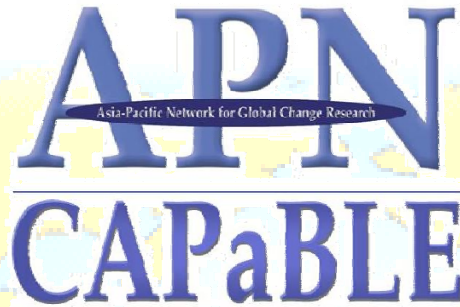


**FINAL REPORT for APN PROJECT
CBA2009-10NSY-Li**



APN
Asia-Pacific Network for Global Change Research
CAPaBLE

- Making a Difference -

Scientific Capacity Building & Enhancement for Sustainable Development in Developing Countries

***Inter-Agency Collaborative Technologies in
Earth Observations (EO) for Global Change
Research in the Asia-Pacific Region***

The following collaborators worked on this project:

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***Inter-Agency Collaborative Technologies in Earth
Observations (EO) for Global Change Research in the Asia-
Pacific Region:***

Project Reference Number: [CBA2009-10NSY-Li](#)
Final Report submitted to APN

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OVERVIEW OF PROJECT WORK AND OUTCOMES

Non-technical summary

One of the most difficult problems APN scientists are facing now is the lack of Earth Observations (EO) data and data usage experience. Global Change Research (GCR) mostly depends on multi-disciplinary knowledge and multi-source EO data and scientists in this field mostly have to base their model research and system development on just a few given EO data sets. The next generation of EO data and information infrastructure are focusing on multi-agency collaboration technologies. This provides users with a new way to both utilize and organize their global change studies. As the leading international organization promoting interoperability and sharing of multi-source EO data, The Working Group of Information Service and Systems in the Committee of Earth Observation Satellites (CEOS/WGISS) has a lot of experience and knowledge on this topic. This proposed project brought the experience and knowledge from CEOS/WGISS to the GCR scientists in the APN region, especially in Mongolia, to demonstrate how to access and use the next generation EO information technology, and to find appropriate approaches to develop their global change models based on this new EO capability and support. This project was supported by and collaborated with the United Nations Global Alliance for ICT and Development (UNGAID), ICSU's Committee on Data for Science and Technology (ICSU/CODATA), as well as GEOSS. A series of workshops have been taken in both China and Mongolia, which collected dozen of local scientists to participant and share the experience from leading experts from USA, Europe and Asia local. The expected outputs listed in the proposal have been reached in this stage and a lot of new opportunities have been addressed from the discussion.

Objectives

The main objectives of the project were:

1. Establish a communication platform among international leading communities (CEOS/WGISS, GEOSS, UN GAID and ICSU-CODATA) and GCR scientists in the Asia-Pacific Region.
2. With a portfolio of best practices show how advanced EO information technologies can support GCR via an operational website
3. Introduce the latest EO data and information-serving technologies to GCR scientists in the Asia-Pacific region
4. Share powerful inter-agency EO data and information resources facilitated by CEOS/WGISS to GCR scientists in the Asia-Pacific region

Amount received and number years supported

The Grant awarded to this project was:

US\$ 38,000 for 1 Year 2009/2010:

Activity undertaken

1. Establish an operational website that provides user information and collected best practices;
2. Enhance the capacity of Asia-Pacific GCR scientists in using emerging EO technologies;
3. Organize training workshop in Mongolia, and
4. Support, promote and align the activities with UN-GAID activities and GEOSS data-sharing principles and actions in the AP region as best practices

Results

1. A scope and preparation meeting was taken in Harbin, China with co-cordinators of this project from China, Mongolia and Thailand.
17th~18th of July, 2009, Harbin, China: Preparation Meeting in Harbin

2. A joint ISDE session on ISDE6 was organized in Beijing. CEODE, CEOS, ISDE, ICSU-CODATA, GEO and UNGAID supported the session.
10th of September, 2009; Beijing, China: Joint ISDE Session "Data Services Infrastructure for Global Change Research"
3. An international training workshop was organized and held in Ulaanbaatar, Mongolia. Scientists from ESA, USA, ICSU-AP, UNGAID e-SDDC CEOS/WGISS, China and Mongolia attended this workshop and served as presenters or trainers.
12th ~15th of September, 2009. Ulaanbaatar, Mongolia: International Training Workshop
4. An operational website was setup to provide user information and collect best practices
<http://int.ceode.ac.cn/apn/>
5. Attended several international symposiums for dissemination
 - (1) 4th GEO-AP Symposium, Bali, Indonesia, 11th of March, 2010
 - (2) WGISS meeting, Pretoria, South Africa, 28th of Sept, 2009
 - (3) 2nd MAIRS, Changchun, China, 25th of July, 2009
6. Collection CD of reports and presentations had been made and distributed to participants.
7. *Additional publish work expended from this project was planned to be edited and published in the following months. It has been promised by support institutes of this project to provide part of financial help. This additional work will be still on behalf of APN and reported to APN. The published book will be delivered to AP countries and GCR communities.*

Relevance to APN's Science Agenda and objectives

Earth Observation data is the most important resource for Global Change research. Most global change researchers are using EO data. EO data related processing and analysis technologies are also heavily affecting the work of global change researchers at various levels, including hypothesis, methodology, and applications. This project focuses on the sharing and easy-access to satellite-based data among multiple agencies. The promotion of such capabilities will also provide much-needed support for Global Change Research Scientists, particularly in developing countries of the Asia-Pacific region. Bringing together international partners to realize this capacity development objective is very much in-line with the objectives of the APN's CAPaBLE programme in promoting and building capacity for research-based activities under the global change umbrella.

Self evaluation

The objectives of project have been reached, with a lot of communication and collaboration between inter-agencies. Longer term cooperation with joint international societies has been built for the capability promotion in AP area on the using of new EO technologies. Training the Global Change experts and users in AP area was implemented with first place in Ulaanbaatar, Mongolia. The collaboration techniques and training experience can be used to promote the APN capability on GC research.

Potential for further work

Through the implementation of this proposal, many experience and inter-agency collaboration techniques on earth observation has been obtained, which is potential for the future work. The international training experience for young scientists and experts obtained from this project can be used in other developing countries. The collaboration technique from GC experts on how to use EO technology can be used in the related GC research project in the future.

Following work have been addressed as the future follow-up of this project:






- (1) To publish a handbook, this will make collection of the leading inter-agency data system's user guide, the EO data sharing principle from GEOSS and CODATA, as well as the technical white-books from leading organizations. It will be delivered to scientists in AP area and it is believed to be helpful for the local experts.

(2) To apply inter-agency data systems to support some select GCR research cases in AP area.

Publications (please write the complete citation)

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- (2) *Additional publish work expended from this project was planned to be edited and published in the following months. It has been promised by support institutes of this project to provide part of financial help. This additional work will be still on behalf of APN and reported to APN. The published book will be delivered to AP countries and GCR communities.*

The contents will include:

-  *Earth Observation Data Sharing Principle;*
-  *Earth Observation Data Facility User Guide Book;*
-  *Global Change Thematic Data On-demand Processing Facility User Book;*
-  *Spatial Data Service Standards and Implementations;*
-  *Related Recommendations and Handbooks from scientific organizations;*

References

1. APN website, <http://www.apn.gr.jp/newAPN/indexe.htm>
2. CEOS/WGISS website, <http://www.ceos.org>
3. GEOSS website, <http://www.earthobservations.org/>
3. UN GAID website, <http://www.un-gaid.org/>
4. CODATA website, <http://www.codata.org/>

Acknowledgments

Besides the support on both finance and scientific scope from APN, our work also has been supported in form of human resources and meeting facilities by the Centre for Earth Observation and Digital Earth (CEODE), CAS and Mongolia National University and Mongolia Sustainable Institute, as well as CEOS,ISDE,ICSU-CODATA,GEO, UNGAID e-SDDC, GISTDA.

Preface

Earth Observation (EO) infrastructures in the last decade have successfully influenced GCR in western countries. These technologies and their implemented information systems have been regarded as an important foundation for such advanced research. Therefore, it is necessary for researchers in the AP region to learn more about it. Supported by leading international organizations of CEOS/WGISS, GEOSS, ICSU-CODATA and UN-GAID, this project was to promote understanding and awareness of new technical trends in the Asia Pacific region, especially for developing countries. Through a joint session and an international workshop that brought experts together to exchange ideas and best practices. Leading GCR scientists and EO data-providers in East Asia were invited and involved in the above activities and shared the experience of inter-agency collaboration technology.

Table of Contents

1.0 Introduction

One of most difficult problems APN scientists are facing now is the lack of Earth Observation (EO) data and data usage experience. Global Change (GC) research mostly depends on multi-discipline knowledge and multi-source EO data. The scientists in this field generally need to base their model research and system development on some given EO data sets. The next generation of EO data and information infrastructures is focusing on multi-agency collaboration technologies. It provides users with a new way to use and organize the global change studies.

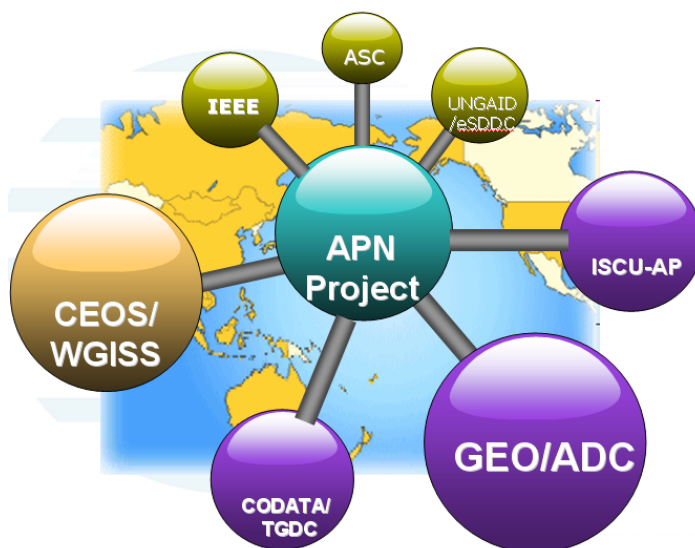


Figure 1. Inter-agency collaboration in the APN project

As the leading international organization promoting interoperability and sharing of multi-source EO data, CEOS/WGISS has a lot of experience and knowledge on this topic. There are three special task teams established inside WGISS to focus on the international research and applications of related EO information topics. These are the Grid Task Team, the International Data Network Task Team and the Interoperation Catalogue System Task Team. From the experiences and research trends of member agencies, these WGISS groups think that the next generation of EO data and information

infrastructures, based on inter-agency and interoperation between the independent systems, will play a key role in both global and regional EO related research and applications.

The Group on Earth Observations (GEO) is coordinating international efforts to build a Global Earth Observation System of Systems (GEOSS) (3). This emerging public infrastructure is interconnecting a diverse and growing array of instruments and systems for monitoring and forecasting changes in the global environment. This “system of systems” supports policymakers, resource managers, science researchers and many other experts and decision-makers. GEOSS is simultaneously addressing nine areas of critical importance to people and society.

ICSU-CODATA is the lead group on the GEO task to develop Implementation Guidelines for the GEOSS Data Sharing Principles. The Global Alliance for Enhancing Access to and Application of Scientific Data in Developing Countries (e-SDDC) of the United Nations Global Alliance for ICT and Development (UN GAID) was launched on 7 May 2007. The mission of e-SDDC is bridging research, education, and policy on scientific data in developing countries under the UN GAID framework, and creating a forum or platform for dialogue for all stakeholders to:

- (1) Identify and evaluate different mechanisms and policies for promoting greater access to and use of digital S&T resources for meeting the needs of developing countries in policy reform in scientific data management and applications; and
- (2) Help build a distributed and decentralized network of networks in scientific data and information resources for innovative research, sustainable development, and better life in the developing world.

The target of our project is to bring the experience and knowledge on EO from CEOS/WGISS and on EO data policy from CODATA to scientists in the APN area, discuss how to access and use the next generation EO information technology, to find appropriate approaches building the AP area regarding the global change inter-agency data infrastructure, to develop their global change models based on this new EO capability and support, and to fulfill and support the GEOSS activities in the AP area. Finally, another important target of this proposed activity is working with the international leaders from the UN GAID e-SDDC, to call for and then to promote an Asia-Pacific Area Global Change Users Earth Observation Joint Data Infrastructure (GC-APWG, Global Changing Asia-Pacific Wide Grid).

The activities of this proposal include a major workshop and a project website with publications from this activity and other related organizations. The workshop will provide the face-to-face platform for exchanging ideas between WGISS, CODATA, the UN GAID project, and other EO experts and Asian Pacific global change scientists. The website with experiences and recommendations from WGISS and best practices from the AP area countries can greatly help Asian Pacific local developing countries to learn and use the new EO data concepts and tools. This project is designed as a regional activity and will focus on East Asia area at this stage. It is hoped that the experience of this stage can be expanded subsequently to other countries and institutions in the AP region, particularly in South and Southeast Asia. Training the Global Change experts and users in AP area was planned to implement, beginning from the East Asia countries, and followed with South-East Asia Countries and Pacific Islands countries. Team members agreed to place workshop in developing countries with less knowledge on related technologies and urgent requirement to such technologies, with first place in Ulaanbaatar, Mongolia. Funded by APN Capable project, the Inter-Agency Collaborative Technologies in Earth Observations (EO) for Global Change Research in the Asia-Pacific Region workshop was held during 12th ~15th of September in Ulaanbaatar.

2.0 Methodology

1. The scoping and preparing meeting is hope to make clear arrangement of following activities.
2. The effective design and invitation of the most important participants was an important beginning of this project. We will invite several key GC research scientists and decision makers from

developing countries, advanced EO technical experts from leading operational EO system groups, as well as the early career scientists in the East Asia area.

3. Best practices will be used to provide examples of how to use the next generation EO technology most effectively to help make GC research most productive. Some best practices will be defined and collected from the partners' work related to GEOSS activities.

4. The project website will be created to share ideas, results, and experiences for the people who cannot participate in this workshop.

5. Monthly tele-conferences and a preparation meeting before the workshop are planned to exchange information and keep the project on track.

6. With the strong background of the team members, the communication with related international communities (CEOS/WGISS, GEOSS, UN GAID and CODATA) will be maintained and support from them continually sought.

7. Searching for additional joint financial support in any form will be taken to enlarge the effect of this activity.

3.0 Results & Discussion

(1)How can we establish a communication platform for regional collaboration?

1) Transfer earth observation technology and knowledge to developing countries like Mongolia. The most important question is how to better deliver earth observation technology for Global change in developing countries, in issues such as dry land research, disaster mitigation, etc.

2) Regional perspectives on global change research, not just countries.

3) Examples of Showcases

a. International Disaster Mitigation Data Network, "International EO data assistant network for Wenchuan Earthquake" will be shown as the easy constructed demo for data sharing and accessing.

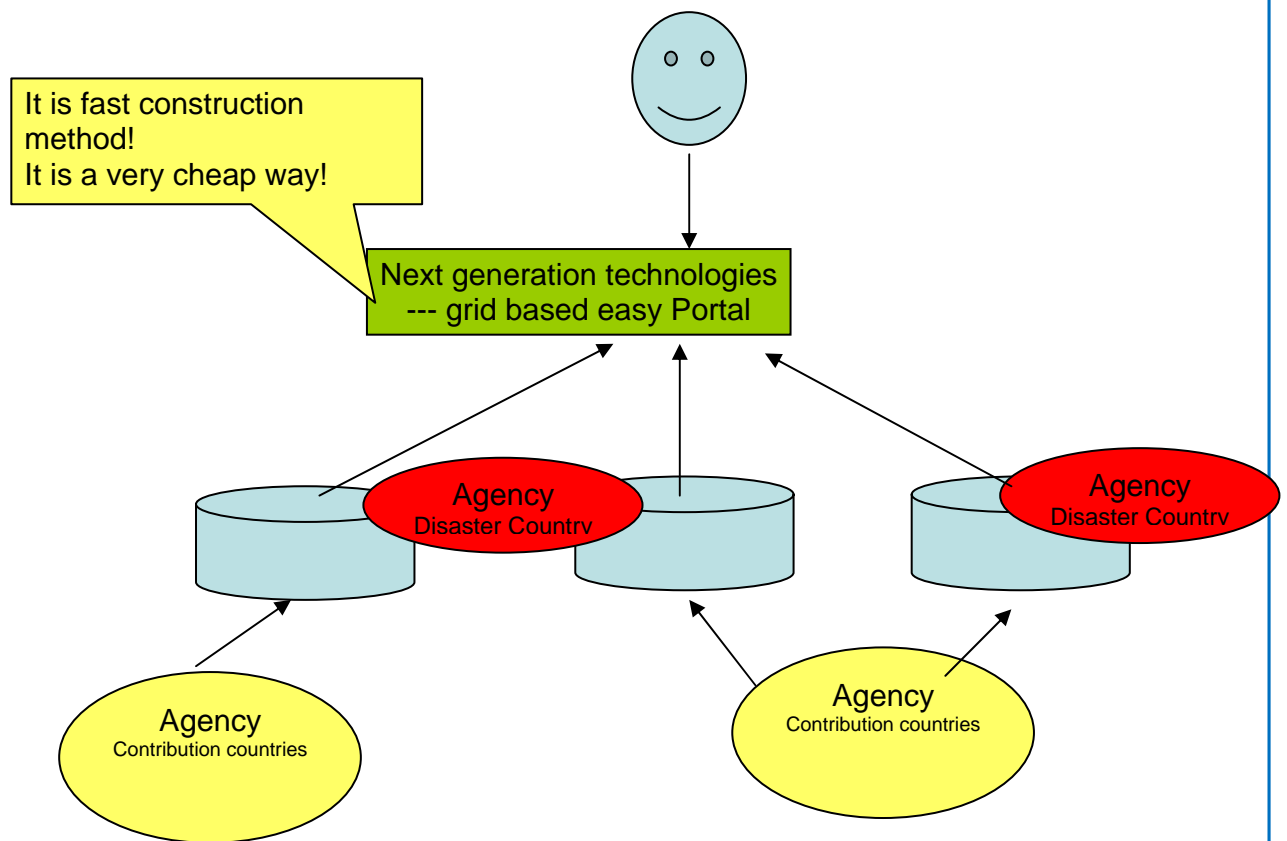


Figure 2. Inter-agency collaboration techniques on EO for disaster mitigation

b. The task of Mongolia is to coordinate with team members in establishing a portfolio of "best practices." Mongolia is also the host of the International Workshop.

- 4) Incorporate stakeholders (policymakers, community members etc.)
- 5) Have young scientists involved into the project and get them trained

(2) How to introduce the latest EO data and information-serving technologies to GCR scientists?

The APN sponsored workshop helped to train the young scientists in Mongolia. Scientists from scientific organization presented at the training workshop and discussed the techniques of Inter-Agency Collaborative Technologies. The hands-on training is more practical and teaches the tools and development technique which are helpful for their future research. The Young Scientists Session provided a forum for the young scientist to communicate on the Global Change issue and ignite the consciousness of international collaboration in their research.

- 1) A joint ISDE session on ISDE6 was organized in Beijing. CEODE, CEOS, ISDE, ICSU-CODATA, GEO, UNGAID supported the session 10th of September, 2009, Beijing, China.



Figure 3. ISDE joint session

2) International training workshop

From 12th to 15th of September, 2009 Ulaanbaatar, Mongolia, a workshop on Inter-Agency Collaborative Technologies in Earth Observations for Global Change Research in the Asia-Pacific Region was held. This workshop was funded by Asia-Pacific network for Global Change Research (APN). The Dryland Sustainability Institute & RSGISL in National University of Mongolia hosted this workshop. The workshop included international conference (one day), hands-on training (two days) and Young Scientists Conference on Global Environmental Change (one day). 40 people attended this workshop. 21 students from universities in Mongolia attended the training session and were awarded certificates.



Figure 4 international training workshop

a. International conference

This conference was held in the conference Hall of National University of Mongolia on 12 September, 2009. There were seven scientists from different international organizations gave presentation to introduce the activities of their organization and their research work. The presenters were Prof. T.Chuluun from NUM-ITC-UNESCO, Laboratory RS/GIS, Dry land Sustainability Institute, Prof. Guoqing Li from CEODE, CAS, China, Prof. Luigi Fusco from European Space Agency (ESA), Italy, Prof. Paul Uhlir from Data Sharing Policies for Promoting Global Change Research, USA, Mohd Nordin Hasan from ICSU-AP office, Malaysia, Prof. Chuang Liu from UNGAID e-SDDC, Prof. Dingsheng Liu from CEOS/WGISS.

b. Hands-on Training

This hands-on training was held at NUM RSGISL on 13, 14 September 2009. Prof. Guoqing Li, Dr. Jibo Xie, Prof. Luigi Fusco and Prof. Chuang liu served as the trainers. 21 students from universities in Mongolia attended the hands-on training session. The hands-on training included three courses "EO data online access" "Web service development" "Data Integration and Data Mining for Grassland Evaluation". All students finished the training courses and were awarded certificates.



Figure 5 Hands-on training workshop

3) Young scientist forum for global change

A Young Scientists Conference on Global Environmental Change was organized in Hustai National Park, Mongolia. The objectives of the workshop are to help young scientists to exchange information and to promote human networks among them. Seven young scientists from China, Japan and Mongolia Presented at the session and reported their recent research activities.



Figure 6 Young scientist's conference on Global Environment Change

3) Results of the training

Technique was transferred to:

- a. National University of Mongolia
- b. Mongolia Dryland Sustainability Institute
- c. National Remote Sensing Center of Mongolia

Technique was transferred :

- a. How to use EarthExplore, ECHO, GEO-Portal, GENESI-DR, as well as Chinese GCR Portal to access EO data
- b. How to develop web service
- c. How to connect EO data with scientific model (grass land data mining model)

(3) How to get Capacity Building and Awareness Raising?

The proposed project fits very well with the CAPaBLE requirement of capacity building and awareness as follows:

First, by focusing on the sharing of knowledge, experience and scientific information on new EO data infrastructures, the researchers from developing countries have less chance to know and to follow the trend of the newest spatial information service technologies and tools, since they typically just have access to the data from the local space activities. Without such awareness and training, they have no chance to use the much more powerful tools to accelerate and simplify their global change research and application projects. For example, ESA has a worldwide EO data scientific research support plan, named CAT-1 project, and hundreds of global change scientists in the Asian Pacific Area have been involved in this. The old method to

get free data from ESA is with CD hard media or from FTP with the manual data searching and ordering months in advance. Now, a new way is available to get data from ESA for CAT-1 scientists. They can get on-line data through GPOD (Grid Portal On-Demand). GPOD can provide not only the original archived data from all ESA databases and many other agencies data resources, but also the processed data with high performance and well-validated value-added productions. It means our global change experts need not to take so much EO data processing work before starting their own filed analyses work. This technology had been successfully used in ESA CAT-1 programme to the Global Changing Project PIs around world.

Data democracy is the new topic discussed by the international information society. The democracy of data is not only the same opportunity to access EO data, but also the capability for processing and analyzing the data. This proposed project is pushing the technical capabilities of global change researchers, particularly in developing countries, to be able to effectively and equally access quality data and data-processing resources with the new technical facilities. It will be providing more data access to the developing countries in the A-P area.

The International Workshop will call for collaborations and the establishment of an MOU to build Global Change Asia-Pacific Wide Grid (GC-APWG). Such an inter-agency data-sharing grid will also be integrated into the UN GAID e-SDDC facilities, which can meet the requirements and needs at the global level. With this facility and methods, GC research activities can be expected to be widely promoted and accelerated.

(4)How to contribution of Each Participating Country and Organizational Arrangements?

ICSU, as the main responsible body for the global-change programmes of IGBP, IHDP, DIVERSITAS and WCRP, has also shown interest and expressed the importance of this activity and it is hoped that the Asia-Pacific regional office of ICSU (ICSU-ROAP, based in Malaysia) will collaborate in the activities (to be confirmed at the time of writing of the main proposal).

China has been the main partner in charge of the organisation and implementation of all project activities, and in ensuring that all collaborators meet their expected project activities on time in order to realise an effective international workshop and project outputs in the 12-month timeline. China is also responsible for the meeting organization, as well as communication with ICSU-CODATA, UN GAID and GEOSS. Beside Prof. Li is taking the leadership of this project, there is some Chinese scientists will be involved in. Prof. Chuang Liu is one of the UNGAID leaders. Prof. Jiasheng Zhang is the Co-chair of the GEOSS ADC committee, who is in charge of GEOSS related data, information and products distribution for the Asia-Pacific region through GEONETCast. The task of China should also include the project website and publishing works. The USA, in addition to co-writing the proposal, will also provide its experience and expertise on this topic. Dr. Paul Uhlir, who is one of the main members of CODATA and one of the main authors for the GEOSS Data-Sharing Principles, will attend the workshop and provide expertise and input throughout the entire project. Prof. Di has served for NASA spatial information sharing technical systems for more than ten years. As the chair country of CEOS in 2009, Thailand will take care of the contact with CEOS/WGISS (Dr. Pakorn will be the Chair of WGISS).

Japan is dealing with the young generation of scientists. Dr. Tomoko is very outstanding young scientist and she has had full experience on young scientist society. The task of Mongolia is to coordinate with team members in Russia and China in establishing a portfolio of "best practices." Mongolia is also the host of the International Workshop. Korea and Russia are also invited to join and ready do their effort to any potential need. Mr. Ermoshin B.B and Mr. Evgenii Egidarev from Pacifica Geographical Institute, Russian Academy of Sciences will take part in the proposed workshop in Mongolia.

(5)How to link to Sustainable Development?

- 1) Historically, there are many technologies can be used to build the EO data infrastructure and access to the existing data systems. However, these technologies cannot always be integrated and work together. It is hard for the developing countries and their entities to decide how to select the suitable technical platform for their global changing applications. The Inter-agency Earth Observation information collaboration technologies based on this condition and sustainable methods for developing countries need to be considered. The basic assumption of the next generation EO system is the existence of different information architectures. Some new technologies, such as grid, have been used to glue these resources together. The meaning for developing countries is that they can simply select the baseline technology and tools to build their information systems and infrastructures at once. They do not need to consider updates in the near future to fit the development of new technology and user requirements. The next generation Inter-agency Earth Observation information collaboration technologies can help many kinds of EO data resources to work well together.
- 2) This workshop can build a mechanism for the communication between AP global change researchers within WGISS, as well as with other partners. Through the GEOSS ADC, CODATA and UN GAID. APN can continually receive help from these relationships.
- 3) A new concept of Global Change Asia-Pacific Wide Grid is brought forward at this time. Some follow-up works will be arranged to promote the implementation of the workshop results by the volunteers' team funded through this workshop.
- 4) This project is designed as a regional activity and it will focus on East Asia area in this stage. It is hoped that the experience of this stage can be expanded to other AP areas in subsequent APN activities, for example in the South-East Asian countries next time.

(6) Lesson learned on data democracy

- 1) To make more datasets open to developing countries
- 2) To provide comprehensive and integrated data search portal
- 3) To promote developing countries' awareness to use these datasets and portal
- 4) To cooperate with global and regional communities in using such new data facilities (Layer 1)
- 5) To encourage and help such countries to create their WS based local portal to connect provided data facilities (Layer 2)

Data sharing from Level 1 to Level 2:

- 1)In this case, Mongolia asked us to help create portal in their language to connect our resources
- 2)China GC Data Portal (GCDP) and European GENESI-DR have agree to consider support them
 - Invoke GCDP and GENESI-DR services
 - Mongolia style portal
 - Simple to use portal
 - No local data replica and storage
- 3)It is a way to promote democracy, which is open for all
- 4)We are documenting the MOU, which is hoped to be funded by APN 2010

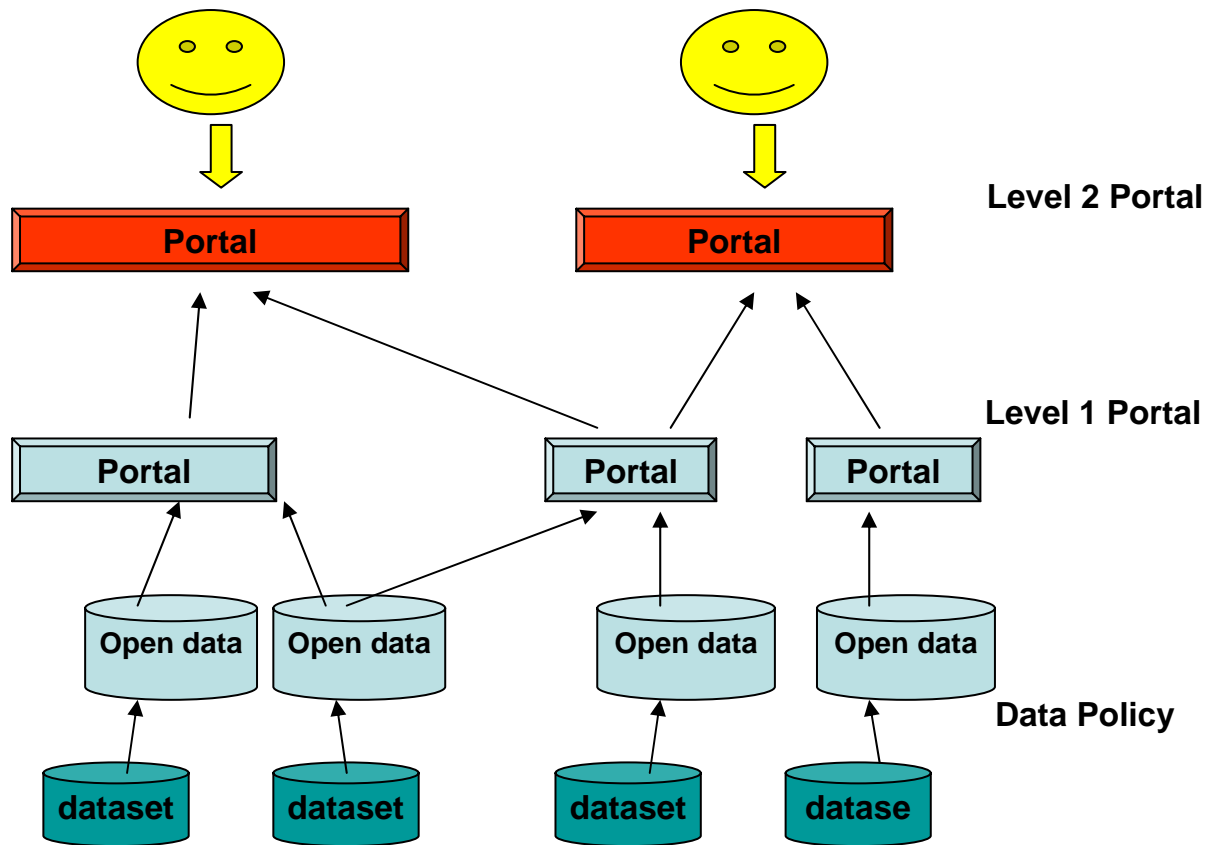


Figure 7. Data sharing based on Data policy

(5) An operational website that provides user information and collected best practices

An operation website was built and maintained in this project. The website includes project information, resources, Handbook, best practices and events.



Figure 8 Project collaboration website
(<http://int.ceode.ac.cn/apn/>)

4.0 Conclusions

(1) How can we establish a communication platform for regional collaboration?

A communication platform is built for regional collaboration. Earth observation technology for Global change in developing countries, in issues such as dry land research, disaster mitigation, etc introduced to developing countries like Mongolia. Two showcases are used: 1) international disaster mitigation data network: international EO data assistant for Wenchuan(China) earthquake.2) Mongolia dryland sustainability.

(2) How to introduce the latest EO data and information-serving technologies to GCR scientists?

From 12th to 15th of September, 2009 Ulaanbaatar, Mongolia, a workshop on Inter-Agency Collaborative Technologies in Earth Observations for Global Change Research in the Asia-Pacific Region was held. Also a Young Scientists Conference on Global Environmental Change was organized in Hustai National Park, Mongolia. The objectives of the workshop are to help young scientists to exchange information and to promote human networks among them. Seven young scientists from China, Japan and Mongolia Presented at the session and reported their recent research activities.

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This proposed project is pushing the technical capabilities of global change researchers, particularly in developing countries, to be able to effectively and equally access quality data and data-processing

resources with the new technical facilities. It will be providing more data access to the developing countries in the A-P area.

(4)How to contribution of Each Participating Country and Organizational Arrangements?

ICSU, as the main responsible body for the global-change program of IGBP, IHDP, DIVERSITAS and WCRP, has also shown interest and expressed the importance of this activity. China has been the main partner in charge of the organization and implementation of all project activities. Japan is dealing with the young generation of scientists. Dr. Tomoko is very outstanding young scientist and she has had full experience on young scientist society. The task of Mongolia is to coordinate with team members in Russia and China in establishing a portfolio of “best practices.”

(5) Project proposed output

- 1) An international training workshop has be organized and held in Ulaanbaatar, Mongolia.
 - a. 12th ~15th of September, 2009. Ulaanbaatar, Mongolia: International Training Workshop
 - b. 17th~18th of July, 2009, Harbin, China: Preparation Meeting in Harbin
- 2) A joint ISDE session was organized in Beijing. CEODE,CEOS,ISDE,ICSU-CODATA,GEO, UNGAID supported the session.
 - a. 10th of September, 2009; Beijing, China: Joint ISDE Session "Data Services Infrastructure for Global Change Research"
- 3) An operational website was setup to provides user information and collected best practices
 - a. <http://int.ceode.ac.cn/apn/>
- 4) Attended several international symposium for Dissemination
 - a. 4th GEO-AP Symposium, Bali, Indonesia, 11th of March, 2010
 - b. 2nd MAIRS, Changchun, China, 25th of July, 2009
 - c. WGISS meeting, Pretoria, South Africa, 28th of Sept, 2009
- 5) Collection CD of reports and presentations had been made and distributed to participants.

5.0 Future Directions

Through the implementation of this proposal, many experience and inter-agency collaboration techniques on earth observation has been obtained, which is potential for the future work. The international training experience for young scientists and experts obtained from this project can be used in other developing countries. The collaboration technique from GC experts on how to use EO technology can be used in the related GC research project in the future.

Following work have been addressed as the future follow-up of this project:

- (1) To publish a handbook, this will make collection of the leading inter-agency data system's user guide, the EO data sharing principle from GEOSS and CODATA, as well as the technical white-books from leading organizations. It will be delivered to scientists in AP area and it is believed to be helpful for the local experts.
- (2) To apply inter-agency data systems to support some select GCR research cases in AP area.

References

Follow a standard format when citing your references

4. APN website, <http://www.apn.gr.jp/newAPN/indexe.htm>
5. CEOS/WGISS website, <http://www.ceos.org>
6. GEOSS website, <http://www.earthobservations.org/>
3. UN GAID website, <http://www.un-gaid.org/>
4. CODATA website, <http://www.codata.org/>

5. GPOD website, <http://gpod.eo.esa.int/>
6. ICSU website <http://www.icsu.org/>

Appendix

Appendix 1: Data Service Infrastructure for Global Change Research Joint Session under ISDE conference with CODATA & WGISS



(APN Reference: CBA2009-10NSG-Li)



Data Service Infrastructure for Global Change Research Joint Session

under ISDE conference with CODATA & WGISS

September 11th, 2009

Beijing International Convention Center (BICC), Beijing, China



Session Agenda

Thursday Afternoon Meeting Room G

THU. PA.G1: Thursday, September 10, 13:30-15:10

PA.G1 - Data Service Infrastructure for Global Change Research (I)

Room G

Co-Chairs: Chuang Liu and Nordin Hasan

No	Time	Paper Topic	Name
1	13:30-13:50	Data Sharing Policies for Promoting Global Change Research	Uhlir, Paul
2	13:50-14:10	Land Cover Change and Desertification Maps of Agricultural Region of Mongolia	Chuluun, Togtoh
3	14:10-14:30	APN: Networking and Global Earth Observations	Stevenson, Linda Anne
4	14:30-14:50	WGISS Activities and Spatial Data Services for Global Change Research	Liu, Dingsheng
5	14:50-15:10	ICSU Scope and Action on Global Change Research	Hasan, Mohd Nordin

THU. PA.G2: Thursday, September 10, 15:30-17:30

PA.G2 - Data Service Infrastructure for Global Change Research (II)

Room G

Co-Chairs: Dingsheng Litt and Linda Anne Stevenson

No	Time	Paper ID	Paper Topic	Name
1	15:30-15:50		UN GAID e-SDDC and Its Activities in the AP Region	Liu, Chuang
2	15:50-16:10		NASA Activities on Easy Access Portal	Di, Liping
3	16:10-16:30		Young Scientist and Global Change Research	Doko, Tomoko
4	16:30-16:50		New Generation Spatial Data Infrastructure and Its Application on Disaster Mitigation	Li, Guoqing
5	16:50-17:10	043069575	The Global Eye: Simultaneous Earth System Presentation	Emmart, Carter David, Herring Zhu, Jin Wang, Yanping

• Full program can be accessed from [here](#).

Contact Information

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Appendix 2. Preparation meeting



(APN Reference: CBA2009-10NSG-Li)



Inter-Agency Collaborative Technologies in Earth Observations (EO) for Global Change Research in the Asia-Pacific Region

Preparation Meeting

July 17th~18th, 2009

FRIENDSHIP PALACE HOTEL, Harbin, China



Meeting Agenda

17th of July

9:00-9:15	Welcome Speak	Guoqing Li
9:15-10:00	Report on APN project working plan	Guoqing Li
10:00-10:30	Discussion on Working Plan	
10:30-11:00	Coffee Break	
11:00-11:30	Report on ISDE joint session	Jibo Xie Dingsheng Liu
11:30-12:00	Discussion on ISDE workshop	
12:00-2:00pm	Lunch	
2:00pm-3:00pm	Report on UB workshop preparation	T. Chuluun, Guoqing Li
3:00pm-4:10pm	Discussion on UB workshop	
4:10pm-4:30pm	Coffee Break	
4:30pm-5:00pm	Report on UB travel and budget	Guoqing Li T. Chuluun
5:00pm-5:30pm	Discussion on travel plan	
6:00pm	Reception Dinner	

18th of July

9:00-9:30	Report on project website	Guoqing Li
9:30-10:00	Discussion on website building	
10:00-10:30	Best Practices	Guoqing Li Chuang Liu
10:30-11:00	Discussion on Best Practices	
11:00-11:30	Report on GC-APWG and its MOU	Guoqing Li
11:30-12:00	Discussion on GC-APWG	
12:00	Lunch	
2:00pm-5:00pm	Additional discussion	all
5:00pm	Close of Preparation meeting	

Participants

Dr. Guoqing Li	CEODE, CAS
Dr. Jibo Xie	CEODE, CAS
Ms. Lin Zhang	CEOS, CAS
Dr. Pakorn Apaphant	CEOS/AGISS, GISTDA
Dr. Togtoh Chuluun	NUM
Prof. Tsolmon Renchin	Mongolian RS Society

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Appendix 3. From 12th to 15th of September, 2009 Ulaanbaatar, Mongolia, a workshop on Inter-Agency Collaborative Technologies in Earth Observations for Global Change Research in the Asia-Pacific Region

International conference on 12 September 2009			
<input type="checkbox"/>	Name	Presentation title	Organization
1	T. Chuluun	Dryland research in Mongolia	NUM-ITC-UNESCO, Laboratory RS/GIS, Dryland Sustainability Institute
2	Liu Chuang	UN GAID e-SDDC and its activities in the AP Region	UN GAID e-SDDC
3	Tsolmon	LUCC research activities in Mongolia	Dryland Sustainability Institute, NUM, Mongolia
4	Guoqing Li	New Generation Spatial Data Infrastructure and its application on disaster mitigation	CEODE, CAS, China
5	Dingsheng Liu	WGISS activities and spatial data services for global change research	CEOS/WGISS
6	Paul Uhlir	Data Sharing Policies for Promoting Global Change Research	Data Sharing Policies for Promoting Global Change Research, USA
7	Luigi Fusco	New European Geospatial Data Infrastructure and Global Change	European Space Agency (ESA), Italy
8	Mohd Nordin Hasan	ICSU scope and action on GCR	ICSU-AP office, Malaysia
9	Tomoko Doko	Young scientist and Global Change Research	PhD candidate, Keio University, Japan

Hands-on Training Session		
Training Course	Trainers	Time
EO data online access	Jibo Xie, Guoqing Li, Luigi Fusco	9:00~ 12:00 September 13, 2009
Web Service Development	Jibo Xie, Guoqing Li	2:00~ 5:00 September 13, 2009
Data Integration and Data Mining for Grassland Evaluation	Chuang Liu	9:00~ 12:00 September 14, 2009

14:00-16:00 Young Scientists Session, (Each people 15 min)

<input type="checkbox"/>	Name	Presentation title	Organization
1	Tomoko Doko	Young Scientists and Global Change Research	PhD candidate, Keio University, Research Fellow of the Japan Society for the Promotion of Science. Co-chair of The UN GAID e-SDDC Young Scientists Forum (YSF)
2	B.Tserenchunt	Social survey Scenarios, analysis and special study	Dryland Sustainability Institute
3	Jibo Xie	Inter-Agency Collaborative technologies application – EO Data Access for Dry Land Research	CEODE, CAS, China
4	T.Erdenzaya, N.Enkhjargal	Landcover Monitoring Using NDVI in Mongolia	NUM-ITC-UNESCO laboratory for RS and GIS, National University of Mongolia
5	M.Altanbagana	Dryland Development Paradigm (DDP) Application for Pastoral Systems in the Southern Khangai Mountains, the Most Vulnerable to Climate and Land Use Changes in Mongolia (DDPPaS)	Dryland Sustainability Institute
6	N.Elbegjargal	National Remote Sensing Center, ICC, MNE	Remote Sensing and GIS specialist Information Centre and Technology and www.icc.mn
7	Prof, N.Bandi	Hustai National Park	Director of Husati National Park
8	Linda Anne Stevenson	Asia-Pacific Network for Global Change Research	APN scientific officer

Appendix 4: Funding sources outside the APN

A list of agencies, institutions, organisations (governmental, inter-governmental and/or non-governmental), that provided any in-kind support and co-funding for the project and the amount(s) awarded. If possible, please provide an estimate amount.

- 1. CEODE, CAS (Center for Earth Observation and Digital Earth) has provided website developing and maintaining resources, which cost about 6,000 USD.*
- 2. NUM (National University of Mongolia) has provided local venue and coffee for the training workshop, which cost about 2,000 USD*
- 3. CEODE, CAS (Center for Earth Observation and Digital Earth) has provided secretary service for three workshops, which valued about 3,000 USD.*

The totally in-kind funding from outside is about 11,000 USD totally.

Appendix 5: List of Young Scientists



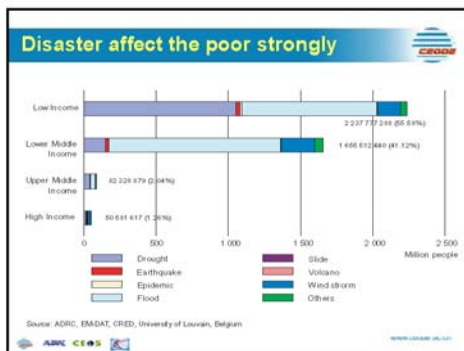
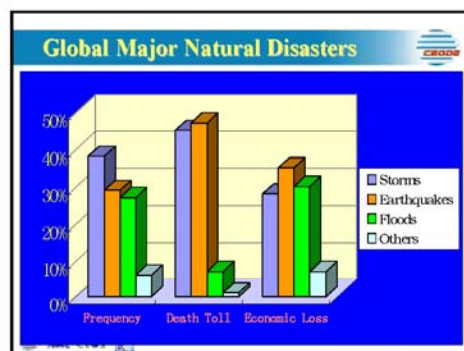
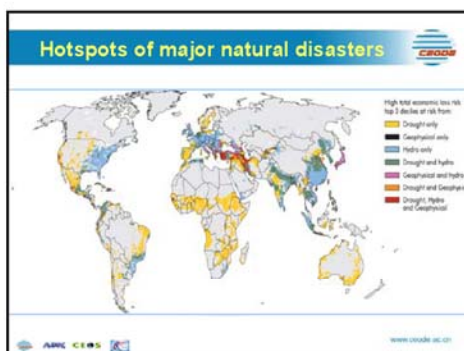
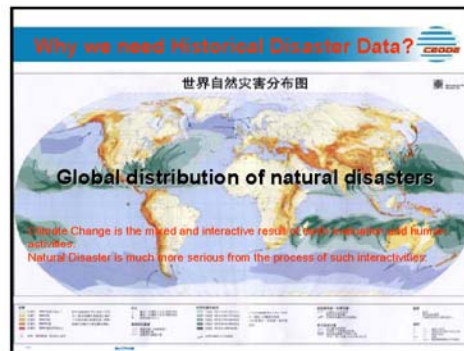
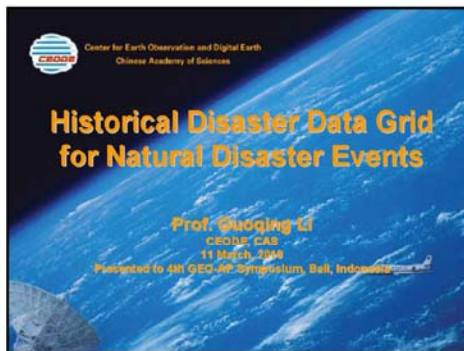
Name	Institution	Email	Address
Tomoko Doko	PhD candidate, Keio University, Research Fellow of the Japan Society for the Promotion of Science.	docochan@sfc.keio.ac. jp	3F, Z-building of Keio University 5322 Endoh, Fujisawa, Kanagawa, 252- 8520 Japan
B.Tserenchunt	Dryland Sustainability Institute	Tserenchunt.b@mail. mn	P.O.Box: 210349/20-8 Ulaanbaatar, Mongolia
Jibo Xie	Center for earth observation & digital earth	jbxie@ceode.ac.cn	45 Bei San Huan Xi Rd, Beijing, 100086, China
T. Erdenzaya	NUM-ITC-UNESCO laboratory for RS and GIS, National University of Mongolia	erdenezaya@gmail.co m	National University of Mongolia
M. Altanbagana	Dryland Sustainability Institute	a_baganad@yahoo.co m	P.O.Box: 210349/20-8 Ulaanbaatar, Mongolia
N.Elbegjargal	Remote Sensing and GIS specialist, ICC		Information & Computer Center Juulchiny gudamj 5 Ulaanbaatar 15160 Mongolia

Appendix 6: Glossary of Terms

Include list of acronyms and abbreviations

EO	Earth Observation
AP	Asia-Pacific
GC	Global Change
CEOS	Committee on Earth Observing Satellites
WGISS	The Working Group on Information Systems and Services
UN-GAID	The Working Group on Information Systems and Services
e-SDDC	Global Alliance for Enhancing Access to and Application of Scientific Data in Developing Countries
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
CODATA	Committee on Data for Science and Technology
ISCU	International Council for Science
ICSU-ROAP	ICSU Regional Office for Asia&Pacific
GC-APWG	Global Changing Asian-Pacific Wide Grid
PWTW	APN Proposal-Writing Training Workshop
CEODE	Center for Earth Observation and Digital Earth
CAS	Chinese Academy of Science
GISTDA	Geo-Informatics and Space Technology Development Agency
ASIAES	The ASEAN+3 Satellite Image Archive for Environmental Study
UNOOSA	United Nations Office for Outer Space Affairs

Appendix 7: Prof. Guoqing Li Presented to 4th GEO-AP Symposium, Bali, Indonesia:



- The mitigation activities from scientific society
 - ◆ Prediction
 - ◆ Monitoring
 - ◆ Re-Construction
- Well-using of Scientific Data is very important for disaster reductions
 - ◆ Earth Observation Data
 - ◆ In-situ Data
 - ◆ Thematic Data
 - ◆ Background Data
 - ◆ Social-economic Data

The Gap of Data using in Disaster Mitigation

- Capacity of satellite observation
 - ◆ orbit, sensor, weather condition.....
- Capacity of real-time processing
 - ◆ Disaster thematic model
 - ◆ Fast detection software
 - ◆ Supporting from Supercomputers
- Capacity of data infrastructure
 - ◆ Distributed data providers
 - ◆ Complicated searching and accessing
- Historical Data
 - ◆ Background Data
 - ◆ Comparative Data
 - ◆ Pass Events' Data

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Data Using Analyses of Wenchuan Earthquake Disaster (12 May, 2008)

Earthquakes over a 30 hour period after the main shock

The duration of high frequent data using in Wenchuan case is only three weeks

Case 1: Wenchuan Earthquake

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Case 2. World Flood Monitoring Grid

Flood event	Date	Satellite instrument	Source of data	Date of imagery acquisition	Date of imagery delivery	Date of product delivery
river Zambezi, Mozambique	Jan-Feb 2008	ENVISAT ASAR WVM	ESA Cab-1	5 February 2008	6 February 2008	8 February 2008
river Mekong, Thailand and Laos	10 August 2008	ENVISAT ASAR WVM	ESA Cab-1	16 and 20 August 2008	20 August 2008	20 August 2008
river Koshi, India and Nepal	18 August 2008	ENVISAT ASAR WVM	ESA Cab-1	20 August 2008	20 August 2008	1 September 2008
Hai Ni City, Vietnam	30 October 2008	ENVISAT ASAR WVM	ESA Cab-1	7-8 November 2008	20 November 2008	21 November 2008
Western Ukraine	23-27 July 2008	SPOT 2-5 (no SAR was available)	International Charter was activated by ROSA. Map produced by SEPTIT	3-4 August 2008	3-4 August 2008	4 August 2008
river Zambezi, Zambia	end March 2009	ENVISAT ASAR WVM	ESA Cab-1	24 March 2009	25 March 2009	26 March 2009
river Norman, Australia, 2009	Jan-Feb 2009	RADARSAT-2	CSA/MSA through GEOSIS Disaster WG, Flood Sensor Web	14 and 17 February 2009	25 February 2009	1 March 2009
Lake Lembeh, Namibia, 2009	20-30 May 2009	RADARSAT-2	CSA/MSA through GEOSIS Disaster WG, Flood Sensor Web	20, 22, 23, 30 May 2009	5 June 2009	17 June 2009
Taiwan 2009	9 August 2009	ENVISAT	ESA Cab-1	11, 14 August 2009	11, 14 August 2009	12, 16 August 2009

Materials from Prof. Natalia Kussul, NASU-NSAU

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Ukraine, river Tisza, 2001 China, river Huaihe, 2007 Mozambique, river Zambezi, 2008

Vietnam, 2008 India and Nepal, river Koshi, 2008 Zambia, river Zambezi, 2009

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WDDG as an e-Infrastructure

- Targets of Historical Disaster Data Grid
 - ◆ To **achieve** the scientific data of each disaster (above certain level)
 - ◆ To **bridge** disaster event with international EO data infrastructures
 - ◆ To make **easy** accessing of assistant EO data from volunteer space agencies
 - ◆ To collect and provide the necessary **background** data and disaster evaluation data
 - ◆ To keep and promote the data **democracy** around the world
 - ◆ To make it possible for disaster suffering country and region to generate thematic disaster information by **themselves**

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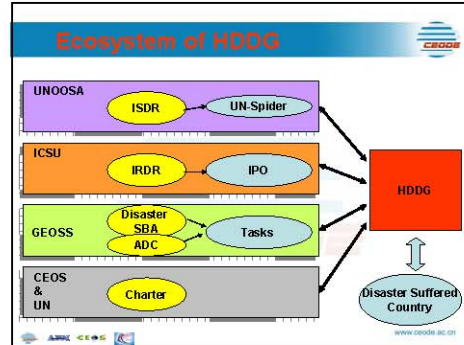
Data on certain disaster event should

- ◆ be captured
 - (ordering, imaging, receiving and preprocessing)
- ◆ be provided
 - (authorization, publishing and transfer)
- ◆ be stored
 - (save to disks and databases, temporary storage)
- ◆ be managed
 - (metadata generating, re-formatting, registration)
- ◆ be archived
 - (operational and long term storage)
- ◆ be reused
 - (scientific study and comparative using)

This moment
Way to go




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Initial Partners of HDDG

- As an idea from CEOSWGISS
 - ◆ Disaster Risk Management Task (with GEOSS and UN-SPIDER)
 - ◆ Data Democracy Task (with UNGAID/reSDDC)



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- As an output of APN project
 - ◆ Inter-Agency Collaborative Technologies in Earth Observations (EO) for Global Change Research in the Asia-Pacific Region (APN 2008-2010)
 - ◆ Original call on "Global Change Asia-Pacific Wide Grid" was specialized to be
 - Regional Global Change Data WAG
 - Regional Disaster Mitigation Data WAG




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HDDG Technical Overview

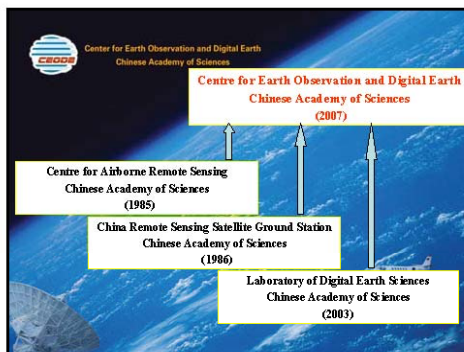
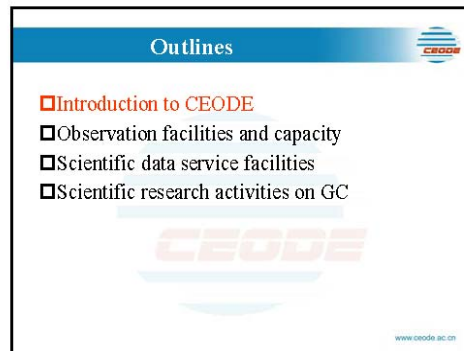
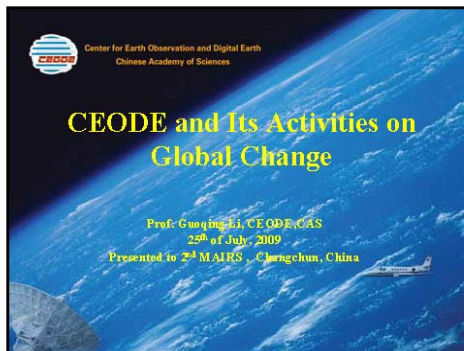
- For data provider
 - ◆ Distributed data collection storages around the world (Each continental ?)
 - ◆ Decentralized architecture (Grid..)
 - ◆ OGC compatible integration middleware for existent data infrastructures
 - ◆ Original format data upload
 - ◆ Multi-point upload
- For data user
 - ◆ One-stop portal for accessing
 - ◆ Self-defined portal and Local language service
 - ◆ Free access to all metadata and security access to physical data

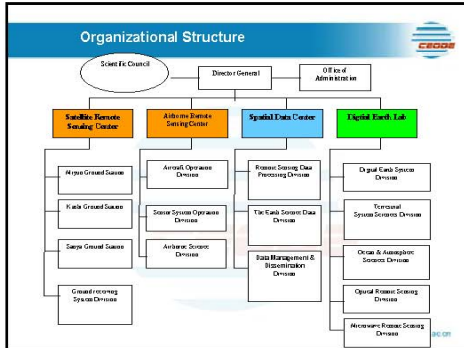


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Appendix 8: Prof. Guoqing Li presented to 2nd MAIRS , Changchun, China, 25th of July, 2009:





Outlines

- Introduction to CEODE
- Observation facilities and capacity
- Scientific data service facilities
- Scientific research activities on GC

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Observation facilities and capacity

- Satellite Ground Station Networks
- Airborne Remote sensing systems

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Satellite Ground Station Networks

Hwyzon ground station
Fkale ground station
Sanyu ground station

Data coverage of the three ground receiving stations

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RESOURCESAT-1, JERS-1, RADARSAT-1, SPOT-1, LANDSAT-7, SPOT-2, SPOT-4, SPOT-5, CBERS-01, ERS-1, ERS-2, ENVISAT-1, LANDSAT-5, Terra&Aqua, CBERS-02

More than 16 Satellites Received by CEODE(RSGS)

Middle Resolution and High Resolution Remote sensing Data


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- Receiving and Archiving
Landsat-5/7, SPOT-2/4/5, Radarsat-1, ERS-1/2, ENVISAT, IRS-P6, MODIS
- Receiving
Chinese Satellites (CBERS-02B, HJ-1A, HJ-1B)
- Resell
ALOS, ASTER
IKNOS, QuickBird

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Airborne Remote sensing systems

□ Two Cessna Citation S/II airplanes were equipped in 1986. Optical, IR, Microwave are mounted in the aircrafts.



Optical Sensor

SAR Sensor

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□ Two new much bigger aircraft will join this team in next two years, with 10 new sensors



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Outlines

- Introduction to CEODE
- Observation facilities and capacity
- Scientific data service facilities
- Scientific research activities on GC

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□ EO Data Center

- ◆ Over 150TB Satellite Data Archived
- ◆ Worldwide largest civil EO Data archive of China Area for more than 20 years
- ◆ Well organized Data Portal and Clearinghouse
- ◆ With high performance on-demand processing capacity

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□ Global Change Data Sharing Facility

- ◆ CEODE is developing the cooperated clearinghouse and one-stop data service platform for Global Change Research
- Global Change Geoscience Data Cooperation Platform (GCDP)
- ◆ It is planned to be published at the middle of next year

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□ Data type defined in GCDP

- ◆ Imagery Data (Spaceborne and Airborne data, Geographic data)
- ◆ In-situ Data
- ◆ Model Description Data
- ◆ Simulation Data (Modelling output)

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Outlines

- Introduction to CEODE
- Observation facilities and capacity
- Scientific data service facilities
- **Scientific research activities on GC**

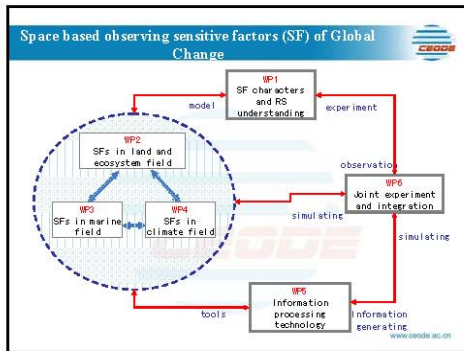


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Scientific research activities on GC

- Space based observing sensitive factors of Global Change (*Major State Basic Research Development Program of China, 973 project*)
- ABCC Global Change Comparison Study (*international cooperation projects supports by both CAS & NSFC*)
- Inter-Agency Collaborative Technologies in Earth Observations (EO) for Global Change Research in the Asia-Pacific Region (*APNCAPaBLB Projects of 2008 & 2009*)

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Joint Space-Air-Ground Observing

- ◆ Two experiment areas
- ◆ More experiment areas will be fixed (include arid and semi-arid test site)

Qinghai-Tibet Plateau Bohai Bay

Welcome Joint Observing activities with MAIRS and other programmes

- 2009-05 Joint observing in Sichuan
- 2009-08 Joint observing in four areas of Qinghai-Tibet
- 2009-later Joint observing in Bohai Bay

Qinghai-Tibet test areas

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ABCC Global Change Comparison Study

The four typical countries in the program: China, Australia, Brazil and Canada are largest countries in Asia, Oceania, South America and North America, respectively, cover 1/4 of total continental lands in the world.



Scientific Issues

- ◆ Spatial information recognition for typical global environmental change phenomena.
- ◆ Interaction mechanism of optical and microwave with typical environmental factors.
- ◆ Combination of temporal and spatial RS observations for global environmental change.
- ◆ Data assimilation techniques for multi-platform and multi-frequency RS observation data.

Main Topics:

- ◆ Snow-Ice and Glacier Covered and Lake Changes
- ◆ Arid & Semi Arid Vegetation Change
- ◆ Tropical Rain Forest Bio-Diversity
- ◆ Environmental Change in Urban Area

Test Area

- ◆ Select Typical Arid, Semi-arid, Snow Covered, Glacier, High Elevation Lakes, Vegetated and Urban Areas.

Inter-Agency Collaborative Technologies in Earth Observations (EO) for Global Change Research in the Asia-Pacific Region

The Asia-Pacific Network for Global Change Research (APN) is an inter-governmental network for the promotion of global change research and links between science and policy making in the Asia-Pacific region.

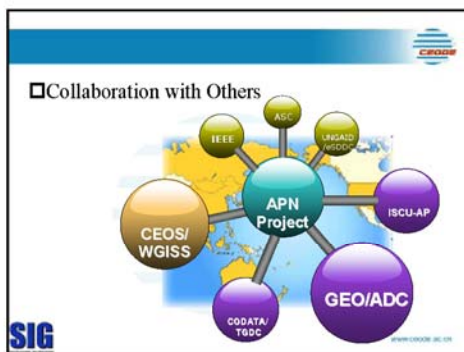
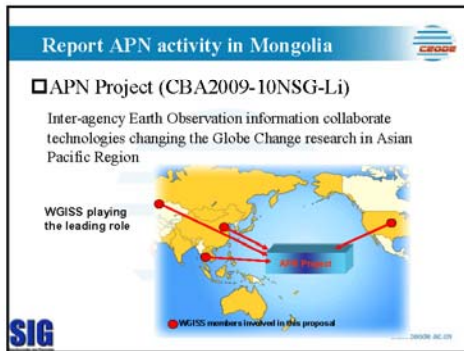
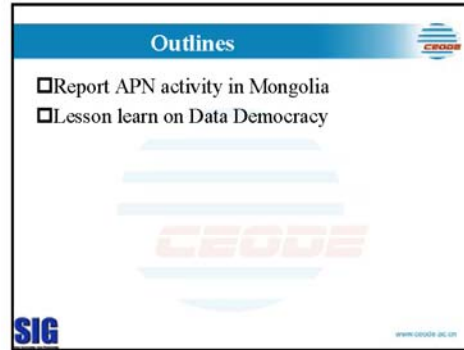
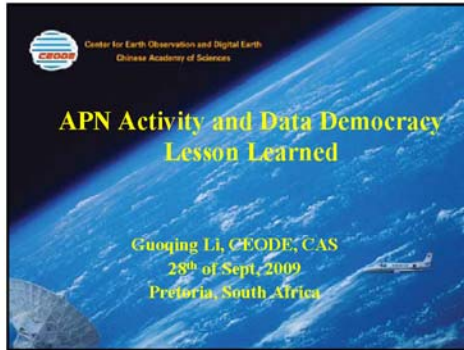
The target of this project is to

- ◆ bring the experience and knowledge on EO from CEOS/WGSS to scientists in the AP area,
- ◆ discuss how to use the new EO information technology (NGSDI),
- ◆ find appropriate approaches to develop their global change models based on this new EO capability and support,
- ◆ call for cooperation on building the AP regional GC scientific data sharing platform.



Appendix 9:

Prof. Guoqing Li presented to WGISS meeting, Pretoria, South Africa ,28th of Sept, 2009:

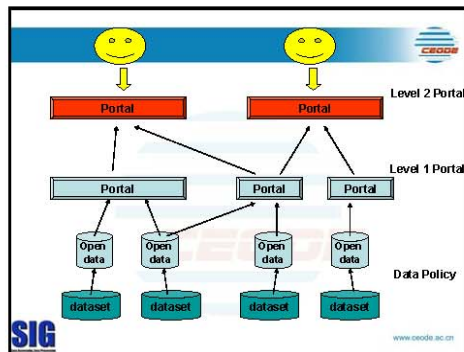




- Technical transfer to
 - ◆ National University of Mongolia
 - ◆ Mongolia Dryland Sustainability Institute
 - ◆ National Remote Sensing Center of Mongolia
- Technical be transferred
 - ◆ How to use EarthExplore, ECHO, GEO-Portal, GENESI-DR, as well as Chinese GCR Portal to access EO data
 - ◆ How to develop web service
 - ◆ How to connect EO data with scientific model



- ### Lesson learn on Data Democracy
- To make more datasets open to developing countries
 - To provide comprehensive and integrated data search portal
 - To promote developing countries' awareness to use these datasets and portal
 - To cooperate with global and regional communities in using such new data facilities (Layer 1)
 - To encourage and help such countries to create their WS based local portal to connect provided data facilities (Layer 2)



Appendix 10

Prof. Chuang Liu presented at APN International Training Workshop 12-15 September 2009, Ulaanbaatar, Mongolia

Data Integration and Data Mining for Grassland Evaluation

*Prof. LIU Chuang
Institute of Geography and Natural Resources, CAS
Co-Chair of Executive Committee of UN GAID e-SDDC*

*APN International Training Workshop
12-15 September 2009, Ulaanbaatar, Mongolia*

The Goals of the Class

- Learn the methodology how to integrate multiple sources data for research;
- Study how to input knowledge into the databases and create new knowledge through data mining;
- Practice how to use ICT technology, especially RS, GIS, Socioeconomic Information and mathematical models to do research for development
- Taking Mongolia Grassland as an Example

Targets of this Class

1. Based on the present data and information (RS, GIS and Socieco. Data) to classify Mongolia Grassland Suitability into 5 Levels:
 - Most suitable
 - Suitable
 - Limited Suitable
 - Suitable with risk
 - Unsuitable
2. Complete the Grassland Evaluation Map

Procedure

1. Data Integration
2. Data Mining
3. Result validation
4. Edit models and parameters
5. Mapping

Data Integration (1) – Data Collection

Soum (name)	elevation (meters)
slope (degree)	area (ha)
population (person)	camel (person)
horse (person)	cattle (person)
sheep (person)	goat (person)
precipitation (mm)	temperature (degree)
MSAVI (no unit)	NDVI (1km no unit)

Data Integration (2) – Data Normalization

Multi-sources and multi-unit data normalization:

1. Change total number of population, camel, horse, cattle, sheep, goat into total number per 1000 ha, get new items population1, camel1, horse1, cattle1, sheep1 and goat1;

Item population / area_ha * 1000
Item camel / area_ha * 1000
.....

**Data Integration (2) –
Data Normalization (3)**

Multi-sources and multi-unit data normalization:
2. Normalize NDVI in 1k resolution into Soum resolution

ENVI tool
Administrative Boundary in Soum level data
integrating with NDVI in 1k resolution
.....
put the NDVI in Soum data into info in ARCGIS

**Data Mining
– Mathematical Meddles**

1. Single element evaluation
2. Weights assignment for each of the elements
3. Multiple elements integration evaluation
4. result: 5 levels group data classified

**Data Mining
– Mathematical Models (1)
Single element evaluation**

Elevation:

$$Y_1 = 0, \text{ if } x_1 \geq 3800$$

Else, $x_1' = \text{number} / \text{maximum number}$

$$Y_1 = 1 / \sqrt{x_1'^2 + 1}$$

**Data Mining
– Mathematical Models (1)
Single element evaluation**

Slope:

$$Y_2 = 0, \text{ if } x_2 \geq 70$$

else, $x_2' = \text{number} / \text{maximum number}$

$$Y_2 = 1 / \sqrt{x_2'^2 + 1}$$

**Data Mining
– Mathematical Models (1)
Single element evaluation**

Precipitation:

$$Y_3 = 0, \text{ if } x_3 \leq 5,$$

$$Y_3 = 1, \text{ if } x_3 \geq 100,$$

else,

$x_3' = \text{number} / \text{maximum number}$

$$Y_3 = 1 / (1 + \sqrt{1 - x_3'^2})$$

**Data Mining
– Mathematical Models (1)
Single element evaluation**

Temperature:

$$Y_4 = 0, \text{ if } x_4 \leq 5,$$

else,

$x_4' = \text{number} / \text{maximum number}$

$$Y_4 = 1 / (1 + \sqrt{1 - x_4'^2})$$

Data Mining
 – Mathematical Models (1)
 Single element evaluation

MSAVI_mean:

$$Y_5 = 1 / 1 + \sqrt{1 - x_5'^2}$$

Data Mining
 – Mathematical Models (1)
 Single element evaluation

NDVI_mean:

$$Y_6 = 1 / 1 + 10 \sqrt{1 - x_6'^2}$$

Data Mining
 – Mathematical Models (1)
 Single element evaluation

Population per ha:

$Y_7 = 0$, if $x_4 \leq 100$,
 else,
 $x_7' = \text{number} / \text{maximum number}$

$$Y_7 = 1 / 1 + \sqrt{1 - x_7'^2}$$

Data Mining
 – Mathematical Models (1)
 Single element evaluation

Camel per ha:

$x_8' = \text{number} / \text{maximum number}$

$$Y_8 = 1 / 1 + \sqrt{1 - x_8'^2}$$

Data Mining
 – Mathematical Models (1)
 Single element evaluation

Horse per ha:

$x_9' = \text{number} / \text{maximum number}$

$$Y_9 = 1 / 1 + \sqrt{1 - x_9'^2}$$

Data Mining
 – Mathematical Models (1)
 Single element evaluation

Cattle per ha:

$x_{10}' = \text{number} / \text{maximum number}$

$$Y_{10} = 1 / 1 + \sqrt{1 - x_{10}'^2}$$

Data Mining
– Mathematical Models (1)
Single element evaluation

Sheep per ha:

$$x_{11}' = \text{number} / \text{maximum number}$$

$$Y_{11} = 1 / 1 + \sqrt{1 - x_{11}'^2}$$

Data Mining
– Mathematical Models (1)
Single element evaluation

Goat per ha:

$$x_{12}' = \text{number} / \text{maximum number}$$

$$Y_{12} = 1 / 1 + \sqrt{1 - x_{12}'^2}$$

Data Mining (2)
– Weights Assignment for each of
the 12 elements

- elevation (0.08)
- slope (0.07)
- population (0.02) camel (0.03)
- horse (0.08) cattle (0.06)
- sheep (0.06) goat (0.04)
- precipitation (0.16) temperature (0.11)
- MSAVI (0.15) NDVI (0.14)

Data Mining (3)
– Multiple Elements Evaluation

$$Y = \sum_{i=1}^{12} w_i * y_i$$

- elevation (0.08)
- slope (0.07)
- population (0.02) camel (0.03)
- horse (0.08) cattle (0.06)
- sheep (0.06) goat (0.04)
- precipitation (0.16) temperature (0.11)
- MSAVI (0.15) NDVI (0.14)

Data Mining (4)
– 5 levels group data classified

- E1 >= 0.65
- E2 >= 0.40, < 0.65
- E3 >= 0.32, < 0.40
- E4 >= 0.10, < 0.32
- E5 < 0.10

Result validation
Edit models and parameters
Mapping

Put the data into ARC/GIS
 ARCVIEW - Mapping