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Future Earth activities in China: Towards a national sustainable development

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Abstract

This article provides an overview to Future Earth activities carried out by the Chinese National Committee for Future Earth (CNC-FE). Future Earth is an international research programme which aims to provide critical knowledge to face the challenges posed by global environmental change and to identify opportunities for a transition to global sustainability. CNC-FE is the main body devoted to implementing the Future Earth programme in China. Incorporating Future Earth themes and national science needs, CNC-FE has identified 14 priority areas. Since its establishment, it has conducted an array of activities to fulfill its missions, including implementing projects, convening international meetings, translating and publishing Future Earth and CNC-FE related documents and promoting Future Earth and CNC-FE on various outreach occasions. CNC-FE closely follows Future Earth's development and meanwhile integrates its themes with Chinese practice. It is hoped that implementing Future Earth in China can boost global environmental change including climate change research in China and also have positive implications for developing countries who are trying to adapt to climate change and address the challenges for the national sustainable development.

Keywords: Future Earth; Global sustainability research; The Chinese National Committee for Future Earth (CNC-FE); Research priorities

1. Introduction

Future Earth is a 10-year international research programme jointly initiated by ICSU (International Council for Science), ISSC (International Social Science Council) and others. It was launched in June 2012 at the UN Conference on Sustainable Development (Rio+20). The programme aims to provide critical knowledge required for societies to face the challenges posed by global environmental change and to identify opportunities for a transition to global sustainability (FE, 2013).

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Embracing the principle of co-design, co-produce and co-deliver, Future Earth also expects to be a platform for international engagement to ensure that knowledge is generated in partnership with society and users of research. The programme defines three broad research themes: dynamic planet, global development and transitions towards sustainability and calls for building of a set of cross-cutting capabilities: observing systems, data systems, Earth system modeling, theory development, scoping and synthesis, communication and engagement, capacity development and education, and science-policy interface activities (FE, 2013).

Recognizing the importance of Future Earth, a Chinese National Committee was established in 2013 to mobilize Chinese scientists and stakeholders to participate in the Future Earth and make full use of international resources to address challenges in the national sustainable development, using a multi-disciplinary approach. The primary focus of this paper is to provide a review of Future Earth activities conducted by the

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Chinese National Committee for Future Earth in China (CNC-FE).

The remainder of the paper is organized as follows. Section 2 presents an overview of Future Earth programme. In Section 3, the establishment of CNC-FE is introduced. Section 4 reviews the evolution of identifying priority, which is the core of CNC-FE work. Various activities are introduced in Section 5. Implications of CNC-FE activities for climate change research in China are suggested in Section 6. A summary and discussion is provided in Section 7.

2. Overview of Future Earth programme

In its 2025 vision released in 2014, Future Earth identified eight grand challenges ranging from synergies and trade-offs of water, energy, and food, decarbonization of socio-economic systems, valuation and governance of biodiversity, ecosystem functioning and services, social resilience building to sustainable pathway development. By developing and publishing strategic research agenda every few years, Future Earth intends to provide information and advice for global environmental change researcher and funding agencies and stakeholders. Based on the three themes and eight grand challenges, it issued Strategic Research Agenda 2014, which further suggested 69 key priorities for global environmental change and sustainability research for the next 3–5 years (FE, 2014). These being the crystallization of compressive consultancy with Future Earth expert panels and global societal partners received favorable comments across global research communities.

Future Earth is to fulfill its vision by building on and integrating existing Global Environmental Change programmes (GEC) (Diversitas, IGBP, IHDP, WCRP and ESSP) and developing new broader initiatives. Up until 31 March 2015, five out of 21 GEC projects have formally merged into Future Earth and transition of other 16 are in progress. The

governance of Future Earth consists of four core bodies: a Governing Council, a Science Committee, an Engagement Committee and the Executive Secretariat. The Executive Secretariat is innovatively globally based, which comprises five Global Hubs in Canada, France, Japan, Sweden and the U.S. and four Regional Hubs in Middle East and North Africa, Latin America, Europe and Asia (<http://www.futureearth.org/secretariat>).

While challenges are posed in global scope, there is a great disparity concerning the implement of GEC projects, economic development, social environment and science-policy among different countries. Thus establishing Future Earth national committee is an effective and feasible way of accomplishing Future Earth missions at national level and networking of national committees serves as good complements to regional hubs.

Future Earth introduced into its projects a new concept of research approach, different from the previous GEC projects. The idea of co-design, co-produce and co-deliver (Fig. 1), in our view, arose from people's, in particular funding agencies and stakeholders' disappointment in traditional linear model of research (Fig. 2) which creates a deep gap between the science and its supposed end-users. This new approach involves stakeholders from the very beginning, instead of only informing end-users when the research results become applications, if there are any, and make sure the end-users' experience and observation is also brought back to the labs for a new cycle of research.

3. Establishment of CNC-FE

3.1. Formation of CNC-FE

Supported by Chinese Academy of Sciences, China Association for Science and Technology and others, Chinese scientists have been involved in several GEC projects. In addition

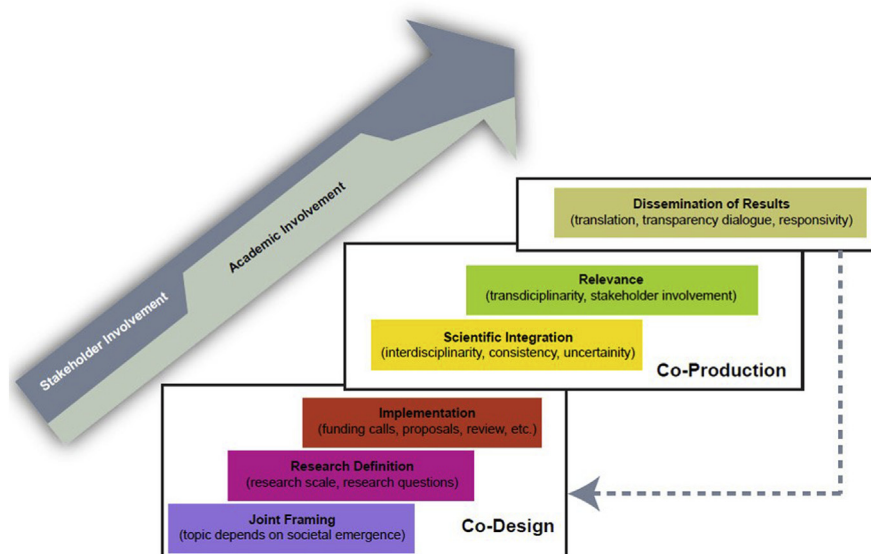


Fig. 1. Framework for interdisciplinary and transdisciplinary co-creation of the knowledge castle (reproduced from Mauser et al. (2013)).

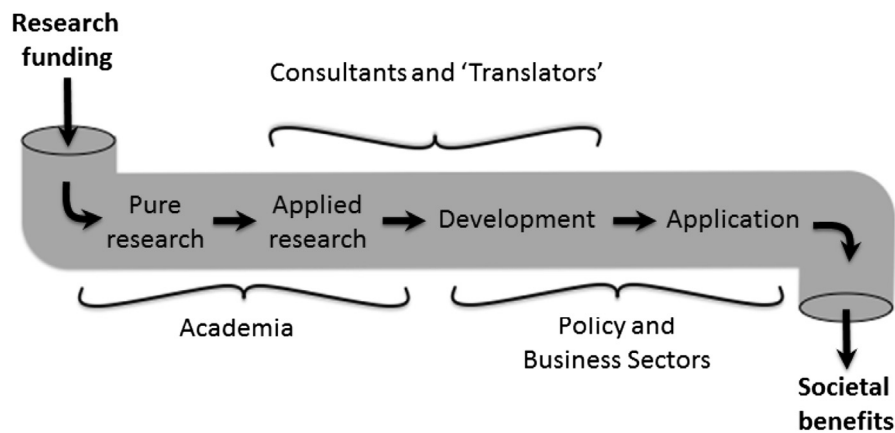


Fig. 2. The Linear Model of traditional research (reproduced from Wilson (2013)).

to participating in projects, some senior scientists held administrative offices, which enable them not only to be accurately aware of the trends of major international scientific programmes, but also try to promote the led-in and advance of new initiative. Prof. WU Guo-Xiong first introduced Earth System Sustainability Initiative (ESSI, the predecessor of Future Earth) to Chinese community and made constructive advice on its strategic planning during his early term of office as ICSU executive board member; Prof. YAO Tan-Dong was elected member of ESSI transition team; Prof. LÜ Yong-Long as ICSU Committee on Scientific Planning and Review member (ICSU/CSPR) joined in reviewing of ESSI. In 2012, ESSI was formally renamed Future Earth. In 2013, Prof. QIN Da-He was elected inaugural Science Committee member of Future Earth. Thus, Chinese academia and leadership have always had adequate knowledge of the progress of ESSI and its evolution to Future Earth.

As the first attempt to bridge Future Earth with Chinese community, the International Workshop on Future Earth in China, under the auspices of China Association for Science and Technology, was held on 26–27 September, 2013 in Beijing. The workshop featured invited talks by leaders of ICSU, ICSU Regional Office for Asia and Chinese experts in GEC community. Participants reached a consensus that China should strengthen the collaborations among existing global/regional environmental change programs and develop science-policy platform at regional and national levels. Establishing the CNC-FE will provide a good mechanism in this regard. Another major achievement of the meeting is that the preliminary science priorities of implementing Future Earth in China and Asia were suggested (<http://cnc-fe.cast.org.cn/about-eng.asp?id=89>). Following this meeting, China Association for Science and Technology mandated the State Key Laboratory of Numerical Modelling for Atmospheric Sciences and Geophysical Fluid Dynamics (LASG), Institute of Atmospheric Physics to make preparatory work as secretary office for the establishment under the guidance of Profs. QIN Da-He and WU Guo-Xiong. On 21 March 2014, the CNC-FE was established in Beijing. The committee is sponsored by China Association for Science and Technology, and jointly supported by Chinese Academy of

Sciences, Chinese Academy of Engineering, Chinese Academy of Social Sciences, and National Natural Science Foundation of China.

3.2. Structure and objectives of CNC-FE

CNC-FE committee is made up of more than 40 experts from the fields of natural sciences, engineering, social sciences, funding agencies and media towards the Future Earth new mode of communications and engagement, i.e. co-design, co-produce and co-deliver. Prof. QIN Da-He, was appointed the Chair of CNC-FE, and Dr. ZHANG Qin, Prof. DU Xiang-Wan, Prof. FU Bo-Jie, Prof. LIU Cong-Qiang, Dr. PAN Jia-Hua and Prof. WU Guo-Xiong were appointed the vice chair of CNC-FE by China Association for Science and Technology. The Secretariat is located at LASG/Institute of Atmospheric Physics, Chinese Academy of Sciences, with Dr. ZHOU Tian-Jun as the Secretary General. More information can be found at the CNC-FE website: <http://cnc-fe.cast.org.cn/eng-index.asp>.

The inauguration of CNC-FE signaled China's full participation in Future Earth. CNC-FE is aimed to organize Chinese scientists and stakeholders to participate in the Future Earth and make full use of international resources to boost China's technological level and policy making in the construction of eco-civilization.

4. CNC-FE priority identifying

Identification of priority research areas is at the top of CNC-FE agenda, and to some extent, the evolution of priorities reflects Chinese communities' attempt in understanding Future Earth themes and combining them with Chinese reality. At the inaugural meeting, it was unanimously agreed that CNC-FE should within the framework of Future Earth, focus on major subjects of public and government concerns to meet the needs of national science and societal sustainable development. The priority research areas have been progressively built up, which correlates with several key meetings. The evolution of CNC-FE priority research areas is illustrated in Fig. 3.

The International Workshop on Future Earth in China held in 2013 laid a good foundation for identifying research priorities. During the meeting, attendees had a preliminary discussion on key issues of implementing Future Earth in China and Asia. Focusing on three Future Earth themes and taking into consideration the existing GEC projects status, the workshop suggested tentatively six science issues as the major points of entry for China to get involved in Future Earth, *viz.* 1) Asian monsoon, variability and its impact; 2) coast zone development; 3) ecological progress and urbanization; 4) disaster mitigation; 5) energy and green economy; 6) population, environment, food and water security. The attendees also recognized lack of social scientists' involvement in these research topics.

The inaugural meeting held in 2014 extended the list to eight. Two were added: attribution and prevention of air, water and soil pollution and public environmental protection awareness enhancement; sustainable development of Polar Regions. Other six were either made more specific or expanded to be linked with national science reality and the needs for future development. These priorities are of wide government and public concerns and addressing theme requests joint efforts of scientists, social scientist, engineers, government and stakeholders. The meeting also suggested forming working groups for each priority in line with three phases of co-design, co-produce and co-delivery.

Following the inaugural meeting advice, further addition and refinements were made. In June 2014, after further exchange with Future Earth Science Committee and interim Engagement Committee, CNC-FE has formally identified and announced 12 priority areas as follows:

1) pollution linked with environmental and climate change;

- 2) urbanization and social harmonic development;
- 3) climate variability over monsoon regions and human activity;
- 4) global change and responses on critical zones;
- 5) food, energy supply and the future development;
- 6) biodiversity and ecosystem services;
- 7) industrial transformation and green production;
- 8) disaster early warning in the context of global environmental change;
- 9) East Asian traditional culture and sustainable development;
- 10) sustainability in Polar Regions;
- 11) observations and knowledge services for the Earth system;
- 12) Earth system model, climate economy model and scientific policy.

Twelve working groups are established accordingly. Each consists of a principal investigator and several group members, all are experts in related field. Priority of each group matches with one of the three Future Earth themes or relates to combination of two or three. Take for an example, group one pollution linked with environmental and climate change examines issues including air, water and soil pollution change due to human activity and natural phenomena, the way to characterize environmental pollution status of at different spatial scales. At the same time, it explores the options, opportunities and risks of the changes towards sustainability, the implication for the national pollution governance and their linkages with regional/global environmental and climate changes and governance. The work spans Future Earth theme one dynamic planet—understanding how planet Earth is changing due to natural phenomena and human activities and

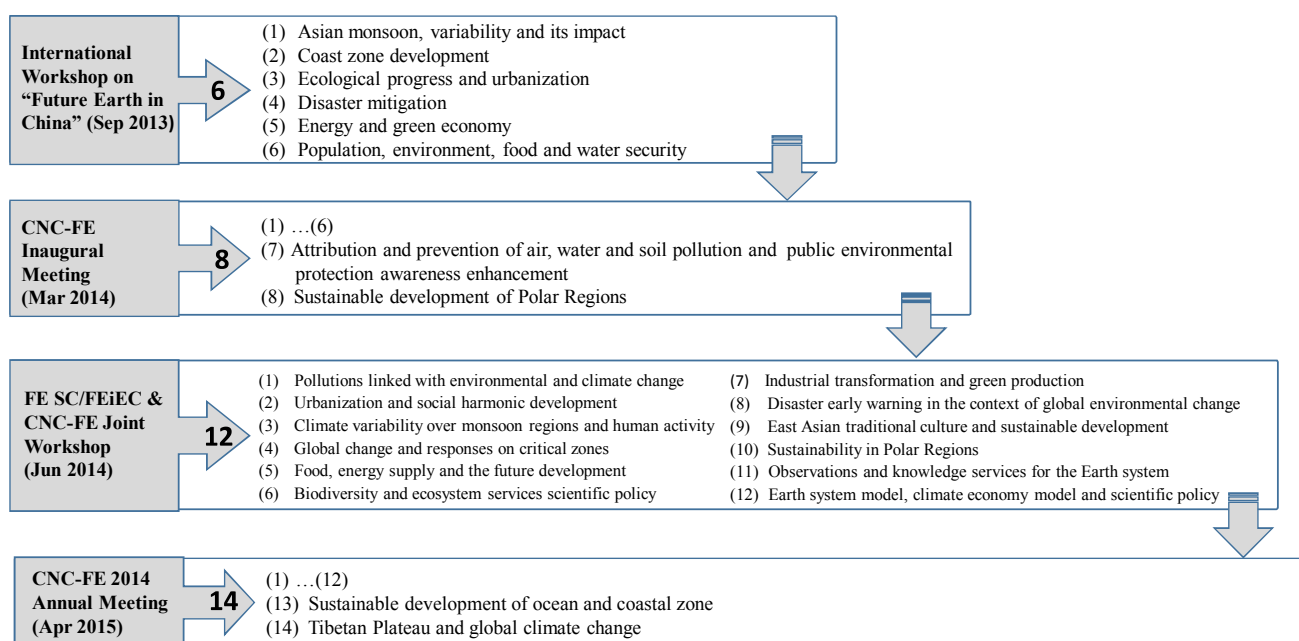


Fig. 3. The evolution of CNC-FE priority research areas.

theme two transformation towards sustainability. It also involves disseminating related knowledge to the public and advice to stakeholders, which aims to co-deliver.

Given their science significance and important roles in national social-ecological development, two priorities were added at CNC-FE 2014 annual meeting held on 30th April 2015: sustainable development of ocean and coastal zone, and Tibetan Plateau and global climate change. Thus, CNC-FE has identified all together 14 priorities areas so far. All in all, the evolution of CNC-FE priority area stems from Future Earth themes and is always in line with and national science development needs. The process represents China's deeper understanding of Future Earth themes as well as continuous efforts in conducting science for policy.

5. CNC-FE activities

5.1. Implement projects

Adhering to co-design, co-production and co-delivery, CNC-FE has mobilized and drew on expertise and resources available to build on international efforts and advice policy-makers. The committee currently undertakes two 3-year projects. One is Chinese Academy of Sciences International Cooperation Program: Co-design of Implementation Plan for Future Earth in China, the other is Academic Divisions of the Chinese Academy of Sciences Consultation Project: Implementation of Future Earth in China and Promote Social Sustainable Development. Prof. WU Guo-Xiong, the vice chair of CNC-FE, is the principal investigator of both projects.

The international project focuses on co-designing an implementation plan of Future Earth in China with scientists, stakeholders, policymakers, funding agency and the public. Involving TWAS and neighboring Asian countries in the multi-disciplinary capacity building and integrating the GEC programs and projects into Future Earth studies are also parts of its scheme. Urbanization and social harmonic development is of great importance for promoting China's ecological civilization. After interacting with Future Earth Science Committee and interim Engagement Committee and another ICSU Programme on Urban Health and Wellbeing in the Changing Urban Environment and other partners of Chinese Academy of Sciences, the project has singled out urbanization for case study. An international symposium themed Co-design for Urban Development in China and the Asia–Pacific Region will be convened on 20–23 October 2015 in Xiamen to explore the co-design pathway (workshop website: <http://cnc-fe.cast.org.cn/ISCUCA/index.asp>).

Compared with the international project, the Chinese Academy of Sciences consultancy project gives more weigh on exploring Science for Policy, putting forward science advice in response to economy development and societal transfer to sustainability and promoting relevant mechanism, capacity and information building. Five subprojects are formed accordingly. The project takes on a systematic integration perspective and expects to output a consultancy report to be submitted to related administrations.

In addition to these two ongoing projects, CNC-FE is also actively engaged in joint application with international projects and expertise for sustainable-related international initiatives. It endorsed a joint application with International Society for Photogrammetry and Remote Sensing for ICSU Grant for Global Land Cover Information for Future Environmental Change and Sustainable Development. The international project members interact widely and teamed up with science community in the U.S. and Germany in response to Belmont Forum call for collaborative research action on Mountains as Sentinels of Change.

5.2. Organize and co-organize workshops and symposiums

Organizing and co-organizing workshop or symposium is the main way for CNC-FE to interact with ICSU, Future Earth Leadership and Future Earth related national activities. It has organized or co-organized a dozens of meetings since its establishment, among which three meeting are especially significant for the committee's development.

As aforementioned, the International Workshop on Future Earth in China held in 2013 engaged ICSU, ICSU regional officers and Chinese experts in GEC community. The six priority areas it suggested tentatively formed the cornerstone for the future planning. The in-depth discussion on how best Chinese scientists could contribute to Future Earth nationally, regionally and globally is also beneficial for the founding of the committee half a year afterwards.

The inaugural meeting is undoubtedly the most important event on the history of CNC-FE as it not only pushed forward priority setting, but also deployed the composition, governance and operation of the committee.

Another crucial activity is Future Earth Science Committee/Interim Engagement Committee & CNC-FE Joint Workshop which was held in Beijing on 3 June, 2014. The workshop composed of overview session and three thematic sessions. Every thematic session was made up of a local natural scientist, a social scientist and a stakeholder. This carefully designed schedule enabled all parties had in-depth communication and made the meeting fruitful indeed. It was at this meeting that the 12 priority areas were officially announced. Future Earth officials spoke highly of CNC-FE initiatives and also provided insightful advice for CNC-FE to better co-design with wider communities, including networking with Asia–Pacific countries, increasing representation of different stakeholders etc.

The international symposium themed Co-design for Urban Development in China and the Asia–Pacific Region to be held in October 2015 expects to bring together urban science community, industry representatives both at home and abroad to develop a set of co-designed research priorities and working partnerships that could deliver to urban development in China and the Asia–Pacific Region.

UNFCCC/COP21 will be held at the end of 2015 in Paris. Co-organizing with China Association for Science and Technology, CNC-FE is actively involved in application for a side

event themed Climate Change and Resilience: Co-design for Urbanization in China. The event aims to introduce Chinese activities on addressing climate change and enhancing resilience from the perspective of co-design. The application is recently confirmed and relevant preparation is well under way.

5.3. Translation and publications

By translating related documents and submitting a special issue on Future Earth to GEC research journals, CNC-FE is making continuous efforts in co-delivering the programme's concept and promoting its implementation in the country.

In December 2013, Future Earth Transition Team published Future Earth Initial Design. The report sets out the initial design of Future Earth, comprising a research framework and governance structure, preliminary reflections on communication and engagement, capacity building and education strategies, and implementation guidelines (FE, 2013). Realizing its special reference, CNC-FE Secretariat, Global Change Research Information Center, Lanzhou Library, Chinese Academy of Sciences and Key Laboratory of Regional Climate-Environment for Temperate East Asia (RCE-TEA)/Institute of Atmospheric Physics, Chinese Academy of Sciences organized experts to co-translate it into Chinese. The Chinese version was published in February 2015 by China Science Publishing & Media Ltd. The book proves to be a key guide for Chinese science community as well as policymakers and various stakeholders to understand the programme essence. This co-delivery effort was greatly affirmed both by Future Earth Secretariat and ICSU.

In 2015 CNC-FE goes on with another two publishing tasks. One is cooperating with *Advances in Climate Change Research* to compile a special issue on implementing Future Earth in China, to which this article belongs. The issue featuring introduction to Future Earth plans, advances and expected achievements in the priority areas will bring multiple perspectives from climate and environmental change related disciplinary. The second is to translate Future Earth 2025 and Future Earth Strategic Research Agenda, two important documents released in late 2014, which intended to be used across different domains, disciplines and regions of the world, by a range of different agencies and stakeholders, to inform priority setting for research and research funding.

5.4. Outreach

CNC-FE is trying to reach out to science community, media, policymakers, NGOs and stakeholders by using traditional and new means, such as website, newsletter and Wechat. A bilingual CNC-FE website is launched shortly after its establishment (English version: <http://cnc-fe.cast.org.cn/eng-index.asp>; Chinese version: <http://cnc-fe.cast.org.cn/index.html>). This dedicated website provides up-to-date news from the Future Earth community and CNC-FE activities. Newsletters are also distributed among CNC-FE communities regularly. Understanding the important role of media in disseminating knowledge and raising public science

awareness, CNC-FE emphasizes media engagement in all its important events. The Future Earth Science Committee/Interim Engagement Committee & CNC-FE Joint Workshop in 2014 invited attendance of several leading media and NGOs, for example, the Nature Conservancy. More than 20 media provided comprehensive, multi perspective news and video coverage of this workshop including Beijing TV, Xinhua News Agency, and People's Daily etc. Bilingual reports of the event and presentation at the workshop can also be found in China Development Gateway. All these helped raising the profile of CNC-FE and public awareness for Future Earth initiative.

CNC-FE also seeks active interaction with international projects and organizations working such as the United Nations Development Programme (UNDP), German Future Earth Committee, Climate and Ocean: Variability, Predictability and Change (CLIVAR) Project, the Oxford Research Encyclopedia, and the Fudan University/East Anglia University joint Tyndall Center.

6. Implications for climate change research in China

In addition to its obvious relevance to sustainable development in China, implementing Future Earth in China has positive implications for addressing climate change research in China.

First of all, Future Earth is a multi-disciplinary research and international collaboration platform for Chinese climate change researchers. One example of multi-disciplinary research is the development of early warning systems for abrupt and irreversible change. Prediction of weather and climate extremes under the background of global warming involves not only oceanographers and hydrometeorologists. Climate researchers are also supposed to work with or talk to researchers and officials working in agriculture, coastal engineering, urban management, architecture and many other disciplines and industries. Future Earth strives to develop a multi-disciplinary approach as integration of science and co-production of knowledge is one of its main aims (Stafford-Smith and Berkhout, 2014). Disaster risk reduction researchers, including climate change researchers in China, have an opportunity to mingle with global environmental change research community. In this regard, the Integrated Risk Governance Project (IRG Project), which is led by CNC-FE member Prof. SHI Pei-Jun, has taken initiatives. It actively seized the chance of GEC projects transforming into Future Earth and is now accepted as Future Earth core projects (<http://irg.bnu.edu.cn/>).

Another field might be observation and models which are important way for monitoring and predicting how key aspects of the Earth system are changing. Future Earth hopes to draw on and add value to existing international projects (e.g. Analysis, Integration and Modelling of the Earth System—AIMES, Past Global Changes—PAGES, Climate Variability and Predictability—CLIVAR, Global Energy and Water Exchanges Project—GEWEX, Stratospheric Processes And their Role in Climate—SPARC) (FE, 2013). Experts suggested engaging

Future Earth in the UN Sustainable Development Goals (SDGs) by enhancing its observing networks, high-performance computing, Earth system models, theoretical frameworks, data-management systems and research infrastructures to track human dimensions and societal changes (Lu et al., 2015). Chinese climate change observations and models scientists involved in these fields or international projects will think about where they can play a part. Recently, the Global Monsoon Modelling Intercomparison Project proposed by Chinese, UK, and U.S. scientists have been formally endorsed by the CMIP6 (Coupled Model Intercomparison Project phase 6) (<http://www.lasg.ac.cn/gmmip/>). This is a nice beginning of these kinds of international endeavors.

Secondly, Future Earth innovative and challenging approach of co-design, co-produce and co-deliver is able to bridge the communication gap which has long existed between climate researchers and end-users. Climate change issue is fundamentally a development issue. Drawing inspiration from this three Cos philosophy, climate change researchers expect to generate knowledge for societal needs and improve social impact of their research.

Broadly speaking, CNC-FE supports translational research: 1) “That covers basic or engineering science discoveries and integrates social sciences toward improved social application; 2) That takes application observations back into the research lab for mechanism studies; and 3) The use of research findings to inform end-users” (Wu, 2014). Take climate research and agriculture for an example, it has been recognized that “Even without climate change, agriculture will face enormous pressure as the global population swells from 7 billion to perhaps 9 billion by 2050” (Schiermeier, 2015). With changes in rainfall and temperature patterns, heatwaves, droughts and floods become more common and farmers, in particular those in poorer countries, feel more stress (WB, 2013). Most developed nations have already started long-term planning by developing comprehensive adaption strategies while developing nations have fewer resources to plan for the future (Schiermeier, 2015). In fact, scientists in developing countries like China have carried out research on the impact of climate change on agriculture for many years, for example, climate change impacts on crop yield and quality (Lin et al., 2005; Zhou and Wang, 2015) and on water resources (Piao et al., 2010), among others. But how much of it arrives on the farm remains a question. Future Earth tries to involve end-users, including agricultural officials and farmers at the stage of designing climate adaptation programme. Co-design enables climate scientists to learn what kind of information will help farmers the most. And during this communication process, social scientists' presence is also vital for the success of the programme. And feedback from farms can provide observation data and validate climate models. There will be a lot of benefits to climate research when climate scientists stop considering publications as the main reward for their work. The research cycle is only complete when science becomes knowledge and knowledge becomes usage to end-users, and end-users, in return, inspire further research ideas with their experience and observations.

7. Summary and concluding remarks

Future Earth is an inspiring and even revolutionary initiative that builds on decades of excellence of existing GEC programs and intends to set up a global platform for global sustainability research. CNC-FE is the main body devoted to implementing Future Earth in China. Incorporating Future Earth themes and national science needs, CNC-FE identified 14 priority areas. Since its establishment, it has conducted an array of activities to fulfill its missions, including implementing projects, convening international meetings, translating and publishing Future Earth and CNC-FE related documents and promoting Future Earth and CNC-FE on various outreach occasions. All these activities have played an important role in the following aspects:

- (1) CNC-FE regional research with global impact approach is welcome by Asian Pacific countries and regions. Future Earth implementation varies largely from country to country. The founding of CNC-FE is a special contribution that China has made to the international initiative. Activities led by CNC-FE have facilitated implementation of Future Earth in China on national level.
- (2) The way CNC-FE participating in Future Earth is not conventional, i.e. it is not involving in Future Earth by simply joining in a specific science project, but by identifying priorities through integrating Future Earth themes with domestic science development needs. The priorities it identified are of great reference to related national science funding agencies and policymakers.
- (3) CNC-FE tries to practice co-design, co-produce and co-deliver in all its activities. This helps to bring Chinese scientists working on global sustainability to work under one umbrella of Future Earth and provides a practical linking mechanism for existing Chinese GEC projects in their attempt for smooth transformation to Future Earth. Its outreach efforts also helps enhancing public awareness for the innovative three Cos concept.
- (4) CNC-FE endeavors to address climate issues, which are essence of global change. Careful assessment of the impact of climate change on China and providing projections and suggestions for stakeholders to adapt to climate change is the core of CNC-FE's priorities.

Exploring sustainability pathway is undoubtedly an exciting and arduous task. CNC-FE would like to share experience with countries that are striving for sustainable development. It is also hoped that its practice can provide positive examples for countries (especially developing countries) that are also questing ways to addressing and adapting to climate change.

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