau (HTP), surrounded by a subduction zone along the periphery of the continent. The HTP and all the mountain ranges that surround it form the highest (average elevation more than 4000 m above sea level) and most extensive highland in the world. The Asian monsoon is a large-scale atmospheric circulation system induced by seasonal differential heating between the Eurasian continent and the Indian and Pacific Oceans. Many previous climate modeling studies have shown the critical role of the HTP (e.g., Hahn and Manabe, 1975; Kutzbach et al., 1993) in the formation of the Asian monsoon. Recent studies using coupled ocean–atmosphere general circulation models have also suggested that the uplift of the HTP over the geological time of the Tertiary to the Quaternary era has greatly impacted the formation of the Asian monsoon system and the

atmosphere–ocean coupled system (e.g., Abe et al., 2003; 2004). Because of the far-ranging impact of the monsoon on climate, agriculture and ultimately human society, the affected region is often referred to as "Monsoon Asia".

The HTP contains the largest amount of glacially stored fresh water (snow and ice) outside the Arctic and the Antarctic (Yao et al., 2012), and is sometimes called the "Asian water tower" (Immerzeel et al., 2010). Asia's major river systems are formed from this water tower, with many alluvial plains and valleys formed under these tectonic and geomorphological conditions, combined with the monsoon climate. These alluvial valleys, plains and delta systems (e.g., of the Ganges, the Mekong, the Yangtze and the Pearl River) have provided ideal conditions for paddy rice cultivation and have given rise to some of the most densely populated areas in the world. These geophysical and climatological conditions, on the other hand, cause frequent and serious natural disasters (e.g., earthquakes, landslides, tsunamis and floods) in Monsoon Asia. Particularly, the major river delta areas are highly vulnerable to shifts or shocks originating upstream or in neighboring seas and oceans (Syvitski et al., 2009).

29.2.2 Changes in Hydro-Climate and Floods in Asia

Typhoons, heavy rains, floods and droughts, landslides, earthquakes and tsunamis are the cause of regular natural disasters in Asia and the region needs to improve its capacity for risk management related to such extreme hydro-climatological and tectonic events (ADRC, 2011; Krechowicz and Venugopal, 2010). In particular, an increase in frequency of extremely heavy rainfall associated with the monsoon and typhoons has been reported in Asia in the past few decades (Fujibe et al., 2005; Goswami et al., 2006; Endo et al., 2005). The IPCC concluded from state-of-the-art climate models that this tendency could be further enhanced by global warming, particularly in this region (Field et al., 2012). In contrast to extreme rainfall events, the frequency of moderate rainfall events over central India during the monsoon season has decreased over the period 1950–2000 (Goswami et al., 2006). For the East Asia summer monsoon, studies have found a clear weakening of the monsoon over the last three decades, exhibiting a drying trend (decrease of rainfall amount) in northern China and a wetting trend (increase of rainfall amount) in the Yangtze River basin; such changes may give rise to simultaneous floods and droughts over eastern Asia (Endo et al., 2005). Strong increasing trends of the very wet day index are observed in both Southeast Asia and Korea, where heavy rainfall events occur during the monsoon period. This contrasts with decreasing trends in northern China and south eastern Australia. It has been shown that the increase in extreme events is linked to global warming and that this development is larger and faster than previously expected (Salinger et al., 2013). These extreme heavy rainfall events frequently cause severe floods in the region. For example, one study of the observed and projected trends in human exposure to tropical cyclones (typhoons in Asia) and floods showed that more than 90% of the global population exposed to such events are found in Asia, both currently and in projections for 2030 (Handmer et al., 2012). Disasters expose different dimensions of social-ecological vulnerability and therefore disaster risk reduction is an important field of sustainability research and action (UNISDR, 2011). In the event of disaster, it is crucial to address immediate recovery needs while also developing learning systems that will improve social-ecological resilience to potential future disasters and build sustainability in the long term (Takeuchi, 2002).

29.2.3 Water Cycles, Water Security and Management

Water is at the nexus of the coupled nature and human systems, connecting human consumption, agricultural irrigation and hydropower generation through important geophysical and bio-geochemical processes in the atmosphere, oceans and land. Water is one of the most important elements for human development and therefore human sustainability. Under changing climate and rapid human development, water security has been threatened in numerous ways that require immediate attention in order to ensure a sustainable Future Earth (Manton et al., 2015). The grand challenge of sustainable water resources management is to secure the access to high-quality water necessary to meet basic human needs, such as health and sanitation, food production and renewable energy. To do this, the linkages among ecological change, land use, urbanization, industrial activities and water systems need to be taken into account (Pahl-Wostl et al., 2008).

Local and regional-scale water cycles in Asia are changing, especially through changes of precipitation associated with changes in the monsoon climate and evapotranspiration processes associated with land use/cover changes. Continued glacier retreat in the Himalaya has significant implications for the water supply to Asia's major rivers and will affect the dynamics of water resources and water availability for human use. The importance of groundwater processes in the water cycle and water resources management is discussed separately in Chapter 13 of this book (Taniguchi, 2018).

Aiming at flood control, water conservation, power generation and crop irrigation, hydrological processes are altered in various ways, including diversion of water to other watersheds and construction of hydropower dams. Measures of agricultural intensification such as irrigation and control of water flows through dams as well as the pollution and contamination of water associated with intensification make the already scarce water less accessible and useable. Urbanization also puts pressure on water resources. Moreover, these human alterations also alter the hydrological processes, which in turn affect water distribution and ultimately the availability to different communities and nations.

A major global study of human water security and river biodiversity (Vörösmarty et al., 2010) found that nearly 80% of the world's population lives in areas of high threat. In Asia, this includes zones of intensive agriculture and dense population settlement, such as large parts of Central Asia, India, and eastern China, Korea and Japan, as well as drylands such as those of Central Asia, where water scarcity is the main factor.

29.3 Changes in Biodiversity and Ecosystems (Services)

29.3.1 Biodiversity and Ecosystems in Asia

Monsoon Asia has a unique and rich biosphere with great diversity, running contiguously from the tropics to the boreal region, forming the "Asian Green Belt" along the east coast of the continent. Recent climate model studies have also suggested that the Asian Green Belt plays an active role in the monsoon climate, by controlling the energy, water and material cycles through vegetated land surface cover (Yasunari et al., 2006; Takata et al., 2009). The Asian Green Belt is rich in biodiversity: it contains seven out of seventeen megabiodiverse countries (Australia, China, India, Indonesia, Malaysia, Papua New Guinea and the Philippines), and fourteen of the world's thirty-five biodiversity hotspots.

The ecosystems with the richest biodiversity per area can be observed in Southeast Asia. The land is naturally covered by dense and tall tropical rain forests dominated by Dipterocarp trees, while the mangrove forests and seagrass beds covering the coastal zone exhibit high productivity and species richness. Vascular plants exhibit higher species richness in Asia than in other regions (Barthlott et al., 2005) and the Borneo lowlands contain more vascular plant species than any other ecoregion on Earth, with ten thousand species (Kier et al., 2005). In Lambir Hills National Park, Sarawak, 1,175 tree species were recorded in a 52-ha plot, the highest documented tree diversity in Borneo (Ashton, 2005). In the sea, the Coral Triangle is known to host the highest species richness, where 76% (605) of the world's coral species (798) are found (Hoegh-Guldberg et al., 2009). These complex structures of autotrophs in turn foster the diversity of inhabiting plants and animals. Besides the tropic regions, rich biodiversity is observed in temperate and boreal regions. The warm ocean current and high precipitation enable the ecosystems to have relatively high productivity and large biomass.

The richness of biodiversity in Asia cannot be attributed only to the current broad spectrum of biomes, but also the geographical properties and history of this area are considered to be essential for the development of this rich biodiversity. Being located in the vast Eurasian continent enabled the floral and faunal elements from adjacent regions to be moved in and mixed, while the mostly continuous terrestrial extent along the latitudinal gradient helped terrestrial species to avoid extinction and enhanced speciation under the dual impact of geological and global climatic cycles (Lohman et al., 2011). For example, consider the period during the Quaternary glacial episodes to see the effect of glacial cycles. The terrestrial continuity prevented extinction of some temperate species in northern Asia by allowing them to migrate southwards to reach refuges and they retained their presence thereafter (Petit et al., 2008). Meanwhile in the Southeast Asian region, the present-day islands of Borneo, Sumatra, Java and Bali and the Malay Peninsula and Sunda shelf were connected to form a large peninsula called Sundaland when sea levels dropped by 120 m at the time of the last glacial maximum (LGM; 21 k.y.a.). The extent of conducive climatic conditions at the LGM is considered to have been large enough for Dipterocarp tree species to sustain the forest biota with their high species diversity (Raes et al., 2014). In contrast, during the interglacial period, the sea level rose and it converted mountains into geographically isolated islands, creating conditions to facilitate speciation. The episodic sea-level changes repeatedly connected the islands of Sundaland to the Asian mainland, enabling biotic migrations from the mainland to the archipelago (Sodhi et al., 2004; Meijaard, 2004). Thus, the natural biodiversity in Southeast Asia took a very long time to become as rich as we are currently observing and can be regarded as the gift of the dynamics and history of the geology and climate of this region. This is the case for the biodiversity richness of Asia as a whole.

The Asian monsoon climate system thus contributes to the rich biodiversity and high ecosystem productivity of the Asian Green Belt, which also means it is eminently suitable for human habitation. The ecosystems in Monsoon Asia, including the agro-ecosystem created mainly in lowland and deltas, have provided people with rich food and other substantial biological resources allowing the population size to exceed 4.1 billion within this region, almost 60% of the world population (Population Reference Bureau, 2016). In the course of population growth, people dispersed over the region and formed diverse traditional systems of agriculture and livelihoods adapted to local biodiversity. The complex mosaic of cultures exhibited by Asia today is the result of this process.

29.3.2 Changing Interactions between Humans and Ecosystems

Recently, however, ecosystems in Asia have been undergoing drastic and sometimes irreversible changes induced by increasing anthropogenic pressures. This is basically due to rapid growth of human population, which increased threefold in 50 years; the increased outbound trade of ecosystem products has also strongly boosted this trend, with its underlying driver being the growth of the global economy. The growing demand for Asian ecosystem products induced the vast land use change through logging, plantation agriculture, aquaculture and overexploitation, especially in Southeast Asia, and these are regarded as the primary threats to its rich biodiversity (UNEP, 2011a). How the biodiversity in Asia is under threat can be recognized, for example, on the maps of globally threatened mammal and bird species (Baillie et al., 2004).

Significant transformations of forest ecosystems in the past two decades can be recognized from the forest cover change from 1990 to 2010. During the first decade, there was a slight decline in forest cover at the rate of some 600 000 ha per year in Asia as a whole. However, in the latter decade, 2000–2010, there was an increase in forest cover with a net gain of more than 2.2 million hectares per year in the period (FAO, 2011). Hidden in this crude trend, however, there exist considerable differences in the forest states and their trends among countries. In the decade of 2000–2010, for example, the bulk of forest cover increase was observed in China because of large-scale afforestation activities, while severe forest loss took place in Indonesia, mainly due to clearing of natural tropical rain forests with the corresponding loss of their rich biodiversity. In Southeast Asia, agriculture is the largest industry (in terms of GDP) for most countries and agricultural production has increased significantly since the 1960s, with most countries more than doubling their cultivated area (Gasparatos et al., 2010).

Threats to coral reefs in the Coral Triangle are also becoming more and more severe. More than 85% of reefs within the Coral Triangle Region are currently threatened by local stressors (such as overfishing, pollution and coastal development), which is substantially higher than the global average of 60%. Nearly 45% are at high or very high threat levels. When the influence of recent thermal stress and coral bleaching is combined with these local threats, the proportion of reefs rated as threatened increases to more than 90%, which is substantially greater than the global average of 75% (Burke et al., 2012).

What do these trends in biodiversity degradation mean in terms of ecosystem services for Asian people? The ecosystem services humans depend on are not only the provision of ecological resources used for food and other raw materials. There are other classes of fundamental ecosystem services, often categorized into regulating, cultural and supporting services (Millennium Ecosystem Assessment, 2005). Rich forest stands, for example, play substantial roles in stabilizing soil layers and in regulating the regional water cycle, which in turn contributes to supply stable water resource and avoidance of disasters. Rich cultural diversity intertwined with local biodiversity of course is essential for the wellbeing and identities of Asian people and their societies. The extensive forests in the Asian Green Belt, expanding from tropics to boreal regions, together with other vegetation and coral reefs, also have the crucially important role of carbon sequestration to regulate the global carbon cycle. These ecosystem services all derive from biodiversity and are intrinsically linked with the environmental issues occurring in the Asian region. Unsustainable tree removal practices, such as clear-felling, prompt erosion and soil salinity, as well as disturbance of the groundwater table. In regions with less precipitation, deforestation facilitates the transformation of fertile areas into barren land, a process known as desertification. Rapid expansion of cultivated area by clearing natural forest is the easiest way to bring about more provisioning services at least in the short term, but will negatively affect services of the other classes that people can enjoy in the longer term. In other words, the Asian countries are, by overly relying on the increase of provisioning services, more and more disturbing the balance of the entirety of ecosystem services for regional people. Further biodiversity decline will threaten hundreds of millions of Asian people in the future.

While the provisioning services are easy to recognize or evaluate economically, the other classes of ecosystem services are generally less visible and therefore their importance for the sustainability of human society is not highly appreciated in comparison with that of the provisioning services; nor is the biodiversity behind

them. The lack of balanced evaluation of ecosystem services has resulted in poor regulation of ecosystem management and, in some cases, unsustainable practices could not be stopped. It has become increasingly apparent throughout the region that the enduring costs from unsustainable land use ultimately overwhelm the more immediate gains even in economic evaluation.[1] However, the values of ecosystem services vary and cannot always be evaluated economically. Therefore, there is an urgent need for developing methodologies to understand what an ecosystem means to the people with different stakes at different scales from local to global, as well as effective governance mechanisms for conservation and sustainable use of biodiversity and ecosystem services.

We do not fully understand the properties of biodiversity and ecosystem services. At least, however, it is certain that they are not sufficiently resilient against or self-sustainable under current anthropogenic pressures *over long periods.* Furthermore, once severely degraded, ecosystems containing rich forests or coral reefs will never recover as they were. Even if partially possible, it requires a long time and large expense. Their loss means the elimination of potential ecosystem resources and this leads to other environmental problems induced by adverse effects of changes in water, soil and climate regimes.

29.4 Development, Environmental Change and Human Health

29.4.1 Urbanization

Asia is home to almost 60% of the global population and exerts a major global impact, both economically and ecologically: it accounts for one-third of global GDP, consumes more than 60% of global materials, is a growing emitter of greenhouse gases and is undergoing rapid demographic change and economic growth (UNEP, 2011). Urbanization and urban growth are an inseparable element of this development process. Historically, the monsoon climate enabled agriculture to thrive in Asia's deltas and plains and this, in turn, supported large populations and thriving cities – sixty-four of the one hundred largest cities were in Asia in 1800 (Satterthwaite 2007). However, from a worldwide perspective, the region has been and still is relatively less urbanized. The urbanization level was 43.1% in 2011, compared to 50.9% for the entire world. Asia is engaged in an unprecedented catch-up race, however, having added a billion urban dwellers since 1980 with an urbanization increase rate that was above the global average. Asia is also home to twelve of the world's twenty-three megacities and this is expected to grow to twenty-one out of thirty-seven by 2050 – thus becoming more in line with Asia's global population share. It should also be noted that, in spite of these powerful urbanizing trends, Asia still contains 69% of all rural people in the world (Manton et al., 2015).

This transformation from a predominantly rural to an urban-dominated society in Asia has therefore been highly compressed in time in comparison with the experiences in the West, and this high-speed change has been accompanied by rapid and profound changes in most aspects of life, as well as the environment. Between 1980 and 2005, 80% of the growth in world materials use happened in Asia and the Pacific – this was not only due to population growth but also to higher per capita use (UNEP, 2011), as urbanization proceeded. A related outcome has been the growth of air pollution problems (discussed in Section 29.4.2), and urban heat island effects are becoming more frequent. Some of these adverse environmental outcomes are likely to be aggravated by climate change. Many urban centers are found in coastal areas and will be vulnerable to sea level rise (World Bank 2010).

29.4.2 Air Pollution

Outdoor air pollution in Asia has grown to such proportions that international media reports about Beijing or New Delhi schools having to close to protect children from the harmful effects of smog have become common.[2] Such media reports are increasingly confirmed by scientific studies such as Chapter 17, this volume. Brauer et al. (2016) report that the highest concentrations of fine particles with a diameter of less than 2.5 micrometers ($PM_{2.5}$) worldwide are found in South and East Asia, especially in northern India and eastern China,[3] resulting from combustion emissions related to such sources as household solid fuel use, coal-fired power plants, landscape fires, industry and transportation. A separate study of $PM_{2.5}$ pollution in forty-five megacities worldwide in 2013 reports that the most polluted cities were found in east-central China and the Indo-Gangetic Plain (Cheng et al., 2016). Likewise, ambient nitrogen dioxide (NO_2), mostly related to the burning of fuel, is a major pollutant in Asia. A recent satellite-based study found that while the population-weighted annual mean NO_2 in Asia Pacific (mainly Japan and South Korea) had peaked in the mid-1990s and then declined, the concentrations in East Asia (China, North Korea and Taiwan) had almost tripled between 1996 and 2012 (Geddes et al., 2016).

The drivers behind this dramatic worsening of the quality of Asia's skies are complex, but they are broadly connected to the fast pace of economic development. This development is driven by and at the same time drives the escalation of fuel use, including the burning of more polluting coal. The increase in income and urbanization has given rise to lifestyles that depend more on fossil fuels, with the use of private cars becoming much more common, while the increase in urban sprawl has given rise to longer commutes.

In parts of Asia, especially Southeast Asia, an important form of air pollution, the haze from forest and peat land fires, relates to development in a different way. It is part of a larger pattern of tropical deforestation due to logging and conversion to palm oil plantations and to some extent the expansion of subsistence farming. In Sumatra and Kalimantan in Indonesia, fire is commonly used in land clearing and may get out of control in the dry season, especially in drained peat lands, which are highly inflammable (Howes and Wyrwoll, 2012). In years of serious drought due to a combination of El Niño and positive Indian Ocean Dipole conditions, such as 1997, 2006 and 2015, severe haze developed and was carried by the prevailing winds across Indonesia and to Singapore and Malaysia (Koplitz et al. 2016). As discussed later, such haze episodes present considerable health threats to the population in the areas affected.

Finally, while air pollution has serious local and regional consequences, developments in Asia increasingly leave their mark on a global scale. Between 1990 and 2013, global $PM_{2.5}$ concentrations increased by 20.4% and this change was mostly due to trends in South Asia, Southeast Asia and China (Brauer et al. 2016).

29.4.3 Population, Health and Environmental Change

Asia is also characterized by great diversity in terms of demography and health (Manton et al., 2015). The population of Asia and the Pacific was almost 4.5 billion people in 2016 (2016 ESCAP Population Data Sheet),[4] 60% of the world's total. Overall, human health as reflected in average life expectancy has increased (72.2 years on average in twenty-two Asian countries in 2010) and fertility levels have gone down (from an average of four children per woman in 1990 to three in 2010) (OECD, 2012). The resulting population structure is young, but with great variation – ranging from very "young" countries such as Afghanistan and Pakistan to the rapidly aging societies of East Asia. In view of this population composition and fertility and mortality levels, it is expected that Asia's population will rise to 5 billion by 2050 and eventually decline to about 4 billion at the end of the century (UNDESA, 2012). Japan is at the head of the Asian (and the world's) demographic curve, with its population now declining, but other countries such as Korea, China and Singapore are also rapidly ageing. It is expected that the dependency ratio (ratio of the population older than 65 to those aged 15 to 64) in Japan, Korea and Singapore will range from 58% to 70% by 2050 (Chomik and Piggott, 2015). The trends in both total population and its composition will have profound implications for sustainability in Asia and beyond.

The region has seen very rapid economic development (on average GDP growth in developing Asia between 1990 and 2010 was 7.0%;Manton et al., 2015) and urbanization has taken place at a very high rate, leading to an urbanization level of 43% in 2011, as described previously. Broadly speaking, as development progresses, disease patterns are shifting from infectious to chronic diseases, but in developing countries a "double burden" is manifested where lifestyle-related chronic diseases are becoming more prominent while infectious diseases still are taking an important toll. Many aspects of health and disease in Asia are directly or indirectly related to human interference with ecosystems. The following sections briefly discuss the linkages of health to air pollution and the threat of emerging infectious diseases in Asia.

29.4.4 Air Pollution and Health

The state of ambient air pollution in Asia and its impact beyond the region have been discussed in Section 29.4.2. The World Health Organization (WHO) has recently sounded the alarm over the threat of air pollution to human health, linking some 3 million deaths a year globally to exposure to outdoor air pollution and a similar number to indoor air pollution. Two in three such deaths occur in Asia and the Pacific, mostly because of non-communicable diseases that result from long-term exposure to pollutants, such as cardiovascular diseases, stroke, chronic obstructive pulmonary disease and lung cancer.[5] $PM_{2.5}$ particulate matter has in recent years received much attention as being particularly dangerous to human health.

It is estimated that 70% of premature deaths due to $PM_{2.5}$ (and ozone) occur in the Asia and the Pacific region (2.3 million deaths) with pollution hotspots being particularly prominent in eastern China and the north of India (Lelieveld et al., 2015). $PM_{2.5}$ pollution in Asian megacities shows clear seasonality with populations being exposed to very heavy pollution

episodes during winters (Cheng et al., 2016). The health impacts of air pollution increasingly have also become a cross-boundary issue in Asia, and researchers, for example, estimate that haze from Indonesian forest fires in 2015 resulted in 100,300 excess deaths across Indonesia, Malaysia and Singapore (Koplitz et al., 2016).

29.4.5 Emerging Infectious Diseases

Asia is a key area in the emergence of new infectious diseases (Jones et al., 2008; Coker et al., 2011). The emerging infectious diseases (EIDs) that have surfaced in Asia in the past two decades have caused much disruption and human and economic costs, but followed diverse trajectories. The Nipah virus that emerged in Malaysia in 1998 was effectively brought under control by policies that separated pig raising activities from the fruit bats that carried the virus. SARS, which rapidly spread from southern China to the corners of the world in 2002–2003, infecting more than eight thousand people and killing almost eight hundred, mysteriously disappeared. Avian influenza H5N1, which from 2003 rapidly spread out of southern China into most of Asia, Europe and Africa, has settled into an endemic existence in poultry in a number of countries with high human and livestock densities, occasionally claiming human victims.

A major study of the emergence of 335 EIDs worldwide between 1940 and 2004 found that 60.3% were caused by zoonotic pathogens and of these 71.8% had a wildlife origin (Jones et al., 2008). It also identified EID "hotspots," among which South and Southeast Asia and China stand out prominently.

While for wildlife-derived diseases the species diversity of wild hosts is an important contributing factor, the emergence and spread of these diseases ultimately are an outcome of economic development and resulting societal and environmental change. Land use change has reduced the natural habitats of wildlife, increasing the likelihood, for example, of migratory wild birds' having contact with domestic poultry. Rising incomes have led to a precipitous increase in the consumption of meat, provided by a burgeoning livestock sector, including the proliferation of largely unregulated intermediate-size commercial farms, connected to live markets by informal trading networks (Scoones, 2010). High densities of rural human and livestock populations continuously place people in close contact with animals. Such factors facilitate pathogens' exploitation of new ecological niches, and once new diseases of humans have emerged, increased mobility and globalization foster their rapid spread (Wu et al., 2017).

Outbreaks of diseases in domestic poultry and related counter measures and market responses have major economic consequences also for small and poor farm families. It is, however, the human pandemic potential of the EIDs that has been the main source of concern and policy attention. The struggle with avian influenza, for example, is a never-ending battle, as the virus rapidly mutates, continuously giving rise to new varieties, some able to infect and kill humans. The spread in 2003 and subsequent continued simmering of avian influenza H5N1 have been referred to earlier. In 2013 a new variety, H7N9, began to give rise to human infections in China, with more than thirteen hundred human cases reported, about one-quarter of which were lethal. Infection largely was due to contact with live poultry. Even more recently, H5N8 has spread from Korea in wild and domestic birds across Asia, Europe and Africa (with even some cases in North America) without infecting people, while the H5N6 strain from southern China is currently widespread in Asia and has had some human victims. It is therefore likely that Asia's countryside will continue to give rise to new infectious diseases with pandemic potential for the foreseeable future.

29.5 Conclusion: A Role for Future Earth in Asia

Asia's sustainability challenges as recounted in this chapter range from greenhouse gas emissions to emerging infectious diseases and from biodiversity loss to societal ageing. It has recently become common to refer to such challenges as "wicked problems," problems that defy close definition, have multiple causes and unforeseeable consequences, affect many stakeholders and lack suitable governance structures (Brown et al. 2012). They are problems that emerge from the solutions to earlier problems and need to be understood from multiple valid, but sometimes contradictory, perspectives. Research that addresses such problems therefore cannot remain confined to specific disciplines, but needs to adopt an interdisciplinary perspective that integrates diverse research fields (across the natural and social sciences, humanities, health and engineering) around shared and synthetic research questions. If research is not only to address wicked problems, but also to contribute to exploring solutions to them, a transdisciplinary approach is called for (Funtowicz and Ravetz, 1993; Pohl and Hirsch Hadorn, 2007; Brandt et al., 2013); in other words, research needs to be co-designed and co-produced in close collaboration with societal stakeholders. It was to support and facilitate such research that Future Earth was established (Future Earth, 2013).

The problems discussed here contribute to and, at the same time, are manifestations of global environmental change. They are, however, also the product of specifically Asian natural conditions and historical trends. We have described how the topography of the region, dominated by the Himalaya-Tibetan Plateau, in combination with seasonal patterns of differential heating of the continent and the surrounding oceans, has given rise to a humid monsoon climate. This benign climate fostered rich biodiversity in the uplands and enabled highly productive rice-based agriculture in the coastal deltas and plains. Such agriculture, in turn, supported large populations including those in thriving towns and cities. Traditional agriculture-based livelihood systems evolved as part of societies with distinct cultures and in some cases were sustained for several thousand years. Therefore, in grappling with the wicked problems of sustainability, not only does research need to involve and engage societal stakeholders, but it should also recognize their regional embeddedness and historic dynamics.

We argue that there is a need to develop an Asian community of research, practice and policy that contributes to solving problems through co-designed and co-produced research. Such research would be embedded in contemporary international understandings of global environmental change, while adopting a regional perspective. Such a community would also take responsibility for fostering a new generation of researchers and practitioners. In collaborating across national borders, it might eventually catalyze the creation of an "Asian Environmental Community" for the sustainable future of Asia.

Internet Resources and Notes

[1] See, for example, the Economics of Ecosystems and Biodiversity initiative, which aims at "making nature's values visible" (www.teebweb.org).

[2] For example: www.theguardian.com/world/2016/dec/17/beijing-smog-pollution-red-alert-declared-in-china-capital-and-21-other-cities and www.bbc.com/news/world-asia-india-37887937.

[3] $PM_{2.5}$ concentrations in northern Africa and the Middle East were also very high, but this is due to mineral dust blown by the wind.

[4] www.unescap.org/sites/default/files/SPPS%20PS%20data%20sheet%202016%20v15-2.pdf.

[5] www.who.int/mediacentre/news/releases/2016/air-pollution-estimates/en/.

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