The Asian Greenbelt –a possible tipping element for Future Earth

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The monsoon Asia has a unique and rich biosphere with great diversity continuously from the tropics to boreal region, forming so-called “the Asian Greenbelt”. The AG is rich in biodiversity: This AG region has had guaranteed many examples of long-term social and ecological sustainability where many traditional systems of agriculture and livelihood have supported large numbers of people through time. Asia is characterized by a complex mosaic of social and ecological diversity developed through a long history of human interaction with nature. The Asian monsoon climate system underpins the ecosystem services on which the livelihoods and wellbeing of billions of people depend. However, ecosystems in the AG are undergoing rapid and sometimes irreversible changes as a result of human activities. As a consequence, their biodiversity resources are under threat and their ability to provide livelihoods to hundreds of millions of people in the future are at risk. In addition, the recent climate model studies have also suggested that the Asian Greenbelt (AG)plays an active role in the monsoon climate, by controlling the energy, water and material cycle through vegetated land surface cover. In other words, the AG and the Asian monsoon climate has been manifested as an interactive system. destructive change of the AG is very likely to cause drastic change of the monsoon climate, which, in turn, will affect biodiversity and human activity of this region. I emphasize here that this AG issue as an important and crucial tipping point element not only for future Asia, but for the Future Earth itself.

キーワード：アジアグリーンベルト、アジアモンスーン、ティッピングポイント、フューチャーアース、人間活動の影響
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Northern Eurasia Future Initiative (NEFI): Nine Science Foci of Research

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Northern Eurasia Future Initiative (**NEFI**) has emerged as an essential continuation of the Northern Eurasia Earth Science Partnership Initiative (**NEESPI**) –an interdisciplinary program of internationally-supported Earth systems and science research –that has addressed large-scale and long-term manifestations of climate and environmental changes over Northern Eurasia and their impact on the Global Earth system. Full-size (i.e. after release of internationally peer-reviewed Science Plan and launching of first individual projects) NEESPI was established in 2004 with its objectives covering the following decade. Since that time, we observed dramatic environmental changes over the continent, some of which strongly affected the human wellbeing and raising the new set of science questions. Shortly speaking, the questions “what is going on?” have been gradually appended by the questions “what to do?”. In some parts of Northern Eurasia (e.g., in the densely populated drylands of the interior of the continent), these “what to do” questions moved to the forefront. Therefore, when two years ago the NEFI researchers formulated the next generation of research objectives they narrow these objectives to nine research foci. These foci (listed in no specific order) are:

♦Global change, particularly the warming of the Arctic;
♦Increasing frequency and intensity of extremes (e.g., intense rains, floods, droughts, wildfires) and changes in the spatial and temporal distributions of inclement weather conditions (e.g., heavy wet snowfalls, freezing rains, untimely thaws and peak streamflows);
♦Retreat of the cryosphere (snow cover, sea ice, glaciers, and permafrost);
♦Changes in the terrestrial water cycle (quantity and quality of water supply available for societal needs);
♦Changes in the biosphere (e.g., ecosystem shifts, changes in the carbon cycle, phenology, land-cover degradation and dust storms);
♦Pressures on agriculture and pastoral production (growing supply and demand, changes in land use, water available for irrigation, and food-energy-water security);
♦Changes in infrastructure (roads, new routes, construction codes, coping with permafrost thawing, air, water, and soil pollution, and strategic planning);
♦Societal adaptations and actions to mitigate the negative consequences of the environmental change and to benefit from the positive consequences; and
♦Quantification of the role of Northern Eurasia in the global Earth and socioeconomic systems to advance research tools with an emphasis on observations and models.

This presentation will briefly describe these foci and justify our selections. Socio-economic research challenges are the top priority for several of these foci. These challenges have not been overlooked in the past but have not been addressed satisfactorily NEESPI domain-wide, nor indeed globally. The introduction of the Future Earth research objectives is a response to this gap and the NEFI is designed to

contribute regionally to the objectives.

Keywords: Northern Eurasia, environmental change, Societal adaptations and actions to mitigate the negative consequences of the environmental change and to benefit from the positive consequences, NEFI Science Plan

Water-energy-food nexus and security for sustainability

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Water-energy-food nexus and security in Asia-Pacific region is analyzed based on national scale in terms of self-sufficiency and diversity of resources use. Energy footprints as energy consumptions for water transports/productions and energy consumptions for food productions are also analyzed as nexus, as well as food consumptions for energy production in Asia-Pacific region. Water footprints are mainly calculated for only water consumptions for food productions, however another water footprints as water consumptions for energy productions are also analyzed as nexus in the Asia Pacific region. Among the various water-energy-food nexus, different type of nexus exist such as tradeoff, interaction, and synergy, depending on the change in quantity and quality of resources, with difference of environment impacts. Top-down indices (e.g. water/energy footprints) should meet bottom-up local context (value, culture etc.) to make sense and be applicable for sustainability.

キーワード：水・エネルギー・食料ネクサス、安全保障、持続可能性
Keywords: water-energy-food nexus, security, sustainability

Future Earth and SIMSEA: A Case Study in Sukumo Bay, Japan

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Marginal seas in South and East Asia have one of the highest marine biodiversity in the world oceans. However, marine environment in the marginal seas has recently become at risk under increasing pressure from surrounding countries. Since little efforts had been made to addressing marine environmental issues based on scientific finding, ICSU/RCAP launched international research alliance, called “Sustainability Initiative in the Marginal Seas of South and East Asia (SIMSEA)”, contributing to Future Earth program as one of its regional activities in Asia. Under the SIMSEA framework, we established international research network among natural and social scientists involving marine environmental researches, and exchanged research outcomes and ideas to prioritize research targets in the marginal seas. For example, the island countries like Philippines claim necessity of integrated coastal management for sea level rise and tidal surge associated with climate variation and change, whereas the countries like Indonesia, which highly depend on fishery activity, stress importance of sustainable ocean monitoring for ocean warming and acidification due to human-induced CO2 increase.
In Japan, we conducted one case study on the integrated coastal management by co-working with local stakeholders. As one of the highest marine biodiversity areas, Sukumo Bay in Kochi Prefecture was selected, because it has experienced steady ocean degradation due to frequent occurrence of red tide and accelerating loss of seagrass. Under these circumstances, local stakeholders and researchers performed ocean health check-up and have been monitoring ocean condition. Also, local fishery cooperative and JAMSTEC co-developed ocean forecast system called SUKUMO500, in which high-resolution (200 m) ocean temperature and current information are provided every one hour via JAMSTEC website. The forecast information was experimentally used not only by local fishermen, but by coastal guard officials during emergency removal of ship oil from a small cargo ship sank near Sukumo Bay. In exchange of the forecast information, local stakeholders provide local observation data on regular basis to validate the ocean forecast. Through this mutual interaction between local stakeholders and researchers, the integrated coastal management is now developing and will contribute to advancing the SIMSEA activity and hence the Future Earth program.

キーワード：SIMSEA、沿岸域総合管理、宿毛湾
Keywords: SIMSEA, Integrated Coastal Management, Sukumo Bay

モンゴル草原におけるCO2吸収量を改善するための適応策
Adaptation strategies for improving the CO2 sequestration in Mongolia's grasslands

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The rapid increase of energy consumption caused the sharp increase of CO2 emission during last decades in Mongolia. However, changes to a warmer and drier climate resulted in a degradation of permafrost, a severity of water deficit or drought, and finally led a decrease in both biomass productivity and its carrying capacity, which finally caused a decrease of CO2 sequestration by terrestrial ecosystems in Mongolia. In order to reduce the CO2 emission or improve the CO2 sequestration by terrestrial ecosystems, several adaptation strategies and techniques were proposed to the decision-makers as follows:

To reduce livestock numbers in accordance with local grassland carrying capacity

Our previous research showed that aggregate herds caused overgrazing in the central Mongolia, especially surrounding Ulaanbaatar City. It is unlikely that herders will spontaneously reduce their herd sizes, without adequate direct or indirect compensation. Irrigated grassland is not a suitable option for herders and breaking open grassland to sow pasture is officially discouraged for environmental vulnerability. Reseeding of degraded land may be possible, but need long term. In this study, we proposed to educate herds to reduce livestock numbers in accordance with local grassland carrying capacity, which was evaluated precisely in a high temporal and spatial resolution.

To promote sustainable grassland management and adaptation ability for climate change

Grassland management practices that sequester carbon tend to make systems more resilient to climate variation and climate change, thus, we proposed: 1) to promote sustainable rangeland management through the implement of national policies and investment plan; 2) to restore degraded lands for enhancement of production in areas with low productivity; 3) to enhance livestock quality, health and productivity through the improvement of pasture, fodder and water supplies; and 4) to promote the adaptation ability for climate change and natural disasters through the improvement of food safety and quality controlling, storing and transporting systems as well as market access networks.

To develop renewable energy technologies for the sustainability of nomadic pastoralism

Attention should be paid to reducing energy loss, so that negative environmental impacts are minimized. In such case, technological innovation plays an important role. Accordingly, in this study, we proposed to develop several renewable energy technologies, such as the Film-solar Power System for Gel, Renewable Energy Refrigeration System, and Solar Power Pumping System etc., which may contribute to not only a decrease in GHGs emission, smog and other pollutants, but also the sustainability of nomadic pastoralism, which might be the most effective way to protect the capacity of CO2 sequestration in grasslands.

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キーワード：CO2 Sequestration、Climate Change、adaptation strategies、Mongolia's Grasslands
Keywords: CO2 Sequestration, Climate Change, adaptation strategies, Mongolia's Grasslands

Rapid seasonal migration of the heavy precipitation region in the Southeast Asia and its relation to the Madden-Julian Oscillation

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It is known that the region of a large variance of the intraseasonal component of precipitation migrates from the Indian Ocean to the western Pacific in late November. The reliable prediction and the understanding of this rapid migration in the intraseasonal time scale are not only useful for managing water resources in the Southeast Asia but also important to prevent disasters due to strong convective activity and heavy precipitation. The ensemble hindcasts using a high-resolution atmospheric model are performed to investigate this rapid migration in late November 2012. It is found that the seasonal change of sea surface temperature in the maritime continents is an important reason for the southeastward shift of the precipitation region. This change also appears to increase the change of the consistent eastward movement of the convective acidity of the Madden-Julian Oscillation (MJO). The observation campaign named as Year of the Maritime Continent, which is starting this year, is expected to be helpful for improving our understanding between the seasonal shift and the MJO.

キーワード：monsoon、atmosphere-ocean coupling、Year of the Maritime Continent (YMC)
Keywords: monsoon, atmosphere-ocean coupling, Year of the Maritime Continent (YMC)

UPDATES ON FUTURE EARTH ACTIVITIES AND ROLES OF SECRETARIAT JAPAN HUB

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Through its co-creation activities, Future Earth has roles to facilitate and coordinate ongoing research projects and actions in the society for global sustainability. It also supports generating new knowledge to fill the gap and for better use in those activities. Knowledge-Action Networks (KANs) have been developed as practical venues to activate such facilitations and collaborations across scientific disciplines and between scientific communities and their partners in the society. So far, about ten KANs were approved to be developed on simple themes such as Food-Water-Energy Nexus, Urban, Health, SDGs etc., and preparatory processes are taken place in individual KANs. Core Projects (now called Global Research Projects: GRPs) are taking leading roles in many of the KANs. Future Earth Secretariat in Global Hubs and Regional Centers/ Offices is supporting GRPs and KANs and connecting them with other projects or activities with similar ideas and missions. Developing communication tools, organizing public engagement events, facilitating science –policy interface, building capacities are other aspects of Future Earth functions. At this session, secretariat roles to support those Future Earth activities, in particular those taken in charge by Japan Hub are introduced.

キーワード：フューチャー・アース、知と実践のためのネットワーク、グローバルリサーチプロジェクト
Keywords: Future Earth, Knowledge-Action Networks, Global Research Projects

Importance of chemical process study for the precise prediction of environmental change

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In the very wide scope of Future Earth program, integration of various scientific and engineering fields as well as social science has been emphasized, which should be further developed to action to general public. This movement is very important when we consider the drastic change of the earth within last 200 years and the fact that the change has not affect our economic system and life style sufficiently to preserve our planet as habitable earth for many living things.

Within earth science community, there are mainly two directions in the researches: (i) one is integrated science based on physical theories on the flow of energy and materials in the earth system mainly based on the physical models and simulation techniques and (ii) the other is process study based on the analyses of materials including chemical, isotopic, and mineralogical studies. The process discovered by the latter direction does contribute to the precise model to predict the future earth. However, the importance of the latter study is sometimes overlooked, even though new findings can be often found in the latter study.

I think that this situation may be also the case in the Future Earth program. We believed that the well-balanced development of model/simulation study and process study which should work close together. It is on the other hand true that the analytical studies using advanced techniques in material and chemical sciences are not readily utilized by most of researchers especial in social sciences. Thus, establishments of any agencies that hold a policy to serve as analytical centers for Future Earth may be needed in future.

Towards co-producing environmental scenario research: A case of climate engineering

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This paper calls for co-production of environmental scenario research in line with the Future Earth's ideal of knowledge co-production with stakeholders. Taking climate engineering as an example, we articulate how such co-production method might benefit discussions of the risks, benefits, and governance challenges of this technique. We believe that this approach can be extended to other areas of sustainability scenario research.

In sustainability research, scenarios occupy a unique position. It is the standard tool of scientific inquiry as well as a communication medium for policymakers, stakeholders, and citizens. Scenario research is also crucial for solar geoengineering, a controversial set of technologies that are gaining increasing traction. It refers to a variety of techniques that are intended to directly cool the climate system to counteract global warming, and is also called solar radiation management (SRM) or climate engineering (which is actually a superset of solar geoengineering). In recent years, the Geoengineering Model Intercomparison Project (GeoMIP) (Kravitz et al., 2011, 2015) have analyzed mostly idealized climate scenarios to identify robust features of solar geoengineering.

The GeoMIP exercise was aimed at improved scientific understanding. It can be contrasted with other scenario exercises such as the shared socioeconomic pathways (SSPs) (Riahi et al, 2017), which were created to help climate projections and analyses of mitigation and adaptation policies. GeoMIP's emphasis on science is understandable because science of solar geoengineering is at an early stage. Nevertheless, sometimes scholars and stakeholders treat the results of GeoMIP as a policy-relevant piece of research, leading to some confusion about the implications of solar geoengineering.

Scenario research on solar geoengineering would benefit from more active engagement of researchers in other fields. Following the SSP process, one might construct narratives for solar geoengineering with the ultimate goal of producing a wide range of quantitative scenarios. Moreover, geoengineering scenario research should actively involve stakeholders and the publics in order to fully reflect their concerns and interests. Since it is a prima facie case of post-normal science, extended peer review would be a crucial input. We should invite various actors to voice their opinions, desires, and worries (Sugiyama et al., 2016).

We think that such an exercise would create a more nuanced, pluralistic set of scenarios. Reflecting diverse concerns about solar geoengineering, the resultant scenarios would range from categorical rejection to limited deployment scenarios (e.g., Keith & MacMartin, 2015) to significant deployment. In limited deployment scenarios, solar geoengineering could be used to shave off the peak warming or slow

down the pace of climate change. We believe that such scenarios would enable better characterization of climate benefits and side effects of solar geoengineering.

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Studies on As contaminated groundwaters –an example of international scientific activity against environmental problems

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Decreasing water resources threaten the human beings, and degradation of water quality is one of those problems widely occurring in the world. Geogenic arsenic contaminated groundwater is a unique but the most serious problems among the quality problems of groundwater resources. Arsenic is known as a highly toxic element, and WHO gives the limited standard value 0.01 mg/L for drinking water. However, people have to use the waters including >0.05 mg/L As, and it has caused fatal disease to millions of people, especially living in the developing countries, for more than three decades. Here, the distribution and formation mechanisms of As contaminated groundwaters and international collaboration activities we concerned are documented as an example of scientific activities for the mitigation of natural environmental hazards.

Arsenic contaminated groundwaters appear mostly in the Holocene aquifer, in which the host phases of As are reactive. Many researchers suggested that the As-adsorbing Fe-oxyhydroxides are the sources of As in most of the contaminated Holocene aquifers, and that the As was released into the groundwater via desorption from and/or decomposition of Fe-oxyhydroxides during biochemical reduction of the aquifer environment. One of our important results was that chlorite was a primary source of As in an aquifer of Bangladesh. Chemical weathering of As-bearing chlorite promoted by infiltrating oxic water must the primary reaction to release As into the studied aquifer and the desorption of As and reduction-dissolution of As-adsorbing Fe-oxyhydroxides would be the secondary reaction, which is important to control the As concentration. The Fe-oxyhydroxides precipitation and As adsorption via chemical weathering of primary As-bearing sulfides and/or silicates must occur in situ. The multi-stages of reactions would be generalized the As contamination mechanisms in the other areas.

Many international teams of scientists from modern and affected countries have been collaborating to cover the lack of finance, facilities and human resources. After accumulating the experiences of collaborations throughout the case studies, more than fifty scientists had a meeting in Hanoi in 2011, and an international team was organized to apply an ICDP project. The team, including the geochemists and hydrogeologists from 8 modern countries and 5 As-affected countries, has been working to realize the drilling of the biologically uncontaminated groundwater aquifer sediments since then. Microbial activities were known to be important for the As cycle, and its importance in the groundwater aquifers is focused on this project. This project is principally a part of natural science and not directly connecting to the mitigation, although many scientists concerning this project are working for the mitigation in various countries. The drilling is still on the schedule and has not been completed yet, however, we have constructed the interconnection not only for the collaboration but also for the education of young researchers throughout the projects. It must be a good example of the organization of scientist group to contribute the mitigation and education against the environmental problems.

Strategic Research Agenda for Future Earth in Japan: Collaborative priority setting with stakeholders of global environmental issues

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Future Earth is a new international research initiative that aims to achieve global sustainability through transdisciplinary approach. The global environment can affect or be affected by everyone in the society. However, the stakeholders of global environmental issues are rarely involved in the research priority setting. Here we present a development of Strategic Research Agenda for Future Earth in Japan through collaborative priority setting with a wide range of stakeholders. We first collected candidate research questions from the general public, local governments and industries, as well as experts. We then convened a workshop where stakeholders and researchers collaboratively identified priority research questions. From an initial pool of 645 candidate questions, 107 priorities were selected. Approximately 70% of the priorities were derived from the questions proposed by the stakeholders. Unlike previous other priorities in global environmental research, the majority of our priorities were social science and inter- or multi-disciplinary questions. The priorities included well acknowledged global problems such as climate change and biodiversity but also provided new perspectives by highlighting the importance of local communities, culture and dialogue. The results also shed light on lack of regional and societal relevance in global research priorities.

キーワード：フューチャー・アース、持続可能な社会、地球環境、研究課題、優先課題設定、コデザイン
Keywords: Future Earth, sustainability, global environment, research questions, priority setting, co-design

Can we improve and strengthen school education for sustainability in Japan?

Can we improve and strengthen school education for sustainability in Japan?

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School education for sustainability should be improved and promoted at all levels, as it is the key to sustainable future of the country and the world. It is easy to say, difficult to do, but in Japan there are some hopeful signs of change within and around school education which are likely to improve the situation. The paper shows what those positive changes are, and discusses how they are made use of in order to improve school education for sustainability in Japan, and ultimately in the world. It is argued that Future Earth can, and should, be involved in such educational activities.

キーワード：school education for sustainability、ESD、Future Earth
Keywords: school education for sustainability, ESD, Future Earth

