

# Global Land Project Sapporo Nodal Office Addressing Land System Studies on Resilience, Sustainability and Vulnerability in Asia

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## Abstract

This article introduces a brief history, the objectives and structure of the Global Land Project (GLP), a joint core project for facilitating land change sciences under the International Geosphere-Biosphere Programme (IGBP) and International Human Dimension Programme (IHDP). The major activities of the GLP Sapporo Nodal Office, one of the four nodal offices worldwide, are also introduced. The article goes on to characterize land system studies on Asia and Asian countries/areas, viewing them through temporal trends in published academic articles. The results suggest that more studies on issues related to resilience and ecosystem services may be needed in Asia and Asian countries/areas. Finally, the future roles and prospects of land science in Asia are discussed.

**Key words:** Asia, Future Earth, Global Land Project (GLP), land system science, resilience, sustainability, vulnerability

## 1. Introduction

The earth supports more than seven billion people today. The world's historical populations have been estimated by various researchers. Kremer (2014), for example, estimated the world's population from 1,000,000 B.C. to 1990. His list suggests that the population in 1,000,000 B.C. was about 0.125 million, increasing to about 1 million in 300,000 B.C., 100 million in 500 B.C., 425 million in 1500 A.D., 1,625 million in 1900 A.D., and 5,333 million in 1990 A.D. Grigg (1974) estimated the number to be 5–10 million in 8,000 B.C. and about 500 million in 1600 A.D. Although differing estimates are available, they all suggest a rapid increase in the world's population. Today, about 60% (4.3 billion) of the world's population (> seven billion) resides in Asia (Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, 2013).

Human beings have expanded their territories from the beginning, with notable land development occurring under the relatively mild climatic environment of the

Holocene. The beginning of agriculture roughly corresponds to the beginning of the Holocene. In Asia, rice cultivation started in an area along the middle reaches of the Yangtze River, China more than 10,000 years ago (Yasuda, 2002). Since then, human activities have impacted more of the earth's surface, by changing land use toward agriculture. In this regard, it is important to understand changes in land use/land cover as well as their impacts on environments in Asia, which has 60% of world's population.

Historical changes in cropland and pastureland at a global scale during the last 300 years were estimated on the basis of population data by Goldewijk (2001) and Goldewijk and Ramankutty (2004), indicating great contributions of human beings to land-use changes globally, although the expansion of population, cropland and pastureland is only part of the scope of land system science.

Due to accelerated development, many mega-cities (population>1 million) have appeared in Asia, including Tokyo, Guangzhou, Jakarta, Shanghai, Seoul, Delhi,

Karachi, Manila and Taipei. Ramankutty *et al.* (2002) suggested that the greatest cropland expansion during the 20th century occurred in South and Southeast Asia. According to Lambin *et al.* (2003), about one-third (33%) of the world's pastureland is located in Asia. These figures indicate the importance of Asian land science. Population growth has not been accompanied by a corresponding increase in cropland expansion, partly because increases in food production have been achieved by agricultural intensification and partly because cropland expansion has not always occurred in the regions with the highest population growth (Brammoh & Vlek, 2008).

The growing population has naturally influenced the climate, ecosystem functions and geochemical cycles of land, as has been addressed by the International Geosphere-Biosphere Programme (IGBP) and International Human Dimension Programme (IHDP). Human beings have induced substantial land-use changes (Reenberg, 2006). Half of the Earth's land surface has been converted to direct human use, and most of the rest is managed for human purposes (GLP, 2005). Nearly 40% of the ice-free land surface of the globe, all of which had previously been covered with natural vegetation, is used for agricultural activities (Ramankutty *et al.*, 2008; Ellis *et al.*, 2010). Getting a grasp of the land system, which is the terrestrial component of the earth system, is central to understanding the relationship between people and their environment (Reenberg, 2006). The Global Land Project (GLP), a joint core project for studying land systems under the IGBP and IHDP, was launched in 2006, based on two preceding core projects, Global Change and Terrestrial Ecosystems (GCTE; 1992–2003) and Land Use and Cover Change (LUCC; 1994–2005). The GCTE focused on the response and feedback of land-ecosystem functions to climatic environmental change, mainly based on ecological science, whereas the LUCC focused on the dynamics of terrestrial landscapes in response to human land use, based mainly on geography and land-use science. The GLP was set up based on the legacy of these, recognizing the necessity for an integrated science, which would investigate how human activities on land affect feedback to the earth system and the response of the human-environment system to global change (GLP, 2005). The International Project Office (IPO) of the GLP, together with the four nodal offices, addresses land system sciences under changing global environments (<http://www.globallandproject.org/>). Each nodal office has its own focuses and tasks in dealing with land system studies associated with the GLP, as will be described later.

This article introduces the GLP Sapporo Nodal Office's way of addressing land system studies on resilience, sustainability and vulnerability in Asia. The GLP Sapporo Nodal Office does not serve to promote land science in Asia alone; but Asia, with a large portion of the world's population and food production, is one of the most important regions regarding global sustainability in the future. Accordingly, understanding state-of-art stud-

ies in Asia will provide a basis for synthesizing global issues.

## 2. Roles and Significance of the GLP

### 2.1 History and objectives of the GLP

The GCTE and LUCC, both of which were IGBP core projects, were launched in 1992 and 1994, and terminated in 2003 and 2005, respectively. While the GCTE addressed the main questions of how global change would affect terrestrial ecosystems, and what the feedbacks to the physical climate system would be, the LUCC aimed to obtain a better understanding of land-use and land-cover changes, such as degradation, desertification and biodiversity loss, and of the physical and human driving forces behind these processes (Turner *et al.*, 1990). The research planning of the GLP was built not only on the extensive heritage of the IGBP's global networks of scientists, data and largely disciplinary understanding, but also on the GCTE and LUCC projects.

The GLP science plan and implementation strategy was published by the GLP transition team, which took over from the former GCTE and LUCC programs, in the context of land system science (GLP, 2005). The overall goal of the GLP is to measure, model and understand the coupled human-environment system under a changing environment. The GLP has three objectives to its research framework: (1) to identify the agents, structures and nature of change in coupled human-environment systems on land, and to quantify their effects on the coupled system; (2) to assess how the provision of ecosystem services is affected by the changes in (1) above; and (3) to identify the character and dynamics of vulnerable and sustainable coupled human-environment systems to interacting perturbations, including climate change (GLP, 2005). The GLP has three major focal topics: (1) dynamics of land system change; (2) consequences of land system change; and (3) integrating analyses and modelling for land sustainability. The GLP was designed to facilitate those kinds of research through various activities such as promoting academic publications, organizing scientific meetings and workshops, networking among scientists and existing research programs/networks, and providing educational programs, tools and materials.

Human Interactions in Past Environmental Changes (PAGES), a core IGBP project, focuses on longer-term issues; Human Impacts on Terrestrial Ecosystems (HITE), one of the focuses of PAGES, for example, concentrates on man-made land-cover conversions over the last 300 years (Goldewijk, 2001). On the other hand, the GLP's main initial interests have been on shorter-term issues with some interests spanning 2–3 centuries, although its current coverage seems to become much longer: *e.g.*, one recent GLP study, Ellis *et al.* (2013), synthesized long-term global land changes starting more than 3,000 years ago, and the demarcation line between the GLP and some of the other projects/focuses might be minimal.

## 2.2 Structure of the GLP

There are four GLP nodal offices worldwide: Sapporo, Beijing, Taipei and Europe (Table 1). The former three offices are based at single organizations (Hokkaido University, the Institute of Geographic Sciences and Natural Resources of the Chinese Academy of Science, and National Taiwan University), while the European GLP Nodal Office is based at a partner platform, the European Land Use Institute (ELI), which is coordinated at and currently hosted by the Center for Development Research (ZEF), University of Bonn. As mentioned earlier, these four nodal offices assist the GLP's IPO, which had been housed at the University of Copenhagen from 2006 to 2011, and which is currently hosted by the National Institute for Space Research (Instituto Nacional de Pesquisas Espaciais: INPE) in Brazil. The IPO performs the central coordinative, organizational and communicative functions of the GLP. The UK previously had a nodal office in Aberdeen which focused on integration and modelling (Stannard & Aspinall, 2011). Unfortunately, the office was closed in 2011 after a major restructuring of the host institution.

Not only the IPO but also the four GLP Nodal offices are strongly tied with the GLP Scientific Steering Committee (SSC), which is composed of about 20 experts internationally. All GLP Nodal offices regularly report on their annual activities at the SSC meeting.

Each nodal office provides infrastructural, personnel and scientific input and support in the process of implementing the GLP Science Plan. The Sapporo Nodal Office (<http://www.glp.hokudai.ac.jp/jp/>), established in November 2006, has thematic focuses of resilience, sustainability and vulnerability of land systems (Table 1). Vulnerability of coupled human-environment systems is a major element of sustainability research. Vulnerability not only results from exposure to biophysical and social perturbations, but also resides in the sensitivity and adaptive capacity of the system experiencing such stresses. Thus, the overall goal of the Sapporo Nodal Office is to improve understanding of the causal processes of vulnerability, the quality of coping capacities linked to different perturbations, and the role of governance in bolstering resilience (Watanabe & Ishihara, 2012).

**Table 1** Thematic focus of the GLP Nodal offices worldwide (as of 2014).

	Sapporo	Beijing	Taipei	Europe
Established year	2006	2007	2012	2012
Office location	Hokkaido Univ., Sapporo, Japan	Chinese Academy of Science, Beijing, China	National Taiwan Univ., Taipei, Taiwan	European Land-use Institute (ELI) Center for Development Research (ZEF), Univ. of Bonn, Germany
Thematic focus	Vulnerability, resilience, and sustainability of land systems	Land use and ecosystem interactions	Nature of social-ecological linkages and their implications for the resilience of land systems at various scales	Land management, land use planning and land use policies
URL	<a href="http://www.glp.hokudai.ac.jp">http://www.glp.hokudai.ac.jp</a>	<a href="http://www.glp-beijing.org.cn/">http://www.glp-beijing.org.cn/</a>	<a href="http://www.glp-taipei.ntu.edu.tw/">http://www.glp-taipei.ntu.edu.tw/</a>	<a href="http://european-nodaloffice.eli-web.com/">http://european-nodaloffice.eli-web.com/</a>

## 2.3 Major activities of the GLP Sapporo Nodal Office

To fulfill its overall goal, the GLP Sapporo Nodal Office has organized/co-organized symposiums, conferences and workshops, which include the International Workshop 'Life history regulation of forest trees: towards cross-biome analysis,' held in Sapporo, September 2-3, 2011; the Annual Meeting of the International Long-Term Ecological Research (ILTER), in Sapporo, September 5-9, 2011; the GLP Open Workshop 'Vulnerability, Resilience and Sustainability of Asian Land Systems,' in Sapporo, November 5, 2011; the Public Forum 'Glacier Changes and Disaster: Himalayan Perspectives on Global Warming,' in Sapporo, November 6, 2011; and the International Symposium 'Changing Mountain Environments in Asia: Vulnerability, resilience and sustainability of land system in Asian mountains,' in Kathmandu, October 7-11, 2012. The nodal office also has contributed to events organized by other nodal offices, such as one organized by the Taipei Nodal Office, the 'GLP Asia Conference 2014,' in Taipei, September 24-26, 2014, to which it contributed as a co-organizer.

The Sapporo Nodal Office has also organized international summer/winter schools to foster education on land system sciences for the younger generation of university students (from undergraduate to PhD) and post-doctoral fellows. The International Summer School 2011 'Understanding coupled natural and social systems: Feedback loops between land-use and ecosystem change' was held from June 27 to July 8, with 18 PhD students from 13 countries. The International Summer School 2012 was held from June 25 to July 3, and the International Winter School 2014 'Changing land systems: Training course of ecological monitoring, advanced modeling and integration' was held from January 8 to 10 with 26 students and 12 faculty members. These summer/winter schools provided opportunities for students to learn about field research and the analytical methods of land system sciences and environmental science. One of the outcomes from these activities led to the publication of a report on the sustainable development of Samani Town in Hokkaido, Japan, by the graduate students participating in one of the summer/winter schools (Dublin *et al.*, 2013).

Publication of books and reports is another effort (*e.g.*, Braimoh & Huang, 2014). The nodal office launched a new online newsletter in March 2014 ([http://www.glp.hokudai.ac.jp/uploads\\_en/Newsletter1Eng.pdf](http://www.glp.hokudai.ac.jp/uploads_en/Newsletter1Eng.pdf)), which introduces the latest research related to the nodal office (Shiodera *et al.*, 2014).

## 3. Asian Land System Studies

### 3.1 Asian land system studies

To understand the state of land system studies, especially in Asia, trends in the numbers of articles on land science focusing on resilience, sustainability, vulnerability and ecosystem services were examined using the Web of Science search service (accessed on October 28, 2014;

Fig. 1). Three of these themes (resilience, sustainability and vulnerability) are the focuses of the Sapporo Nodal Office (Table 1), and ecosystem services is the most important additional focus of the nodal office. A search was performed among articles published in journals for the following combinations of words in their titles, key words or abstract:

1. ('land' OR 'terrestrial') AND ('Asia' OR the names of Asian countries/areas) AND 'resilience,'
2. ('land' OR 'terrestrial') AND ('Asia' OR the names of Asian countries/areas) AND 'sustainability,'
3. ('land' OR 'terrestrial') AND ('Asia' OR the names of Asian countries/areas) AND 'vulnerability,' and
4. ('land' OR 'terrestrial') AND ('Asia' OR the names of Asian countries/areas) AND ('ecosystem service' OR 'ecosystem services').

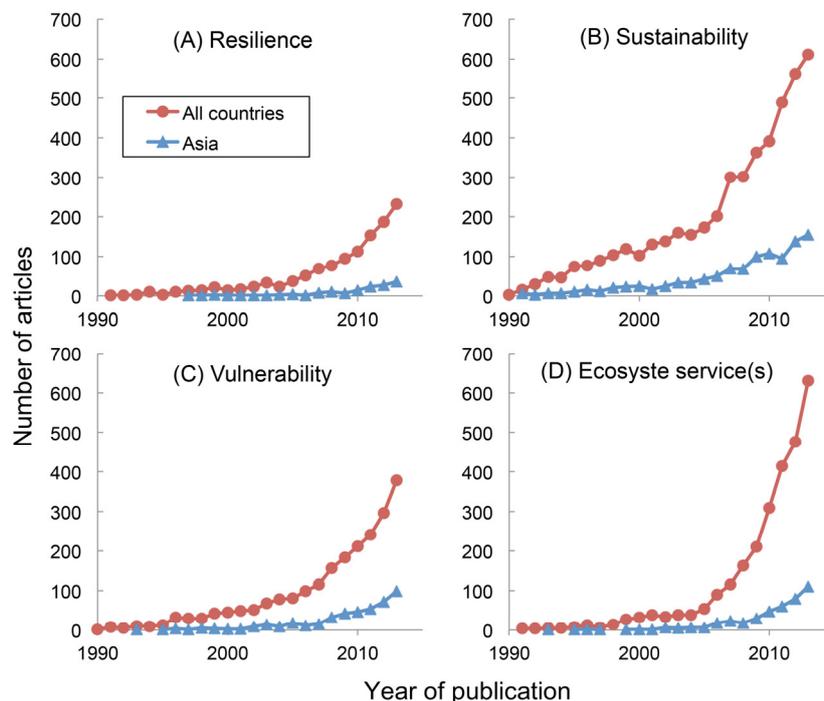
We followed UN classification to identify countries/areas in Asia, so the examined countries/areas included those in West Asia but excluded Russia. In addition, we also searched for articles by excluding "(('Asia' OR the names of Asian countries/areas))" to find land science articles on all countries/areas, regions, and the globe including Asia. Land science covers coastal areas/regions, but the retrieved data observed only small numbers of articles on these areas/regions, so the actual number of land science articles is even larger than that presented here.

We found a total of 10,862 articles on all countries/

areas, regions, and globe published in 1,531 journals of different disciplines spanning scales from local and landscape to global, and covering fields from natural sciences to social sciences. Table 2 summarizes the top 30 journals. The articles focusing on resilience, sustainability or ecosystem services tended to be published more in journals such as *Ecological Economics*, *Agriculture Ecosystems Environment*, *Ecology and Society*, *Environmental Management*, and *Landscape and Urban Planning*, while the articles focusing on vulnerability tended to be published more in different journals whose thematic focus was on natural hazards or global environmental change. Even *Ecological Economics*, the journal with the largest share, published only 2.1% of the total number of articles. These results suggest that land science covers diversified disciplines.

Figure 1 shows the number of land science articles on resilience, sustainability, vulnerability and ecosystem services in all countries and in Asia and Asian countries/areas. It is clear that the number of articles published each year has increased. This increase has accelerated since the middle of the 2000s, especially in articles focusing on ecosystem services (Fig. 1-D). This may be due to the Millennium Ecosystem Assessment conducted from 2001 to 2005. In 2013, the number of articles on ecosystem services exceeded 600.

More articles on sustainability have been published than on the other thematic focuses until 2012 (Fig. 1-B).



**Fig. 1** The number of the published land science articles on Asia and on all countries/areas, regions and the globe including Asia.

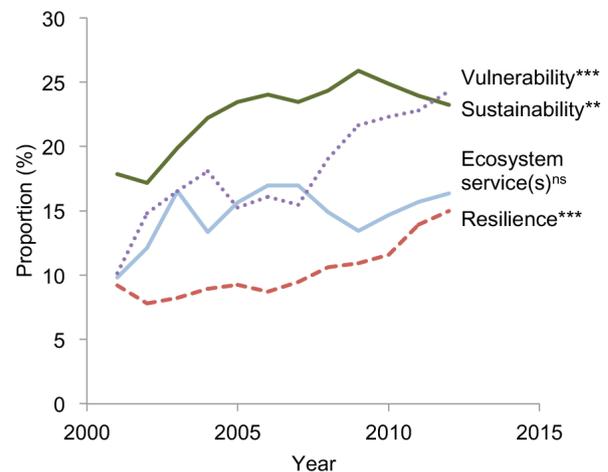
A search was executed to find numbers of the articles by applying the following words as search parameters among titles, key words and abstracts of articles published by 2013, using the Web of Science search service:

- A: ('land' OR 'terrestrial') AND 'resilience',  
 B: ('land' OR 'terrestrial') AND 'sustainability',  
 C: ('land' OR 'terrestrial') AND 'vulnerability',  
 D: ('land' OR 'terrestrial') AND 'ecosystem service(s)'.

For land science articles on Asia, ('Asia' OR 'the names of Asian countries/areas') was added to the search parameters. Asian countries/area are based on the UN classification.

The number jumped from about 200 in 2006 to about 300 in 2007. This increase was not due to the publication of special issues in any journals. The annual publication continuously increased reaching more than 600 in 2013. Three journals, *Ecology and Society*, *Forest Ecology and Management*, and *PLOS ONE* tended to carry more articles on resilience (Table 2). The number of articles on sustainability in Asia and Asian countries/areas was also larger than that of articles on other thematic focuses. On the other hand, there have been fewer articles on resilience compared to those on the other thematic focuses since the early 2000s both globally and for Asia (Fig. 1-A).

The proportion of published land science articles on Asia to those on all countries/areas, regions or the globe increased during 2001 and 2012 (Fig. 2), suggesting increased interest in land science in Asia. The exception was articles on ecosystem services. The proportion of Asian papers that focused on ecosystem services did not increase during this period. This result coincides with a



**Fig. 2** Proportion of published land science articles on Asia or Asian countries/areas among those on all countries/areas, regions and the globe.

The articles were searched for using the Web of Science. \*\*\*  $P < 0.001$ , \*\*  $P < 0.005$ , ns: not significant by the linear regression of the moving average of the proportion (three years) to the published year.

**Table 2** Top 30 journals that have carried land science articles as of 2013.

Rank	Journal	Number of published articles*				Total
		Resilience	Sustainability	Vulnerability	Ecosystem services	
1	<i>Ecological Economics</i>	15	109	12	95	231
2	<i>Agriculture Ecosystems Environment</i>	17	124	23	64	228
3	<i>Ecology and Society</i>	61	47	15	66	189
4	<i>Environmental Management</i>	14	66	29	62	171
5	<i>Landscape and Urban Planning</i>	19	58	22	67	166
6	<i>Land Use Policy</i>	13	92	8	51	164
7	<i>Journal of Environmental Management</i>	4	76	25	58	163
8	<i>Forest Ecology and Management</i>	24	65	19	54	162
9	<i>Biological Conservation</i>	15	31	42	52	140
10	<i>Proceedings of the National Academy of Sciences of the United States of America</i>	16	33	21	52	122
11	<i>Ecological Indicators</i>	6	45	12	52	115
12	<i>Ecological Applications</i>	8	28	17	60	113
13	<i>PLOS ONE</i>	22	16	21	45	104
14	<i>Global Environmental Change Human and Policy Dimensions</i>	20	25	32	19	96
15	<i>Land Degradation Development</i>	10	54	13	14	91
16	<i>Landscape Ecology</i>	11	33	12	34	90
17	<i>Environmental Monitoring and Assessment</i>	3	25	38	23	89
18	<i>Journal of Applied Ecology</i>	13	17	8	50	88
19	<i>Conservation Biology</i>	8	19	21	32	80
20	<i>International Journal of Sustainable Development and World Ecology</i>	4	56	8	12	80
21	<i>Agricultural Systems</i>	3	63	4	8	78
22	<i>Ecological Modelling</i>	17	29	8	24	78
23	<i>Climatic Change</i>	14	7	46	10	77
24	<i>Global Change Biology</i>	16	14	20	24	74
25	<i>Biodiversity and Conservation</i>	11	13	21	28	73
26	<i>Natural Hazards</i>	7	2	59	3	71
27	<i>Agroforestry Systems</i>	5	49	1	14	69
28	<i>Applied Geography</i>	7	19	24	18	68
29	<i>Journal of Sustainable Agriculture</i>	3	58	1	4	66
30	<i>Biomass Bioenergy</i>	2	59	2	3	66
	Total	388	1,332	584	1,098	3,402

\*: The number of published articles with the following words in either the title, key words or abstract in journals in the Web of Science search service: (land or terrestrial) and (Asia or country names in Asia) and (resilience or sustainability or vulnerability or ecosystem service).

review paper by Schägner *et al.* (2013), who showed that there were few case studies of ecosystem service mapping in Asia if China was excluded. Another notable trend in Asian land science is that resilience is less focused on than sustainability or vulnerability. As of the average of 2011–2013, the proportion of articles on sustainability or vulnerability in Asia and Asian countries/areas exceeds 25%, while that of articles on resilience or ecosystem services reaches about 15% (Fig. 2). Therefore, resilience and ecosystem services may need to be studied more in the GLP's Asian framework.

### 3.2 The GLP's endorsed research and endorsed networks

The GLP has five endorsement criteria, by which individuals, groups and institutions are encouraged to participate in GLP-related studies and communities: (1) research projects, (2) PhD projects, (3) research networks, (4) research institutions and (5) events. Research projects and research networks are briefly examined below.

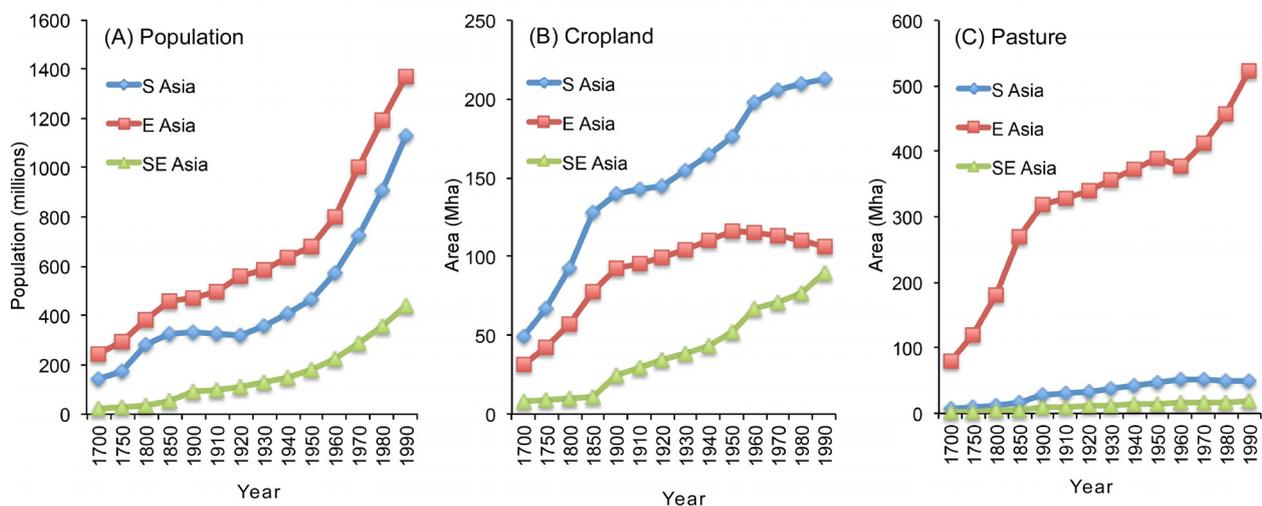
Endorsed research projects are those of special relevance to the land science community and addressing the GLP research challenges outlined in the GLP Science Plan (GLP, 2005). More than 50 endorsed research projects are listed on the GLP website. Among the projects, many consider global issues, which include the Asian region, and at least 18 projects target Asian countries/areas.

Endorsed networks are research networks related to the land science community. Twelve endorsed networks are currently listed on the GLP's website. These endorsed networks do not aim for Asia, but are global networks: nevertheless, many activities are performed in Asia. For example, the ILTER network is one of the GLP's endorsed networks, focusing on site-based long-term socio-ecological research (Vihervaara *et al.*, 2013). The research groups in ILTER recently synthesized current understandings and future research needs in the context of nitrogen biogeochemistry in coupled human and ecological systems under climate change (Shibata *et al.*, 2014).

## 4. Future Roles/Perspectives of Land Science in Asia: the GLP as a Future Earth Joint Project in the Next 10 Years

As there has been rapid population growth and expansion of cropland and pastureland in South, South-east and East Asia since 1700 (Fig. 3), it is expected that Asia will continue to have rapid increases in population and food production, structural changes in its economy and vast land-use changes during coming decades (*e.g.*, Ellis *et al.*, 2010). This suggests GLP research is important and valuable for the Asian region not only to obtain regional findings but also to contribute scientifically to regional and global governance to achieve future sustainability. A large spatial gradient and heterogeneity of natural and social changes are also unique characteristics of Asian land systems, providing useful case-study areas for examining how those drivers alter the functions and services of coupled social and ecological systems. For example, Japan will face aging and shrinking of its population during the coming couple of decades, suggesting that those societal changes will alter the country's land-use patterns including human residence, which may affect ecosystem services and other environmental parameters in the future. Understanding and predicting those socio-environmental dynamics would contribute not only regarding Asian regional aspects, but also regarding other regions, where similar problems will arise in the near future. Thus, the GLP's Asian research can produce good examples for implementing dynamic land system science under changing natural and anthropogenic perturbations (GLP, 2005). More integration and collaboration will be necessary to make those research programs feasible.

The Millennium Ecosystem Assessment (2005) takes the view that sustainable provision of goods and services depends critically on managing land resources without damaging the natural resource base. Our understanding of land systems has been deepened in the last few decades (Reenberg, 2006; Rounsevell *et al.*, 2012). The future of land system science, however, strongly depends



**Fig. 3** Historical estimates of population (A), cropland (B), and pasturage (C) from 1700 to 1990 (data compiled from Goldewijk, 2001). The population is given in millions, and cropland and pasturage are in Mha. This is a product of one of the GLP's endorsed research projects.

on the research community's capacity (Rounsevell *et al.*, 2012). Further efforts under an international research framework are important, and the GLP should be one of the research communities taking the lead.

The GLP is now going to transit to a new program – Future Earth<sup>1)</sup>, a research platform on global sustainability (<http://www.icsu.org/future-earth>). Future Earth, funded by the International Council for Science (ICSU), is a global joint research program with transdisciplinary approaches for creating scientific knowledge and solutions for sustainable societies and environments by following the previous global environmental programs and partnerships (*i.e.*, Earth System Science Partnership: ESSP, IGBP, IHDP, World Climate Research Programme: WCRP and DIVERSITAS). The overall research framework and direction of Future Earth and the GLP are strongly linked and largely overlap with each other in the context of sustainability research in coupled natural and human systems, meaning that the GLP has a great potential to lead Future Earth and contribute to it through the GLP's endorsed projects, various academic publications, meetings and educational programs. The Asian region, in particular, as one of the most dynamic, intensely active regions regarding land systems, will be an exciting and important research arena for understanding regional and global resilience, sustainability and vulnerability, which are central focal topics of the GLP Sapporo Nodal Office.

## 5. Conclusions

The GPL, a joint core project to facilitate land change sciences under the IGBP and IHDP, promotes academic publications, organizes scientific meetings and workshops, scientist networks and existing research programs, and provides educational programs, tools and materials.

Since 2006, the GLP Sapporo Nodal Office, one of the four nodal offices worldwide, has organized/co-organized international symposiums, conferences and workshops; organized international summer and winter schools; and published books, reports and an online newsletter.

Among these activities, the international summer and winter schools for younger generations provide an important base for educational tools.

The Sapporo Nodal Office does not address regional issues of Asia, but thematic issues worldwide, with resilience, sustainability and vulnerability as its three key thematic words. Nevertheless, Asian issues are among its major concerns, not because of its geographical location but because of the importance of the explosive growth of population and land-use/land-cover changes.

To understand the state of land system studies, especially in Asia, the number of articles on land science that focused on the three thematic topics (resilience, sustainability and vulnerability), together with ecosystem services, an additional key focus, was examined using the Web of Science search service. In total 10,862 articles were identified in 1,531 journals. The number of pub-

lished articles on the four thematic topics has increased at all spatial levels especially since around 2000. Among these published articles, resilience has been focused on less often than vulnerability or sustainability in Asia. Studies on ecosystem services have been rather limited in Asia. Therefore, resilience and ecosystem services may need to be studied more in Asian land science.

The GLP is in a transitional phase to a new program, Future Earth. The GLP has great potential to lead Future Earth and contribute to it through the GLP's endorsed projects, various academic publications, meetings and educational programs, because of the strong links and large overlaps of the overall research framework and directions of Future Earth and the GLP. The Asian region, one of the most dynamic, intensely active regions for land systems, will be an exciting and important research arena for understanding regional and global resilience, sustainability and vulnerability, which are central focal topics of the GLP Sapporo Nodal Office.

## Note

<sup>1)</sup> Future Earth is a global research platform providing knowledge and support to accelerate our transformation to a sustainable world ([www://futureearth.org](http://www.futureearth.org)). Being tied with existing programs on global environmental change such as the IGBP, IHDP and WCRP, Future Earth will be an international hub to coordinate new interdisciplinary approaches to research on three themes: dynamic planet, global sustainable development, and transformations towards sustainability. It will also be a platform for international engagement to ensure that knowledge is generated in partnership with society and users of science. It is open to scientists of all disciplines, natural and social, as well as engineering, the humanities and law.

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#### Postscript

After acceptance of the manuscript, two more nodal offices joined the GLP: Latin American Nodal Office in Argentina and West Africa Nodal Office in Côte d'Ivoire.



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