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## Asia: proving ground for global sustainability

Tetsuzo Yasunari<sup>1</sup>, Daniel Niles<sup>1</sup>, Makoto Taniguchi<sup>1</sup> and Deliang Chen<sup>2</sup>

### Addresses

<sup>1</sup> Research Institute for Humanity and Nature, Kyoto, Japan

<sup>2</sup> Department of Earth Sciences, University of Gothenburg, Sweden

Corresponding author: Yasunari, Tetsuzo ([yas.monsoon@gmail.com](mailto:yas.monsoon@gmail.com), [yasunari@chikyu.ac.jp](mailto:yasunari@chikyu.ac.jp))

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If sustainability entails maintaining wellbeing over time, including environmental, economic, and social dimensions at local to global scales, Asia is its proving ground. The region is characterized by diverse climate, ecosystem, and social-historical conditions. It contains more than 60% of the global population, 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 [1<sup>\*\*</sup>]. Moreover, Urbanization (see [Figure 1](#)) and industrialization have increased resource extraction, processing, transport, and consumption and waste generation, transforming local and regional environments at a pace and scale that is unprecedented in modern history. At the same time, significant disparities of wealth both within and between countries intensify social and ecological vulnerability to the potential impacts of climate change. This article suggests the region requires well-integrated researches by global environmental change (GEC) research community and sustainable development (SD) research community, and proposes formation of a special Future Asia (Future Earth in Asia) network within the Future Earth initiative for global sustainability.

### Regional complexity

The Asian monsoon climate system underpins the ecosystem services on which the livelihoods and wellbeing of billions of people depend [2<sup>\*\*</sup>,3]. Human activity is increasing industrial pollution, land-use change, and greenhouse gas emissions in the region and is leading to changes in monsoon patterns that may significantly

harm social and economic development in the region [4–6].<sup>a</sup>

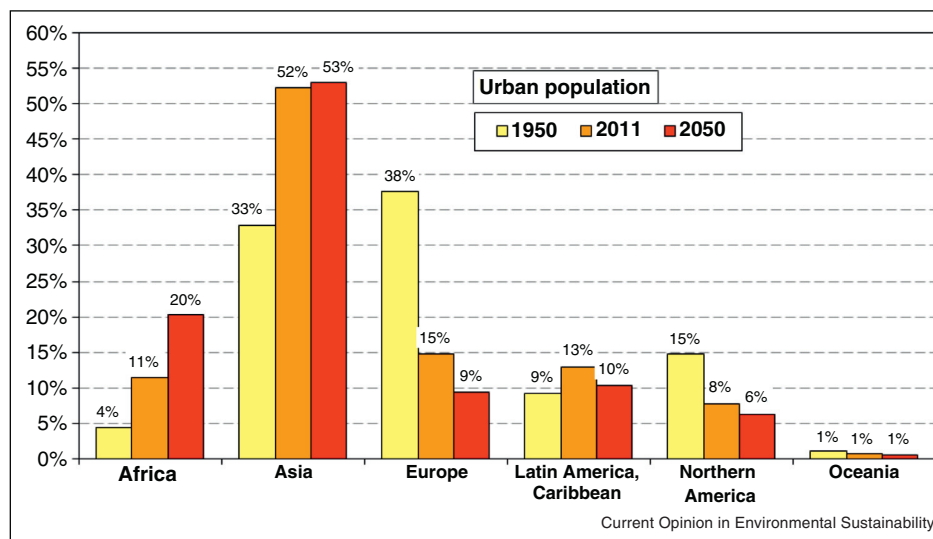
Asia contains a complex mosaic of social and ecological systems developed through a long history of human interaction with nature [7]. Many customary but large-scale systems of resource management, such as paddy-rice, agro-pastoralist and agro-forestry systems, have contributed to agro-biodiversity and maintained intensive food production, employment opportunities and community livelihood over long periods of time [8–10]. The combined effects of globalization and climate change, however, threaten ecosystem productivity throughout the region, undermining resource-based livelihoods and communities and exacerbating social inequity [11].

Asia is experiencing significant transformation of terrestrial and aquatic ecosystems [12]. Most extensively, forest disruption and conversion continues in developing countries, particularly those of the tropics [13], while some countries have experienced a ‘forest transition’ characterized by forest re-growth in the late 20th century [14,15]. Multiple scale and transnational analysis is required to determine the specificity of such trends and whether they reflect gross reduction or displacement of forest resource use and degradation to other countries or regions [16].

Over-extraction of surface and subsurface water sources and pollution, diversion and obstruction of waterways have significant negative impacts on ecosystems and human populations at local, regional and continental scales [17,18]. The Tibet-Qinghai Plateau and all the mountain ranges that surround it provide the highest (average elevation more than 4000 m above sea level) and most extensive highland in the world and contain the largest glacially stored fresh water (snow and ice) outside of the Arctic and the Antarctic [19]. Asian delta systems are often densely populated, intensively used and highly vulnerable to shifts or shocks originating upstream or in neighboring seas and oceans [20]. A grand challenge of sustainable water resources management is to secure the access to quality water necessary to meet basic human needs, such as health and sanitation, food production and renewable energy, taking account of the linkages between ecological change, land use, urbanization, industrial activities, and water systems [21].

<sup>a</sup> See also MAIRS: <http://www.mairs-essp.org/UserFiles/File/Brochure-new.pdf>.

Figure 1



Distribution of World's Urban Population: 1950, 2011, and 2050 (predicted).

Source: United Nations Department of Economic and Social Affairs/Population Division 5. World Urbanization Prospects: The 2011 Revision.

Asia exhibits three important trends related to urbanization: urban growth, especially through increasing migration to urban centers; the emergence of new urban centers; and the convergence of multiple cities into mega-urban regions [22]. Contemporary urbanization is therefore central to global economic and environmental change [23,24]. Coastal Asian cities are highly vulnerable to impacts of climate change, particularly those related to sea level rise [25], and decisions need to be taken now to promote their social and ecological resilience. The pursuit of low carbon cities and innovative industrialization is increasingly promoted as a strategy for achieving urban/domestic sustainability and addressing global climate change [26]. In addition to the rapid urbanization, remarkable increase of fertilizer use for enhancing food production in rural areas in east and south Asia, the heavy loading of nitrogen to the earth surface is very likely to change the global nitrogen cycle [27]. The extent to which such strategies put significant pressure on natural resources in other parts of the globe should also be considered.

In addition, Asia must improve its capacity for risk management of both natural and human-caused disasters, since the region exhibits high human vulnerability to extreme hydro-climatological and tectonic events (e.g. typhoons, heavy rains, floods and droughts, landslides, earthquakes, and tsunamis) [28,29]. Remarkable increase of frequency of extremely heavy rainfall in monsoon Asia has been reported in the past few decades [30–32], and the prediction by the IPCC state-of-the art climate models has concluded that this tendency would be enhanced further

by the global warming particularly in this region [33]. Disasters expose different dimensions of social-ecological vulnerability and therefore disaster risk reduction is an important field of sustainability research and action [34]. 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 [35].

Asia demonstrates great disparities of wealth and political power and accountability both within and between countries. Concerns for national development and security increase competition for control over key natural resources. Yet, large-scale foreign direct investment (FDI) and mega-development projects can disenfranchise local communities and increase disparities between nations [36]. Because social, political, and economic marginalization is often linked to environmental degradation, participatory decision making it an essential component of sustainability governance. There is a need for analysis of local, domestic, and international institutions, and of the structural conditions that perpetuate inequities as well as those that can enable positive social-ecological transformations [37].

Reducing poverty and inequity is thus also an intrinsic component of sustainability. At the same time, the negative ecological impact of current patterns of consumption is already evident in both local and distant environments. In this sense, traditional indicators of economic growth such as GDP are insufficient measures of development and are unable to describe key components of human

wellbeing and environmental sustainability [38]. Similarly, a 'green economy' strategy based principally on economic development and technological change will not address environmental risk and ecological scarcities [39]. New concepts such as 'inclusive wealth' that combine measures for ecological surety and social equity are necessary to develop a more comprehensive description of human wellbeing [40].

In the context of deeply embedded human ecologies, interlinked economies, and environmental changes that cascade through landscapes and biomes, reconciling local and regional viewpoints presents significant challenges, but also opportunities, to re-imagine environmental governance [41]. 'Panacea' sustainability policies should be avoided in favor of those emerging from participatory processes and closely tailored to crucial regional and subregional issues and contexts [42–44].

### Science in society: a new future-Asia network

In order to address the Asian challenge, sustainability science must overcome its emphasis on environmental science approaches and incorporate knowledge from the social sciences and humanities, enter into dialogue with other knowledge traditions, and direct studies to enhance human wellbeing and biodiversity and ecosystem services, paying special attention to the priorities of developing countries. In other words, the tight collaboration between GEC research community and SD research community is urgently required particularly in Asia, to achieve Asian sustainability goal.

There is an emerging research framework capable of coordinating multi-national research networks with sufficient depth and breadth necessary to address the Asian challenge. Now, the International Council for Science (ICSU), with an alliance of partners (including the International Social Science Council, Belmont Forum, UNESCO, UNEP, and UNU), has proposed a ten-year initiative to deliver solution-oriented research on global environmental change, following identification of five Grand Challenges in Earth System science for global sustainability [45]. The initiative, now called 'Future Earth — Research for global sustainability' [46], provides a single overarching structure for researchers, funders, service providers, and users, and integrates the existing Global Environmental Change (GEC) programmes.<sup>b</sup> The GEC programmes have provided foci for several extensive international and multi-disciplinary networks of researchers investigating key human–environmental

<sup>b</sup> Four major global environmental change programmes, all (co)sponsored by ICSU, operate in the planning and coordination of international global environmental change research: DIVERSITAS: An International Program on Biodiversity Science; International Geosphere-Biosphere Program (IGBP); International Human Dimensions Program on Global Environmental Change (IHDP); World Climate Research Program (WCRP).

dynamics. Future Earth would develop a new generation network building on these.<sup>c</sup> Future Earth proposes national and regional level committees, in addition to the regional nodes.

Currently, some international collaboration/coordination efforts have already been made in the GEC communities in Asia. The MAIRS under ESSP has promoted integrated regional GEC studies in some typical land-surface conditions (of mega-cities, dryland and mountain areas) of monsoon Asia. The Monsoon Asia Hydro-Atmospheric Study Initiative (MAHASRI) under the Global Energy and Water cycle Experiment (GEWEX) of WCRP has promoted studies on changes of regional hydro-climate and extreme weather regimes and their impact on natural disasters and water resources issues of monsoon Asia. The effort of regional climate change and its impact on agriculture, business, ecosystem and water resources in Asian region are being undertaken as part of the Coordinated Regional Climate Downscaling Experiment (CORDEX). DIVERSITAS in the Western Pacific and Asia (DIWPA) has promoted international network, cooperative studies and information exchange on biodiversity in the Western Pacific and Asia as part of DIVERSITAS. On the other hand, some inter-governmental efforts, for example, the East Asia low carbon growth partnership (MOFA), the Acid deposition monitoring network in East Asia (ENET), have been developed. There is a particularly strong need to integrate and/or coordinate these existing initiatives to establish a new consonant network throughout Asia, considering the complex and urgent issues mentioned above.

We propose that, following ICSU and its partners' lead, national science foundations, relevant government agencies, and multi-national actors and institutions in Asia should establish a Future-Asia network to play a key role for promoting Future Earth in Asia. The fundamental task of Future-Asia would be to increase research coordination and capacity necessary to address the specific regional dimensions of global environmental change in Asia described above. At a regional level, Future-Asia would lead the way in identifying and creating innovative funding needs and sources, as well as the appropriate institutional support mechanisms that will facilitate regionally-based integrated sustainability research to establish action agenda [45] for sustainable development in Asia. Accordingly, the network would promote (and facilitate coordination between) national-level committees for Future Earth and, importantly, also work to link the emerging Future Earth research network to innovative country-level research centers within the monsoon Asia and Australasia regions, as these centers are crucial bases for coordinated training, research, and policy initiatives.

<sup>c</sup> <http://www.icsu.org/future-earth/>.

The complexity of sustainability issues in Asia requires visionary political and scientific leadership and a high level of exchange and coordination between different epistemic communities in the region. This includes enhancement of research capacity in developing countries, especially through investment in the training of a new generation of developing world scientists who are able to develop in-depth disciplinary research while effectively contributing to problems requiring interdisciplinary and transdisciplinary approaches.<sup>d</sup> Leadership, capacity building and education for transformative change are the foundation of sustainability and require specific attention at local, national, and regional scales. Future-Asia should be a base platform for these interdisciplinary and transdisciplinary research networks, integrating new centers relevant to Future Earth and ongoing regional endeavors (e.g. The Asian-Pacific Network for global change research (APN)).

Given the scale and complexity of social-ecological systems in Asia and their unparalleled impact on the whole earth system, designing sustainable interactions between humanity and nature in Asia represents a major step towards the goal of Future Earth, that is, global sustainability itself. Future-Asia should play a significant role in providing the research framework to make such a transformation possible.

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