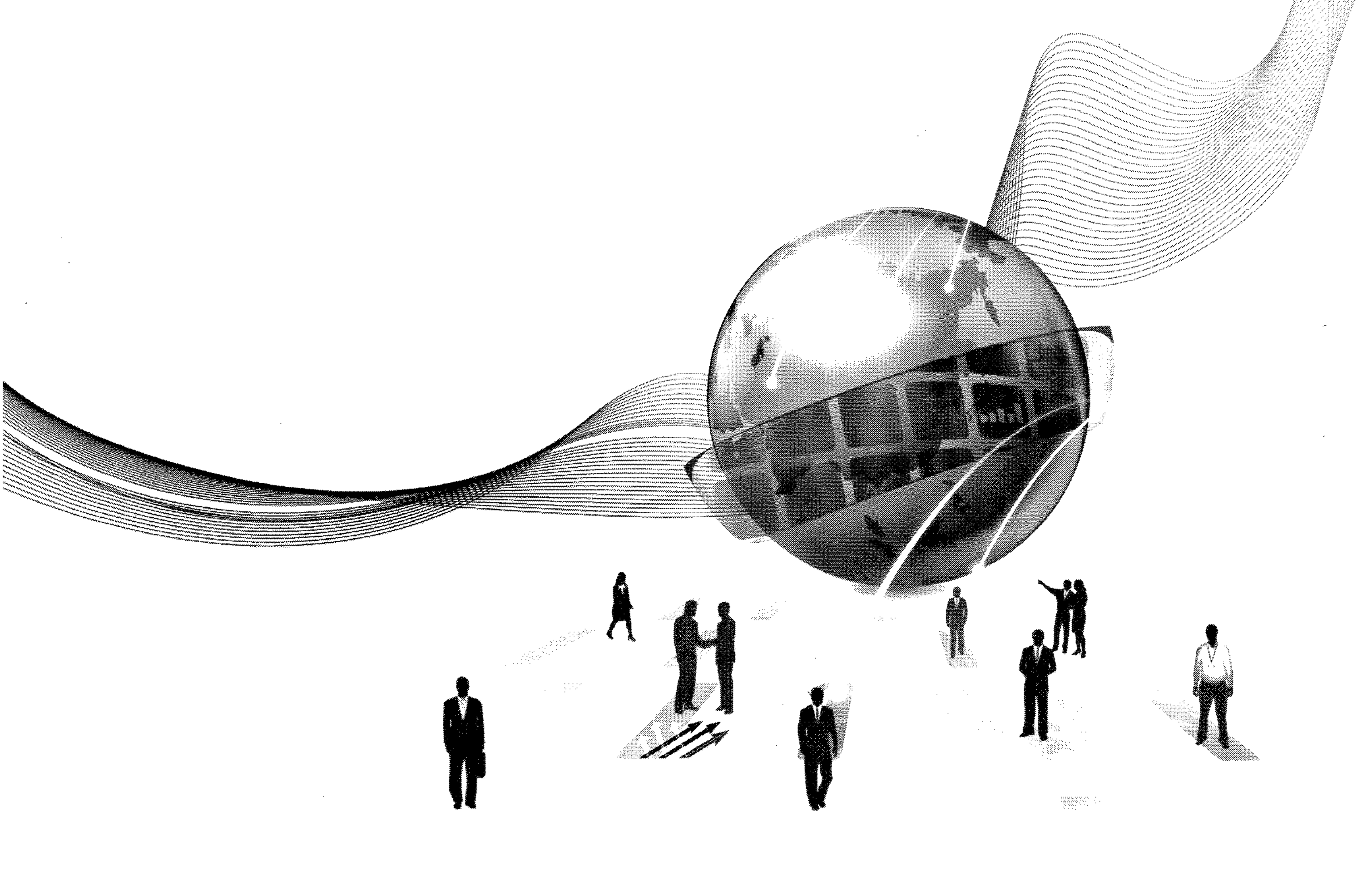
Smart Geospatial Expo 2012
2012 디지털국토엑스포

ICG-TEK 2012 | International Conference on sharing Geospatial Technology, Experience and Knowledge

소셜 인터페이스를 위한 공간정보 혁신

Geo Innovation for Social Interfaces

- 일 시 : 2012년 10월 11일(목)~12일(금) 10:00~18:00
- 장 소 : 서울 코엑스COEX 3층 회의실No.318



○ 주 최

국토해양부 Ministry of Land, Transport and Maritime Affairs 국토연구원 KRIHS

○ 후 원

한국측량학회 한국공간정보학회

History of International Seminar on GIS

	Theme	Date	Place	Organizing Committee	
				Chair	Member
1st (1996)	Strategies for NGIS Development	4.18-19	Seoul Education & Culture Center, KRIHS	Young-Pyo Kim, Director, Geospatial Information Center	Woo-Seok Cho, Mi-Jeong Kim Moon-Sub Chung
2nd (1997)	GIS Applications in the Public Sector	10.16-17	Seoul Education & Culture Center	Young-Pyo Kim, Director, Geospatial Information Center	Yong-Bok Choi, Mi-Jeong Kim
3rd (1998)	GIS Development Strategies for the 21st Century	9.10-11	Renaissance Seoul Hotel	Young-Pyo Kim, Director, GIS Research Center	Mi-Jeong Kim, Sung-Mi Park
4th (1999)	GIS in Local Government	9.16-17	Renaissance Seoul Hotel	Young-Pyo Kim, Director, GIS Research Center	Mi-Jeong Kim, Sung-Mi Park, Hong-Jun Choi
5th (2000)	Toward a Knowledge-based Society: NGIS Policy and Technological Development	9.28-29	Ritz-Carlton Seoul Hotel	Young-Pyo Kim, Director, GIS Research Center	Sung-Mi Park, Hong-Jun Choi
6th (2001)	Present and Future of GIS Technologies	5.17-18	Seoul Education & Culture Center	Young-Pyo Kim, Director, GIS Research Center	Sung-Mi Park,
7th (2002)	GIS Workshop & Seminar	11.8	COEX Intercontinental Hotel	Hyung-Min Yeom, Director, GIS Research Center	Dong-Han Kim
8th (2003)	Envisioning Cyber-geospace and Spatially enabled E-government	11.20-21	COEX	Young-Pyo Kim, Director, GIS Research Center	Jung-Hoon Kim Dong-Han Kim Seung-Mi Hwang Ki-Hwan Seo
9th (2004)	Emergency and Disaster Response with GIS	9.8-9	Seoul Education & Culture Center	Young-Pyo Kim, Director, GIS Research Center	Jong-Taek Park Dong-Han Kim Ki-Hwan Seo
10th (2005)	NGIS Policy in Ubiquitous Computing Environment	11.14-15	Seoul Education & Culture Center	Byoung-Nam Choi, Director, GIS Research Center	Jung-Hoon Kim Dong-Han Kim Jung-Yeop Shin Jin-Hyeong Park
11th (2007)	Collaborative GIS toward the Geospatial Information Society	10.24	KRIHS	Ho-Sang Sakong Director, Geospatial Information Research Center	Jung-Hoon Kim Young-Joo Lee Jae-Il Han
12th (2008)	NSDI Policy for National Spatial Data Integration	10.9	KINTEX	Ho-Sang Sakong Director, Geospatial Information Research Center	Jung-Hoon Kim Chun-Man Cho Mi-Jeong Kim Hae-Kyong Kang
13th (2009)	The World Geospatial: Trends and Prospects	9.10	KINTEX	Moon-Sub Chung Director, Geospatial Information Research Center	Ki-Hwan Seo Dae-Jong Kim Kyung-Hee Kim
14th (2010)	GI Application Strategies for Realizing SMART KOREA	9.1	KINTEX	Moon-Sub Chung Director, Geospatial Information Research Center	Young-Joo Lee Gye-Wook Kim Jae-Sung Choi
15th (2011)	International Collaboration for Global Geospatial Information Society	10.27	KINTEX	Moon-Sub Chung Director, Geospatial Information Research Center	Dong-Bin Shin Mi-Sook Yi Joo-Hee park Kyo-Min Kim
16th (2012)	Geo Innovation for Social Interfaces	10.11~12	COEX	Byoung-Nam Choe Director, Geospatial Information Research Division	Young-Joo Lee Dong-Han Kim Hoe-Hun Ha Ji-Young Oh

2012.10.11 (Thu)

프로그램 Program

Time	Program
09:30~10:00	Registrations
Opening Session	
10:00~10:10	• Opening Address : **Dr. Yang-Ho Park** (President of KRIHS) • Congratulatory address : **Mr. Sang-Woo Park** (Deputy Minister for Housing and Land, MLTM) • Welcoming speech : **Prof. Jae-One Lee** (Head of Korean Society of Surveying Geodesy Photogrammetry and Cartography)
10:10~10:50	[Keynote Speech] Beyond Spatial Enablement-Engaging Government, Industry and Citizens **Prof. Abbas Rajabifard** (University of Melbourne)
10:50~11:30	[Keynote Speech] A Way to Geo Innovation : Through a Love Affair between Gaia and Khronos **Dr. Young-Pyo Kim** (KRIHS)
11:30~12:00	Q&A
12:00~13:30	Lunch
Session 1 : Geo Innovations and Supporting Policies in East Asian Countries	
13:30~14:00	NSDI, Location Intelligence and Business Geographics in Japan **Prof. Hiroyuki Kohsaka** (Nihon University, Japan)
14:00~14:30	Web-based Geospatial Information Sharing Platform and its Application in China **Prof. Jianya Gong** (Wuhan University, China)
14:30~15:00	National GIS Strategic Development toward Geospatial Interoperability Application in Taiwan **Prof. Tien-Yin Chou** (Feng Chia University, Taiwan)
15:00~15:20	Coffee Break
15:20~15:50	Geo Cloud and Geo Social Network : Policy Implications of Spatial Information Industry in Korea **Prof. Il-Young Hong** (NamSeoul University, Korea)
15:50~16:20	Needs on Geospatial Technologies for Sustainable Development in Asia and the Pacific and Expectation for Collaborative Partnership **Mr. Yusuke Muraki** (Space Technology Specialist, Asian Development Bank)
16:20~16:40	Coffee Break
16:40~17:40	Panel Discussion Chair : **Prof. Woo-Sug Cho** (Inha University)
18:00~20:00	Receptions

2012.10.11 (Thu)

Time	Program	
9:30~10:00	Registrations	
Session 2 : National Spatial Data Infrastructure for Developing Countries I		
10:00~10:10	Opening	
10:10~10:30	Vietnam	• Hai Minh Pham (Vietnam Institute of Geodesy and Cartography) • Son Truong Nguyen (Center Archive of Land Information)
10:30~10:50	Philippines	• Febrina Espiritu Damaso (National Mapping and Resource Information Authority) • Joselito Turtal Reasol (National Mapping and Resource Information Authority)
10:50~11:10	Indonesia	• Tandang Yuliadi (Geospatial Information Agency) • Marcelina Rinny Hendrawati (Ministry of Public Works)
11:10~11:40	Q&A	
11:40~13:30	Lunch	
Session 3 : National Spatial Data Infrastructure for Developing Countries II		
13:30~13:50	Chile	• Sofia Alejandra Nilo (Ministry of National Property)
13:50~14:10	Uruguay	• María Victoria Alvarez (Montevideo City Hall) • Yuri Sebastián Resnichenko (Agency for the Development of Electronic Government)
14:10~14:30	Peru	• Edgar Huarajo Casaverde (Geographical National Institute of Peru) • Reynaldo Flores Rivero (National Geographic Institute) • Angelica Maria Portillo (National Superintendence of Public Registry)
14:30~15:00	Q&A	
15:00~15:20	Coffee Break	
15:20~15:40	Mongolia	• Adilbish Nergu (Administration of Land Affairs, Construction, Geodesy and Cartography)
15:40~16:00	Uzbekistan	• Omirbek Kamalov (Goscomzemgeodescadastre) • Bobomurod Makhsudov (National Centre of Geodesy and Cartography)
16:00~16:30	Q&A	
16:30~17:00	Coffee Break	
17:00~18:00	Discussions Chair : Dr. Byong-Nam Choe (Director of Geospatial Imformation Research Division, KRIHS)	

Speakers

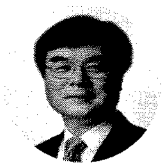
발/표/자

Head of the DIE, Director of CSDILA, Past President of GSDI

Abbas Rajabifard

Australia

Prof. Rajabifard is Head of the Department of Infrastructure Engineering and Director of the Centre for Spatial Data Infrastructures and Land Administration, both at the University of Melbourne. He is immediate Past-President of Global Spatial Data Infrastructure (GSDI) Association and is an Executive Board member of this Association and was Vice Chair, Spatially Enabled Government Working Group of the UN supported Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP). Prof Rajabifard has spent his career researching, developing, applying and teaching spatial information management and strategies and also SDIs to deliver benefits to both governments and wider society and is acknowledged as a pioneer in the concept of spatial enablement-using location to facilitate decision making. He has authored/co-authored over 240 publications including 6 books. He has been also consulted widely on spatial data management, SDI, land administration and spatial enablement, to many national government agencies and ministries. He is a frequent keynote speaker at international geospatial conferences, forums and organisations and through his academic and professional activities, tirelessly promotes the surveying and spatial science professions driven in his belief that these professions play an integral role in delivering the vision of a sustainable future.



Senior Research Fellow, Past Vice President of KRIHS

Young-Pyo Kim

Korea

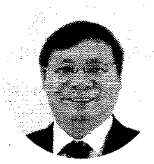
Dr. Kim is a senior research fellow and former vice president at the Korea Research Institute for Human Settlements (KRIHS). He has worked at KRIHS for 34 years. He had lead Korean GIS circles since the mid-1980s to 2005. He served as the chairman of the advisory committee for ubiquitous urban planning under the Ministry of Land, Transport and Maritime Affairs. He also participated as a member of the committee for special research and development zone under the Ministry of Knowledge Economy. His research fields cover spatial analysis and GIS, System Dynamics, history and policy of national territory development, land policy. His major research works include 「Strategies for Creating Cyber-National Territory toward the Ubiquitous World」, 「Integrated Spatio-temporal Simulation Model for National Territorial Policy」, 「History(1945~2008) of National Territory Development in Korea」, 「A Study on Land Policy Reform Measures」, etc.

Nihon University Professor, Past President of GISA

Hiroyuki Kohsaka

Japan

Prof. Kohsaka had his doctorate degree from Department of Geography at Tukuba University in 1975. He has worked in Geography Department of Nihon University at Tokyo for 30 years. He served as the President of GIS Association of Japan (GISA) between 2000 and 2002. Prof. Kohsaka has been head of Business GIS sub-committee at GISA and Visiting Professor at Center for Spatial Information Science, Tokyo University. He has implemented a wide range of Business GIS projects including geodemographics, customer prediction model, site evaluation system, location analysis for business solution as the President of Geographical Information Technology Institute (GITI).



Wuhan University Professor

Jianya Gong

China

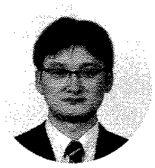
Prof. Jianya GONG got his doctorate degree from the department of photogrammetry and remote sensing in Wuhan Technical University of Surveying and Mapping in 1992. He has been as director of the State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing, Wuhan University from 2006, and has been Academician of Chinese Academy of Science from 2011.

Up to now Prof. Gong has experienced several professional careers in different countries. He worked as a lecturer at Department of Surveying and Mapping, East China Geology College from 1982 to 1988, and an Associate Professor at Department of Photogrammetry and Remote Sensing, Wuhan Technical University of Surveying and Mapping, from 1992 to 1995. He has been a Changjiang Chair professor at the State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing, Wuhan Technical University of Surveying and Mapping and Wuhan University since 1996,

His research interests include geospatial data structure and data model, geospatial data integration and management, geographical information system software, geospatial data sharing and interoperability, Photogrammetry, GIS and remote sensing application. He has published 12 books and more than 400 scientific papers.

Il-Young Hong

Korea



NamSeoul University Professor

Ilyoung Hong is Assistant professor, Department of GIS Engineering, Namseoul University. He had his doctorate degree from Department of Geography, University at Buffalo in 2007. He has been the research fellow at Software Industry Promotion Agency in Korea. He specializes in Software Industry Policy, Spatial Analysis and Web-Based Geographic Information Systems. He implements a wide range of GIS researches and projects, including Spatial Information Industry Policy in Korea, Geospatial Ontology of Place, Mobile Mapping, and Spatial Statistical Analysis.

Tien-Yin (Jimmy) Chou

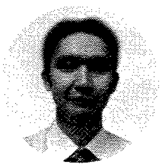
Taiwan

Feng Chia University Professor

Prof. Chou had his doctorate degree from Department of Resources Development at Michigan State University in 1990. He has been the Director of GIS Research Center of Feng Chia University (GIS.FCU) for 20 years, and served as a Distinguished Professor since 2009. With his profession and enthusiasm, Prof. Chou has performed an excellent achievement with his 140 employees to bring the GIS.FCU as one of the leading role in the GIS-related academic and industry field. GIS.FCU has implemented a wide range of GIS projects, including resource management, hazard monitoring, e-Learning, fleet monitoring, etc. He also supervises graduate students and teaches courses pertaining to GIS science, land management, and resources management at FCU. Prof. Chou also initiated the OGC Asia Forum with several partners from Asia area in 2011.

Yusuke Muraki

ADB



Space Technology Specialist, Asian Development Bank

Mr. Muraki had his master degree of Mechanical Engineering from Hokkaido University in 2005. He worked as an engineer and a flight controller for Japanese Experiment Module, "Kibo" in the International Space Station program in JAXA. After that he was assigned to Satellite Applications and Promotion Center of JAXA and engaged in the promotion of satellite applications. He started to work as Space Technology Specialist in Asian Development Bank since 2011 and has been promoting remote sensing and GIS application in the bank and its developing member countries.

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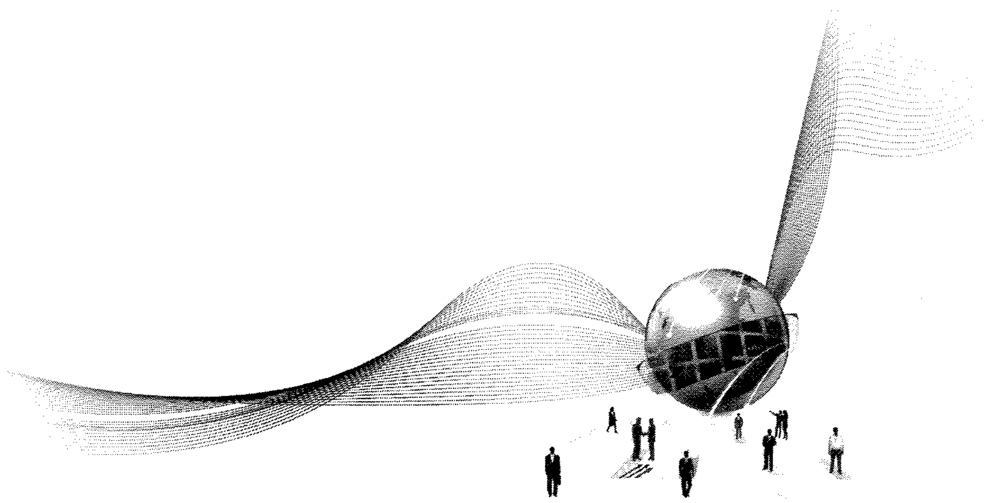


[Keynote Speech]

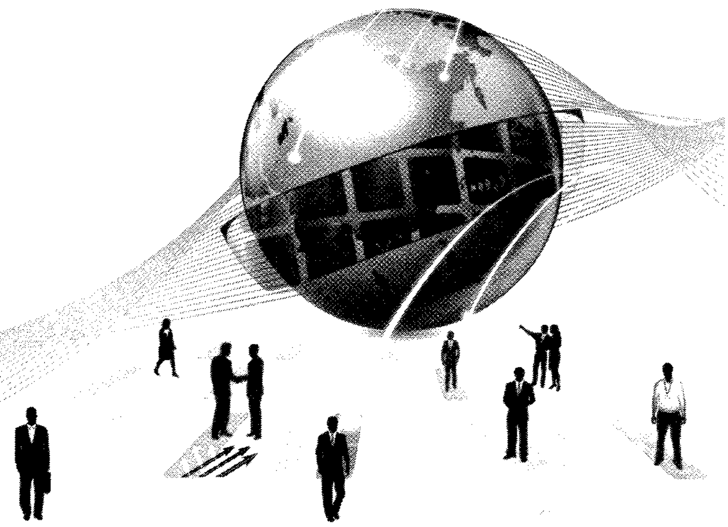
1

Beyond Spatial Enablement:

Engaging Government, Industry and Citizens

Prof. Abbas Rajabifard

(University of Melbourne)



Beyond Spatial Enablement: Engaging Government, Industry and Citizens

Abbas Rajabifard

The University of Melbourne, Australia
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Abstract

In response to challenges at all scales, there is an increasing use of geographic information technologies and spatial data infrastructures to underpin location-based information for better decision-making. Spatial enablement uses the concept of place and location to organise information and processes and is now a ubiquitous part of e-Government and broader government ICT strategies. But for spatial enablement to occur, it needs to be regarded as a concept that permeates all levels of society - government, industry and citizens.

The spatial community needs to make location, innovation and collaboration its key priorities to not only realise the vision of spatial enablement, but to move beyond it. Collaboration across levels drives spatial innovation to make better use of the available geo-spatial information and to create new, smart applications to harness, integrate and interpret this data. An enabling platform is key to facilitating delivery of spatial data and services. Establishing new partnerships will bring together communities of practice and enable knowledge sharing to overcome both technical and non-technical issues that still persist in realising spatial enablement.

Keywords: spatial enablement, spatial data infrastructure, collaboration, government, industry, citizens

1. Introduction and Background

As a global community, we continue to witness amazing technological advancements and progress. At the same time, we continue to face unprecedented challenges at multiple scales - the recent earthquake and tsunami in Japan; the widespread flooding in Australia; the ongoing ramifications of the 2009 Global Financial Crisis. These are just some examples of large-scale disasters that have had persistent and long-term consequences on communities.

These challenges will continue to exist and potentially be exacerbated as a result of urbanisation, population growth, the growth of coastal cities, climate change and the increasing interconnectedness of economies. These events underscore the demand for a spatially enabled society. Around the world, the use of geographic information technologies and spatial data infrastructure is becoming increasingly vital in enabling governments, local communities, non-government organisations, the commercial sector, the academic community and ordinary citizens to make progress in addressing many these challenges.

With advancing maturity in the use of spatial information resources, location is emerging as a key facilitator in decision-making and is now commonly regarded as the fourth driver in the decision- making process, complementing the more traditional triple bottom line approach (social, economic and environmental drivers). I note the pressing demands for further innovations, to make better use of the available spatial information, and the drive to create new, smart applications to harness, integrate and interpret spatial data. Effective and efficient geo-information as well as spatial information infrastructures plays a key role in supporting evidence-based decision-making to facilitate our response to the global agenda and achieving sustainable development. To move forward, there is a need for greater collaboration - forging new partnerships, bringing together communities of practice, sharing knowledge and working together to better prepare for and respond to global challenges.

The notion of spatial enablement, and a spatially enabled society, is a reference to the use of spatial information and technology across all levels of society - government, industry and citizens, to improve decision-making, transparency and increase efficiency. This paper will address the movement of societies to support the increasing use of location-based information in the delivery of services and processes. The paper discusses the concept of spatial enablement and provides examples of different initiatives around the world. Some of these will provide context for the benefits of engaging government, industry and citizens to leverage location information, facilitate collaboration and drive innovation to overcome current challenges in realising spatial enablement. The paper will conclude with some propositions on future trends and directions for moving beyond spatial enablement.

2. Spatial Enablement

Spatial enablement is a concept that adds location to existing information and thereby unlocks the wealth of existing knowledge about the land, its legal and economic status, its resources, potential use and hazards. Spatial enablement uses the concept of place and location to organise information and processes and is now a ubiquitous part of e-Government and broader government ICT strategies. It addresses the importance of an enabling platform to facilitate delivery of spatial enablement in government and society. It also highlights the need for connected technologies and connected organisations in order to realise spatial enablement (see Figure 1).

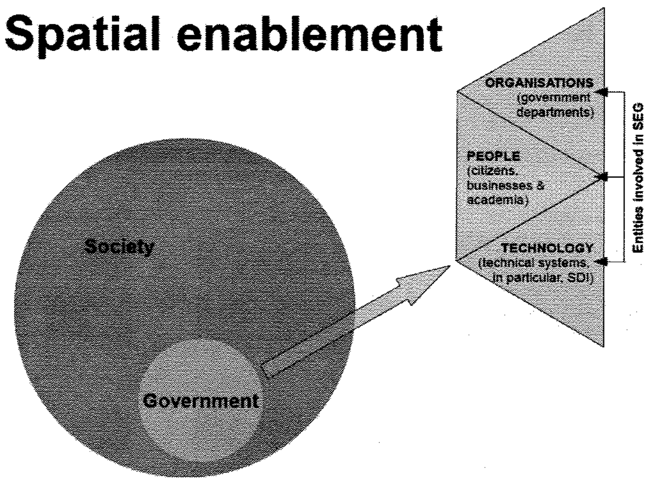

Figure 1. Spatially enabled government (Holland, Rajabifard and Williamson, 2009)

2.2 Spatially Enabled Society and Government

A Spatially Enabled Society (SES) is one where location and spatial information are commonly available to citizens and businesses to support innovation by encouraging creativity and product development (Wallace et al., 2006) but also to support and promote e-Democracy.

Spatial enablement contributes to the expansion of consultative and participative government services to the society such as:

- e-government;
- policy and administration through cost reduction;
- public safety through more efficient emergency services;
- improved utilities infrastructure;
- better management of health services; and
- environmental sustainability

For example, spatial enabling mortgage and foreclosure information by linking it with large-scale and more people-relevant information such as the cadastre, which arguably could have played a key role in reducing some of the information asymmetries that contributed to the global financial crisis of 2008 (Bennett et al, 2010). The aggregation of such information at different levels would have facilitated the detection of patterns or clustering phenomena that would otherwise be missed. The spatial representation of such phenomena as an example, can serve important political decision-making processes (see Figure 2).

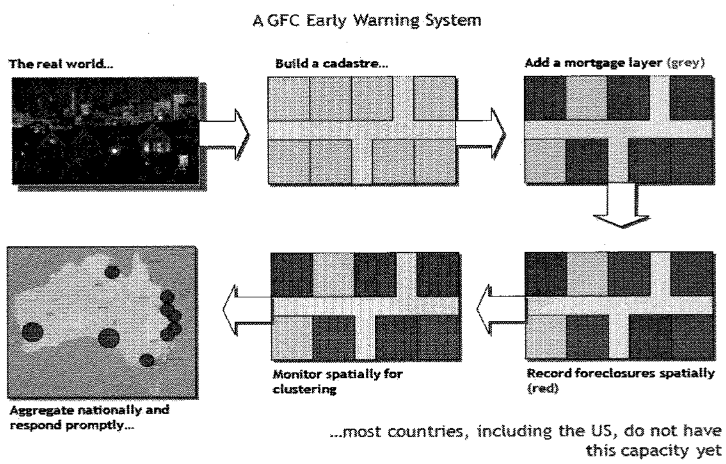

Figure 2. Example of spatial enablement in action.

The concept of SES and inherently, the concept of Spatially Enabled Government (SEG), has gained momentum internationally as jurisdictions begin to recognise the benefits it delivers. SEG is now part of the objectives of governments in many countries, highlighting the importance of spatial information and strategies in policy development and decision-making in the public sector. SEG increasingly operates in a virtual world, but SEG initiatives need to be coupled with real world institutional and structural reforms in the use of spatial information and spatial data infrastructures as an enabling platform.

In this context, Steudler and Rajabifard (2012) provided the following definition to encompass the broad applications of this concept:

> A spatially enabled society - including its government - is one that makes use and benefits from a wide array of spatial data, information, and services as a means to organise its land and water related activities. Spatial enablement is a concept that adds location to existing information and thereby unlocks the wealth of existing knowledge about land and water, its legal and economical status, its resources, potential use and hazards. Information on the ownership of land and water is thereby a basic and crucial component to allow for correct decision-making. Such data and information must be available in a free, efficient, and comprehensive way in order to support the sustainable development of society. It therefore needs to be organised in such a way that it can easily be shared, integrated, and analysed to provide the basis for value-added services.

2.3 Key Components

To support this concept, a joint initiative between the International Federation of Surveyors (FIG) and the Global Spatial Data Infrastructure Association (GSDI) identified six core elements, which are critical for the implementation SES and ensure its successful progression (Steudler and Rajabifard, 2012). These are:

a. Legal framework: to provide a stable basis for the acquisition, management, and distribution of spatial data and information. SES needs to be based on a legal framework, which takes a whole-of-government approach to spatial data and information, and which enables and supports the broad use of geo-information.

b. Common data integration concept: to facilitate that existing spatial data - from government as well as other sources - respect the common standards in order to ensure interoperability for the benefit of all. It is crucial for SES to have a common data integration concept, which ensures interoperability of data and information and which respects the institutional independence of the different actors.

c. Positioning infrastructure: to provide a common geodetic reference framework in order to enable the integration of spatial data and information. The concept of SES is built upon a set of several infrastructures: the development of those needs to be based on business cases, demonstrating their - mostly long-term - benefits and contributions to the overall goal of sustainable development

d. Spatial data infrastructure: to provide the physical and technical infrastructure for spatial data and information to be shared and distributed. SES needs a spatial data infrastructure that provides the platform for interoperability.

e. Landownership information: to provide the updated and correct documentation on the ownership and tenure of the land, fisheries, and forests, without which spatial planning, monitoring, and sound land development and management cannot take place. SES needs complete information about ownership of land and water resources in order to guarantee their sustainable management and development

f. Data and information concepts: to respect and accommodate the different developments in the acquisition and use of spatial data and information. Crowd-sourced data carry a high potential for impact, which public sector institutions need to learn how to deal with.

Spatial enablement is an evolving concept and there are different views on what constitutes spatial enablement. What we do know is that spatial enablement is not just about developing and using geographic information system (GIS) technologies; we know that the vast majority of the public are users, either knowingly or unknowingly, of spatial information; and we know that a spatially enabled society will demand accurate and timely information about land. Therefore, it essentially requires data, and in particular, services, to be accessible and accurate, well-maintained and sufficiently reliable for use by the majority of society which is not spatially aware. Finally, for spatial enablement to occur, it needs to be regarded as a concept that permeates all levels of society - government, industry and citizens, and its ability to flow through all levels of society will depend primarily on the spatial data infrastructure (SDI) and the land administration system available in the jurisdiction (Williamson et al, 2010a; Williamson et al, 2010b).

3. Engaging Government, Industry and Citizens

Collaboration is central to spatial enablement - especially across government, industry and citizens. Such collaboration drives spatial innovation - to make better use of the available spatial information, and the drive to create new, smart applications to harness, integrate and interpret spatial data. Establishing new partnerships will bring together communities of practice, enable knowledge sharing and working together to better prepare for and respond to global challenges.

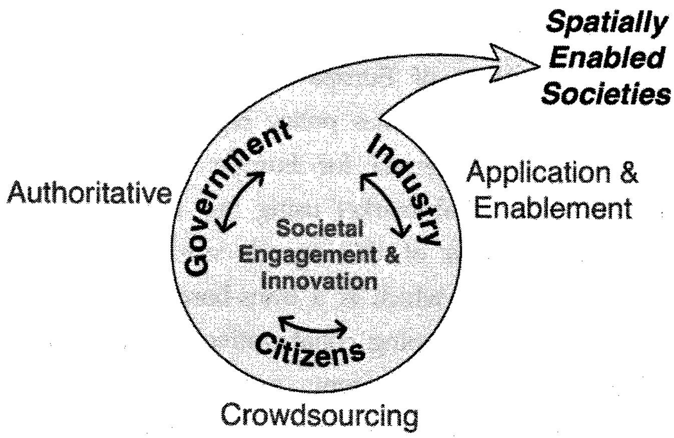

Figure 3. Spatially enabled societies require collaboration between government, industry and citizens.

3.1 Engaging Government

The aim to develop spatially enabled governments was a key outcome of the 17th United Nations Cartographic Conference for Asia and the Pacific (UNRCC-AP) and the 12th meeting of the United Nations supported Permanent Committee for GIS Infrastructure for Asia and the Pacific (PCGIAP) in September 2006 in Bangkok, Thailand. Subsequent activities resulted in the definition of Spatially Enabled Government (SEG) as a scenario where "data, information and related business services with spatial content become ubiquitous in the daily conduct of government agency business and in the efficient and effective delivery of government services".

Governments around the world are increasingly acknowledging the benefits of spatial enablement, particularly as this is necessary for achieving e-government. This has resulted in spatial enablement being adopted as a cornerstone for key policy initiatives. Within Australia, this can be seen in the inclusion of the concept of spatial enablement in our national information technology strategy since 2008. Spatial enablement of public information is also a way to improve transparency in government and a way to facilitate public participation - integral to any democratic system.

Governments play a crucial role in spearheading spatial enablement initiatives as these are intrinsically linked to cadastres and land administration (typically government responsibilities). The importance of these two elements reflects the importance of land as a key issue for socio-economic development and sustainable development and the reason that many governments are stimulating growth in the spatial information sector. A prime example here is the governments of Europe and the formation and development of the INSPIRE directive. INSPIRE now legislates policy regarding spatial information management in support of the wider digital agenda for Europe: to deliver sustainable economic and social benefits from a single digital market using fast internet and interoperable objectives. Some examples of implementation of this agenda are the development of the European Land Information Service (EULIS), which is a trans-border portal for purchasing land across Europe, and a move towards developing collaborative relationships. An indication of trends in spatially enabled governments, a recent agreement between Eurogeographics and PSMA in Australia breaks new ground in the conflation and delivery of continental datasets.

Within the Asia Pacific region, the Malaysian government's vision for spatial enablement is inherent in the development of a broad national strategy to move towards a knowledge-based society. There have been many new initiatives - both spatial and non-spatial - to support access, discovery and use of information. In particular, initiatives are increasingly focused on improving service delivery and strengthening the public sector. From a spatial perspective, a proposed national geospatial act aims to advance policies, clarify responsibilities of the various levels of government and define policies for the dissemination of geospatial information. This is in support of a vision to realise a digital Malaysia for spatial enablement, where all levels of geospatial data and common geocentric datum/framework serves as the basis for all information enabling all levels of government data to be connected.

These various initiatives underscore the growing importance placed by governments on facilitating the availability of accurate and timely data, especially from remote sensing and geospatial sources, to facilitate evidence-based decision-making as well as policy design.

3.2 Engaging Industry

Spatial enablement is a holistic endeavour that requires a multi-sectoral approach. While governments may have led efforts in the past, it is necessary that achieving spatial enablement move beyond being the sole responsibility of government. To deliver benefits to the whole of society, it is necessary to engage industry, who performs important roles as enablers, producers and consumers of spatial information and technology.

In the current fiscal climate, economic limitations drive a desire to maximise returns on investment. Issues of duplication of products and services between spatial data producers within government and solution providers within industry, needs to be addressed through greater collaborative efforts. In Australia, PSMA - an industry organisation, has done so by playing a leading role in the assembly and delivery of national fundamental datasets. PSMA has been crucial in streamlining the interactions and transactions between organisations by providing an essential service as an aggregator and developer of national spatial datasets.

Engagement with industry can also facilitate the adoption of best practices and service delivery. This is especially important in the pursuit of spatially enabled data that is ubiquitous and seamless, and where success in other industries such as the adoption of cloud technology can prove beneficial to current practices.

3.3 Engaging Citizens

The public are now used to spatial information being available on-line and on-demand, a need satisfied by the large, private systems such as Google Earth and Maps, Microsoft Virtual Earth and other applications. Additionally, recent technological developments such as Web 2.0 and ubiquitous location-based services have made it easier for ordinary citizens to become spatially enabled. Just as importantly, these developments have also provided them with tools to contribute to the flow of spatial information through all levels of society.

We have seen the effectiveness of engaging citizens in the contribution of spatial information, most notably in their ability to respond immediately to support information needs in times of disasters. The example of the production of crowd-sourced maps of different jurisdictions, e.g. the construction of a map of Haiti in the wake of the earthquakes in 2010 is notable for its role in facilitating relief efforts - since no coherent map of Haiti existed before the earthquake. The social media, communication and contribution of people in response to different disasters, and extending to include other types of local or global events, showcases the trend and value in engaging citizens.

However, trends in embracing and utilising volunteered information necessarily imply a need to differentiate between authoritative (or the new concept of concept of 'AAA' information - Accurate, Authoritative and Assured, to reflect high accuracy data), and volunteered (including crowd-sourced) information sources. Both types of information are important in their own right and provide value towards spatial enablement and the enrichment of societies.

It is exciting to see more instances of collaboration across government, industry and citizens to support the use of location in responding to challenges. For example, in the 2011 floods and tropical cyclone that devastated the state of Queensland in Australia, the Queensland Fire and Rescue Service who were mapping damage and assessment inspections, received technical support from Esri in the United States, who were able view the mapped data in real time through web-based synchronisations over a server hosted with cloud technology (Esri, 2011). It is clear that it is only through the effective engagement of government, industry and citizens that we can hope to overcome some of our current obstacles to realising true spatial enablement.

4. Issues and Challenges

Currently, the realisation of spatial enablement is still limited and challenged by technical and non- technical issues. Of primary concern, significant institutional issues, both across different organisations and/or jurisdictions and between different levels of government, still prevail. Institutional failure poses a key risk to implementation of spatial enablement as it underpins all other issues. The existence and perpetuation of data silos both within and between organisations poses a real and continuing challenge to spatial enablement. This has downstream effects on the discovery, access, use and sharing of spatial data. Additionally, legal issues often challenge the availability and accessibility of information. In response, there is a growing awareness in many countries of the need to articulate specific access and licensing initiatives to facilitate free or low cost information such as the adoption of Creative Commons.

In terms of technical issues, a lack of clear standards limits the ability of organisations to collaborate and facilitate multi-source data and information. The issue of metadata is also common, as it is often not systematically addressed. Terrestrial and non-terrestrial information continues to remain disconnected - there is a real need to develop a seamless

SDI model to bridge the gap between the terrestrial and marine environments: improved connectivity between these datasets will facilitate better decisions regarding sustainable development.

There is also a growing concern that in trying to achieve spatial enablement, we are creating a dependency on spatial data, where other forms of information may otherwise suffice. Investment in geospatial information could be ill spent if the information is not calibrated to meet specific needs, that is, fit-for-purpose, instead of applying template solutions.

5. Conclusion and Future Directions

The future of spatial enablement, and therefore the realisation of a spatially enabled society incorporating government, industry and citizens, lies in it being a holistic endeavour where spatial and non-spatial data are integrated according to evolving standards and with the SDI providing the enabling platform. Spatial enablement, and the concept of spatially enabled societies, is offering new opportunities for governments and wider society in the use and development of spatial information, but it needs to move beyond the current tendency for the responsibility to achieve spatially enabled societies to lie solely with governments. Spatial enablement that benefits the whole of society will be more readily achieved by increasing involvement from the private sector, and in the same vein, if the surveying and spatial industries start to look toward other industries for best practices in service delivery.

There are some emerging trends in geospatial information, which presents new opportunities for the application of spatial technologies and geographic information. These trends include (but are not limited to):

- location as the fourth element of decision-making;
- differentiating between authoritative and volunteered (including crowdsourced) information, yet recognising the importance and value of both types of information towards spatial enablement and the enrichment of societies;
- changing directions: simple to complex, autonomous to interdependent, spatial ubiquity;
- growing awareness for openness of data e.g. licensing, and resultant improvements in data quality;

- move towards service provision; and
- recognising the difference between spatial enablement and spatial dependency.

In light of these trends, future activities will need to be fit-for-purpose, ubiquitous, transparent and seamless to the user.

There is also a need to consider the developing challenges that are arising from having differing levels of maturity in use and management of geospatial information, and perhaps a need to increase the focus on critical areas that are proving to be challenging. These include:

- improving the appeal of spatial information to attract a broader audience;
- institutional processes to facilitate spatial enablement particularly around information policies, access, and risk management;
- capacity building e.g. research and education, bandwidth;
- standards and licensing as a means to enable and facilitate partnerships; and
- creating a seamless platform.

Even as we begin to think about what the future of spatial enablement may look like, at its heart, the realisation of spatial enablement and spatially enabled societies will always be predicated on six key components: legal framework, data integration abilities, positioning and network infrastructures, and the various data and information principles. These key elements need to be embraced by the established professional communities or face the threat of being taken over by those that better understand the messages of change. As spatial information specialists, it is imperative that we understand the technological changes, developments and possibilities, so that we can convey these messages and requirements to our partners, to political decision-makers, and to society at large.

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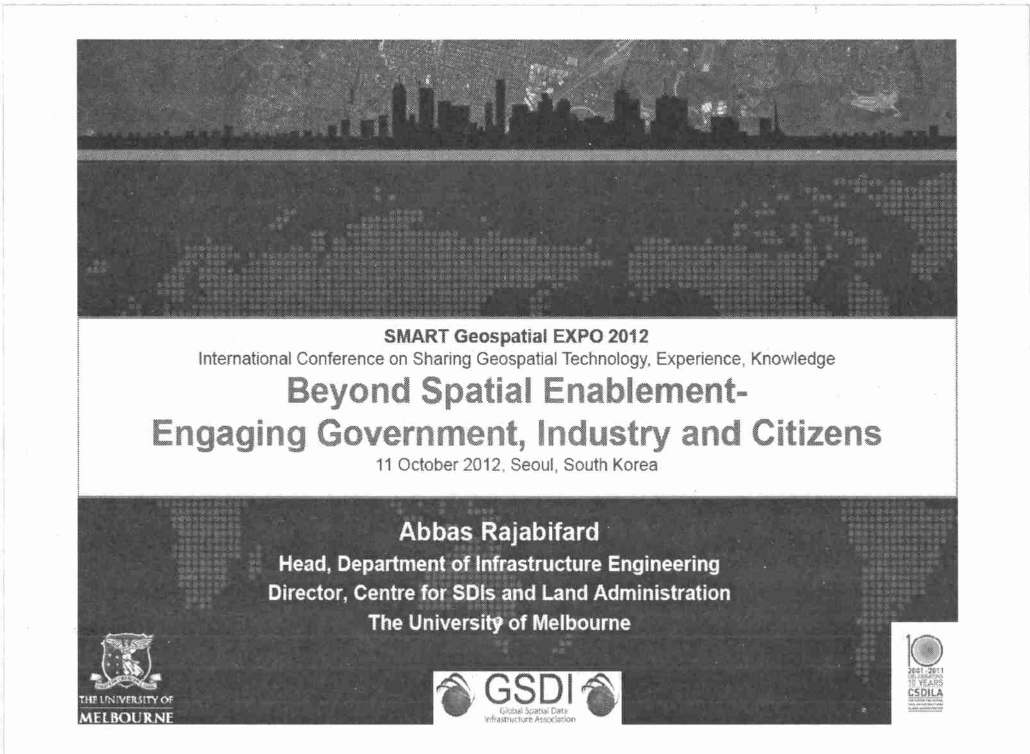
Williamson, I., Rajabifard, A. and Holland, P. (2010b). Spatially enabled society. Proceedings of the 2010 FIG Congress, "Facing the Challenges - Building the Capacity", Sydney, Australia, 11-16 April 2010. Retrieved from www.fig.net/pub/fig2010/papers/inv03%5Cinv03_williamson_rajabifard_et_al_4134.pdf.


SMART Geospatial EXPO 2012
International Conference on Sharing Geospatial Technology, Experience, Knowledge
Beyond Spatial Enablement-
Engaging Government, Industry and Citizens
11 October 2012, Seoul, South Korea
Abbas Rajabifard
Head, Department of Infrastructure Engineering
Director, Centre for SDIs and Land Administration
The University of Melbourne
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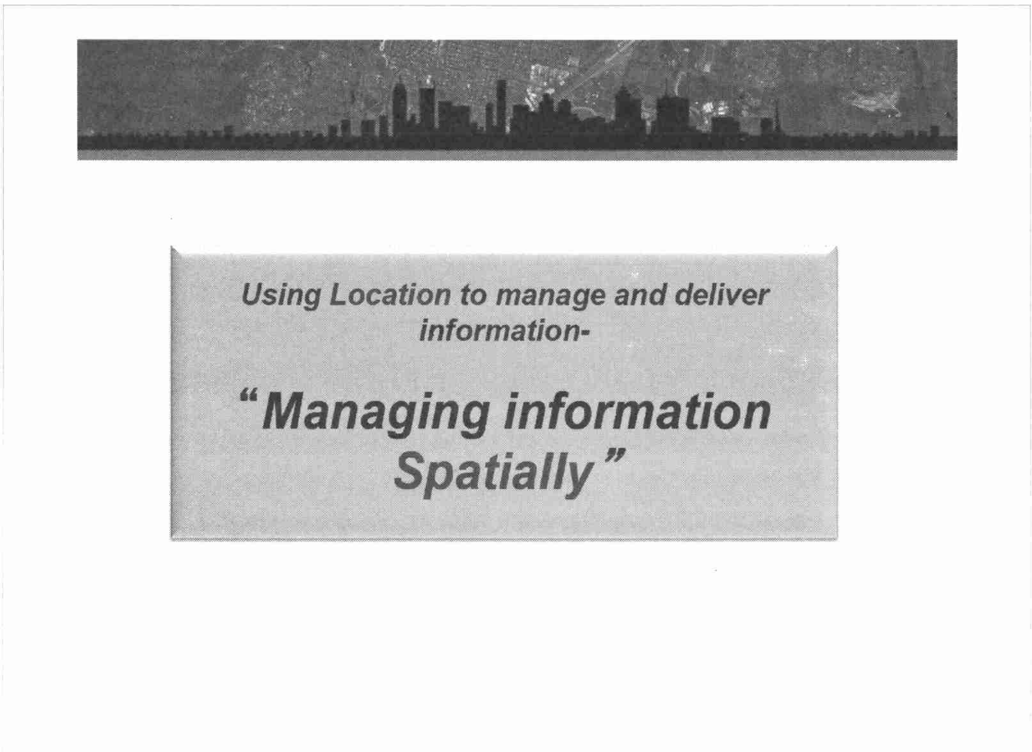
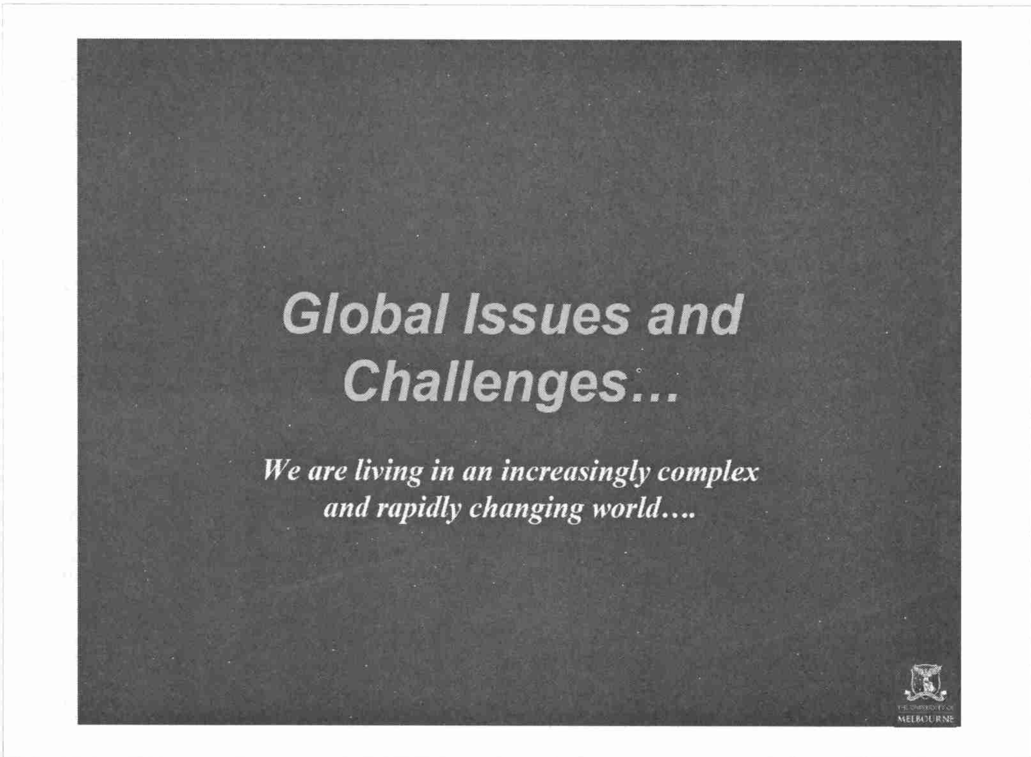
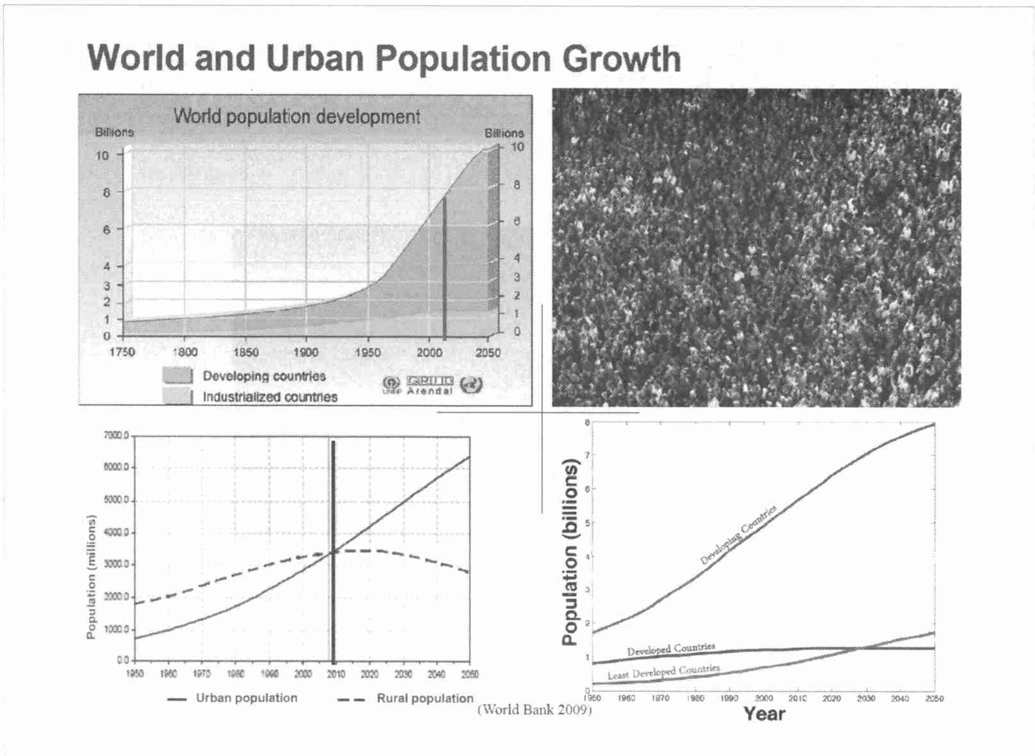
GSDI
CSDILA

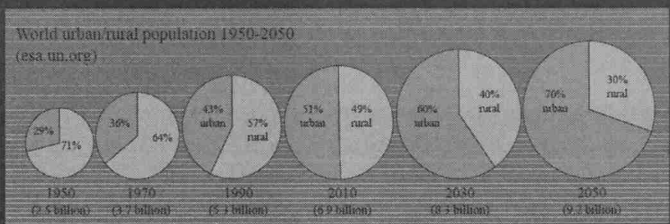

Using Location to manage and deliver information-
"Managing information Spatially"


Global Issues and Challenges…
We are living in an increasingly complex and rapidly changing world….
MELBOURNE


World and Urban Population Growth
World population development
Billions
Developing countries
Industrialized countries
Arendal
Population (millions)
Urban population
Rural population
(World Bank 2009)
Population (billions)
Developing Countries
Developed Countries
Least Developed Countries
Year

Challenge – Population growth

- **World pop.** increasing to 9.2 billion by 2050
- huge urbanization process
- UN-Habitat (2010): urban population in Africa of 400million will triple until 2050
- **Challenges:** development of infrastructures, basic services such as health, education, drinkable water, waste water treatment, public transport, security,...



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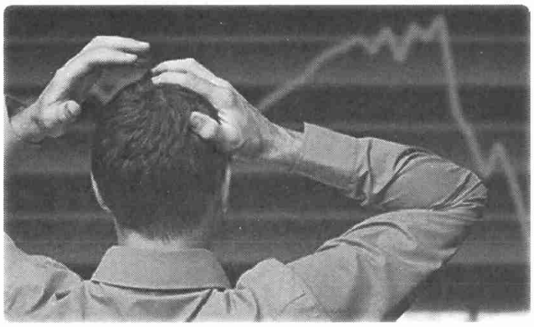
Challenges to Our Society



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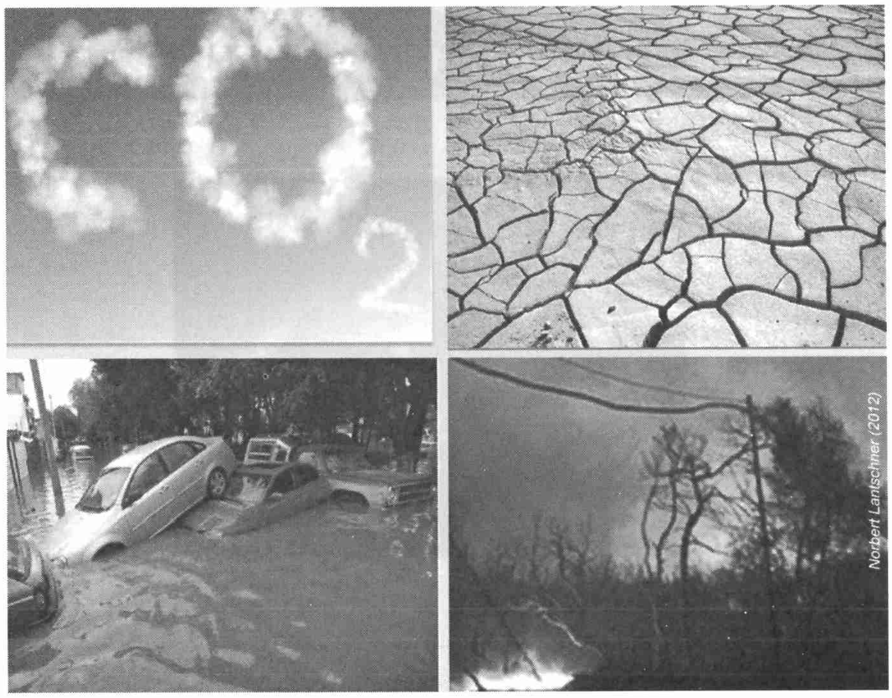
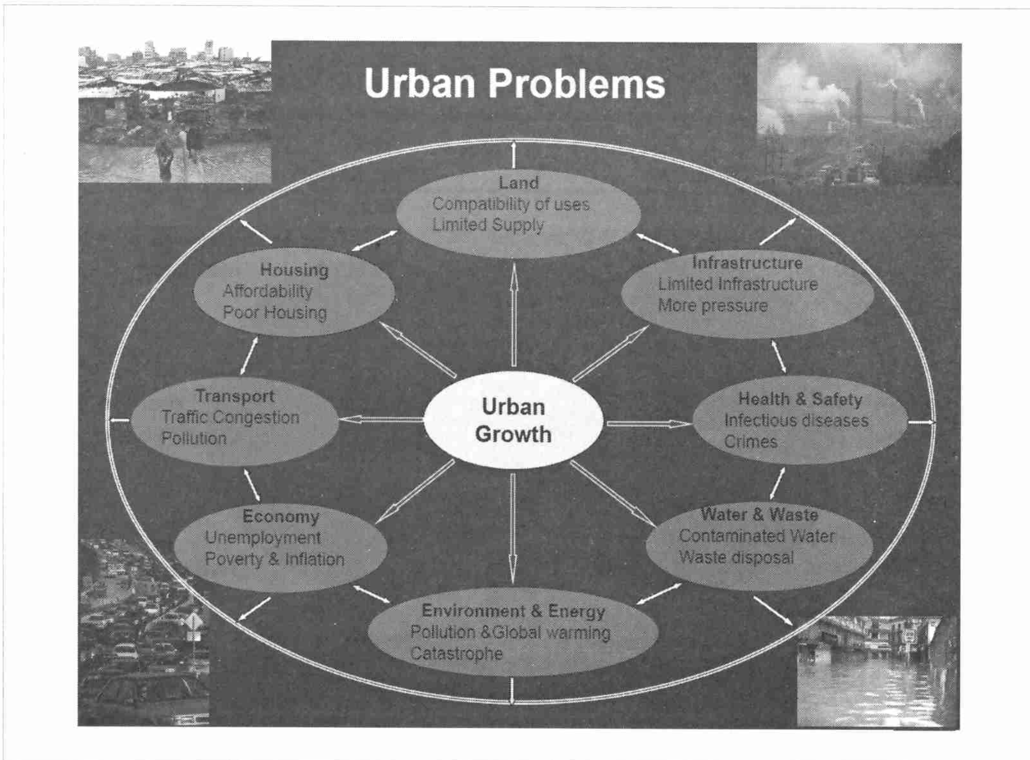
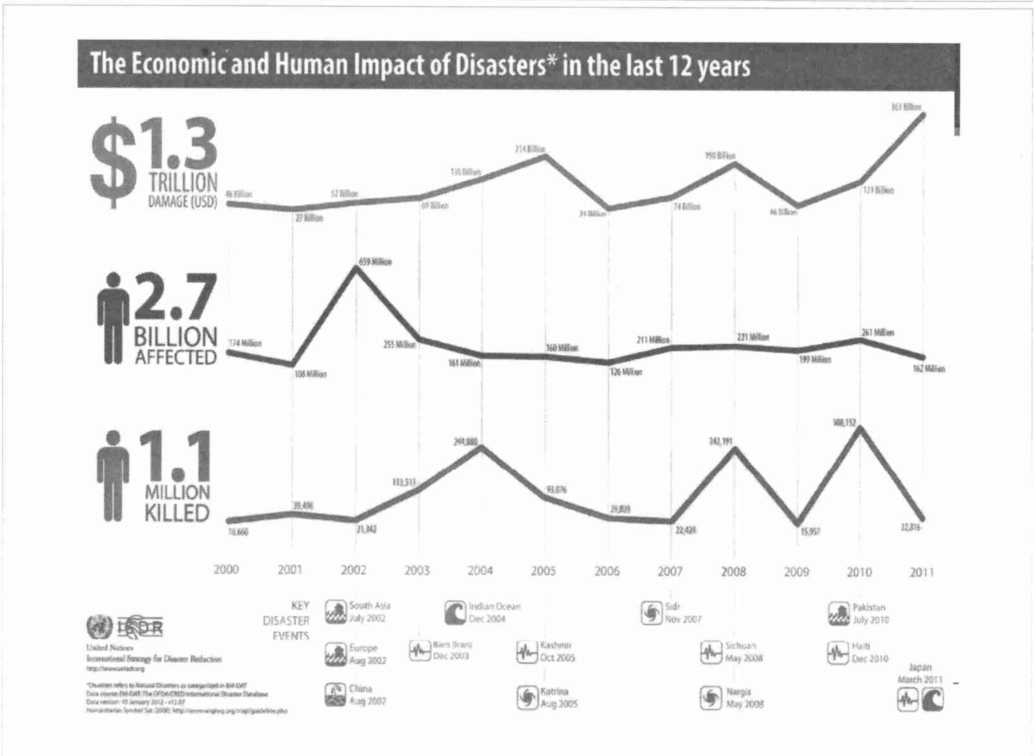
Challenges to Our Society

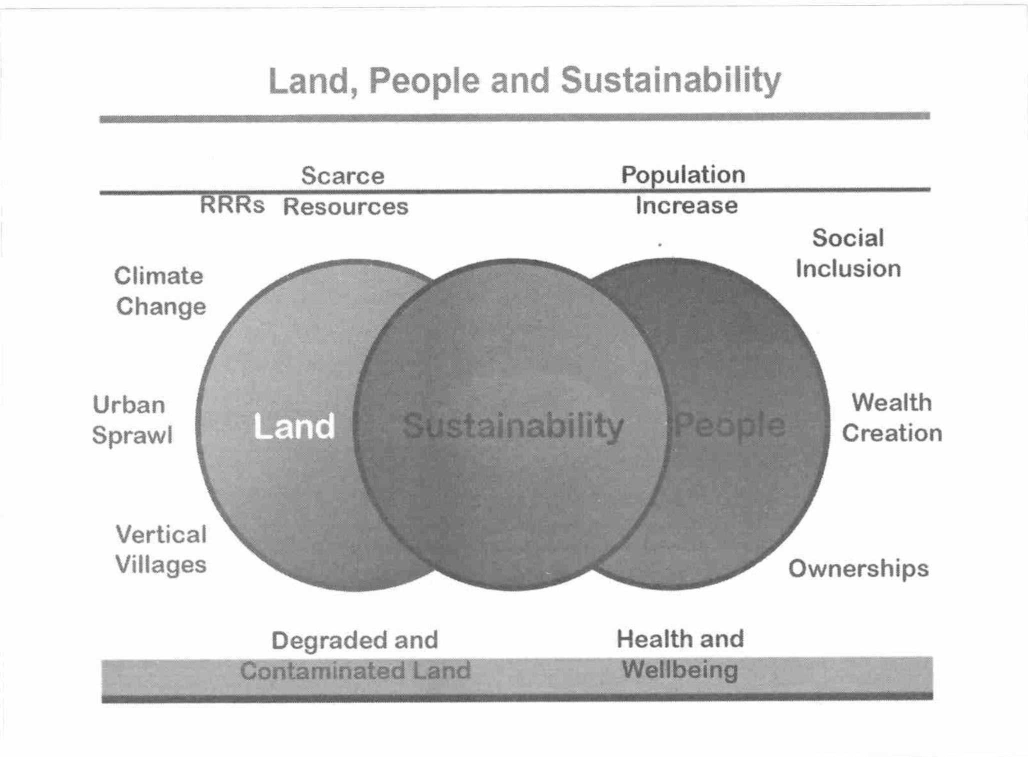
What is changing…

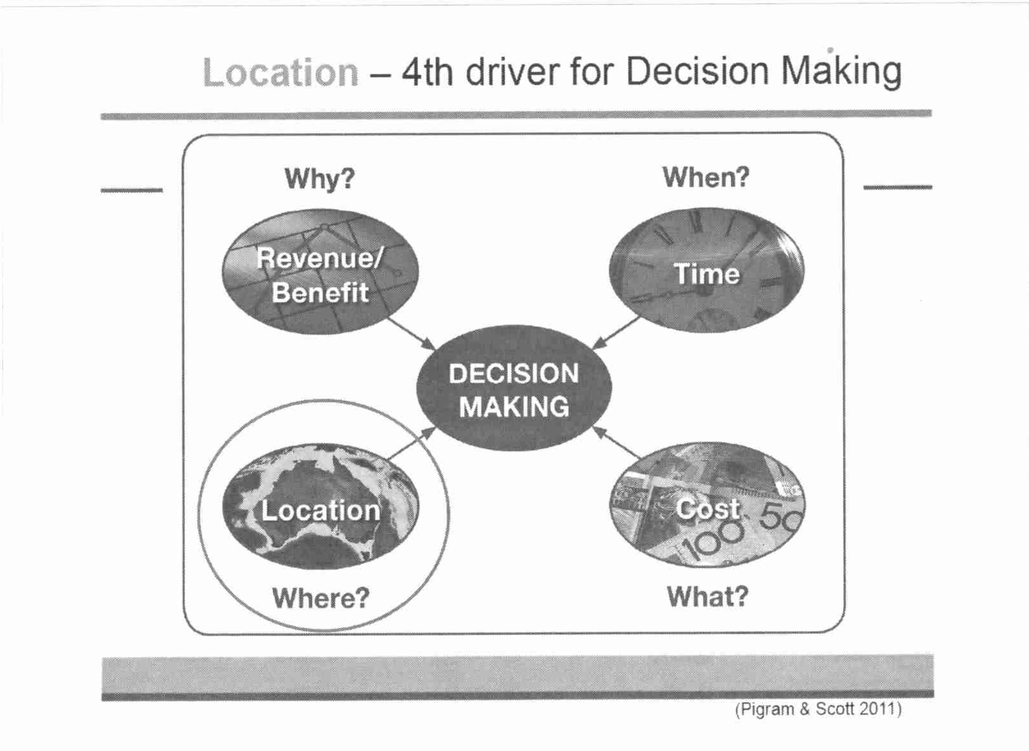
THE UNIVERSITY OF MELBOURNE

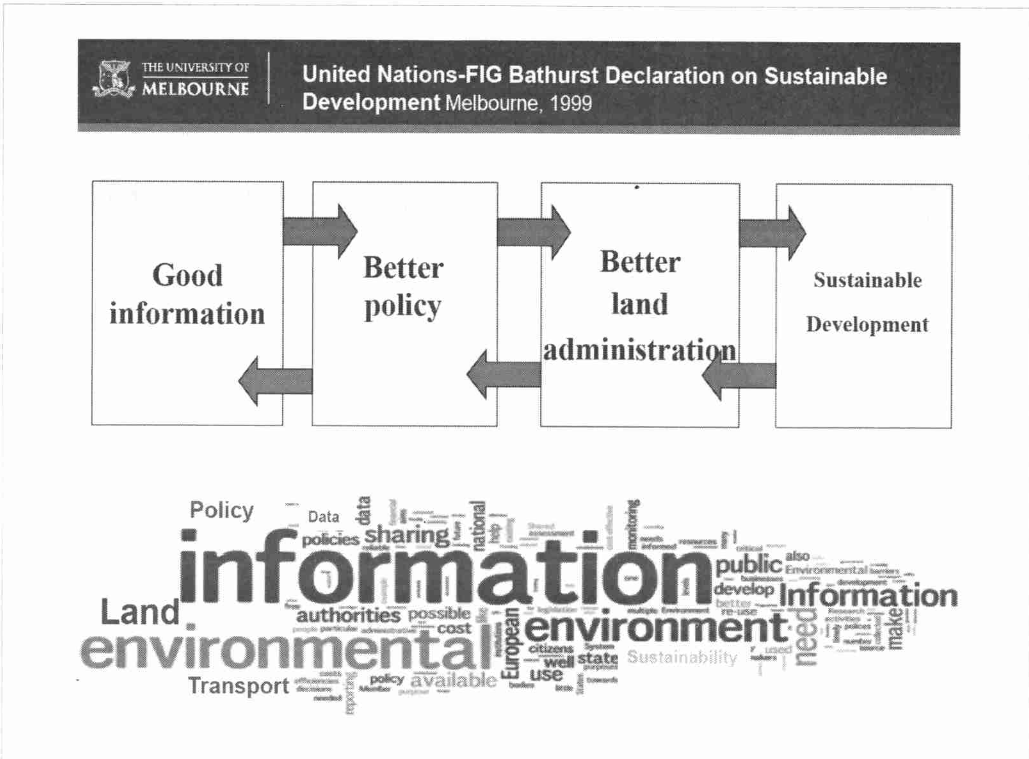

Norbert Lantschner (2012)


Urban Problems
Land
Compatibility of uses
Limited Supply
Housing
Affordability
Poor Housing
Infrastructure
Limited Infrastructure
More pressure
Transport
Traffic Congestion
Pollution
Urban
Growth
Health & Safety
Infectious diseases
Crimes
Economy
Unemployment
Poverty & Inflation
Water & Waste
Contaminated Water
Waste disposal
Environment & Energy
Pollution &Global warming
Catastrophe


The Economic and Human Impact of Disasters* in the last 12 years
$1.3
TRILLION
DAMAGE (USD)
46 Billion
27 Billion
52 Billion
69 Billion
135 Billion
214 Billion
34 Billion
74 Billion
190 Billion
46 Billion
131 Billion
363 Billion
2.7
BILLION
AFFECTED
174 Million
108 Million
659 Million
255 Million
161 Million
160 Million
126 Million
211 Million
221 Million
199 Million
261 Million
162 Million
1.1
MILLION
KILLED
16,666
39,496
21,342
113,513
244,880
93,876
29,839
22,424
242,191
15,957
308,152
32,816
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
KEY
DISASTER
EVENTS
South Asia
July 2002
Europe
Aug 2002
China
Aug 2002
Bam Iran
Dec 2003
Indian Ocean
Dec 2004
Kashmir
Oct 2005
Katrina
Aug 2005
Sidr
Nov 2007
Sichuan
May 2008
Nargis
May 2008
Pakistan
July 2010
Haiti
Dec 2010
Japan
March 2011
ISDR
United Nations
International Strategy for Disaster Reduction


Land, People and Sustainability
Scarce Resources
RRRs
Population Increase
Social Inclusion
Climate Change
Urban Sprawl
Vertical Villages
Land
Sustainability
People
Wealth Creation
Ownerships
Degraded and Contaminated Land
Health and Wellbeing


Location – 4th driver for Decision Making
Why?
Revenue/ Benefit
When?
Time
DECISION MAKING
Location
Where?
Cost
What?
(Pigram & Scott 2011)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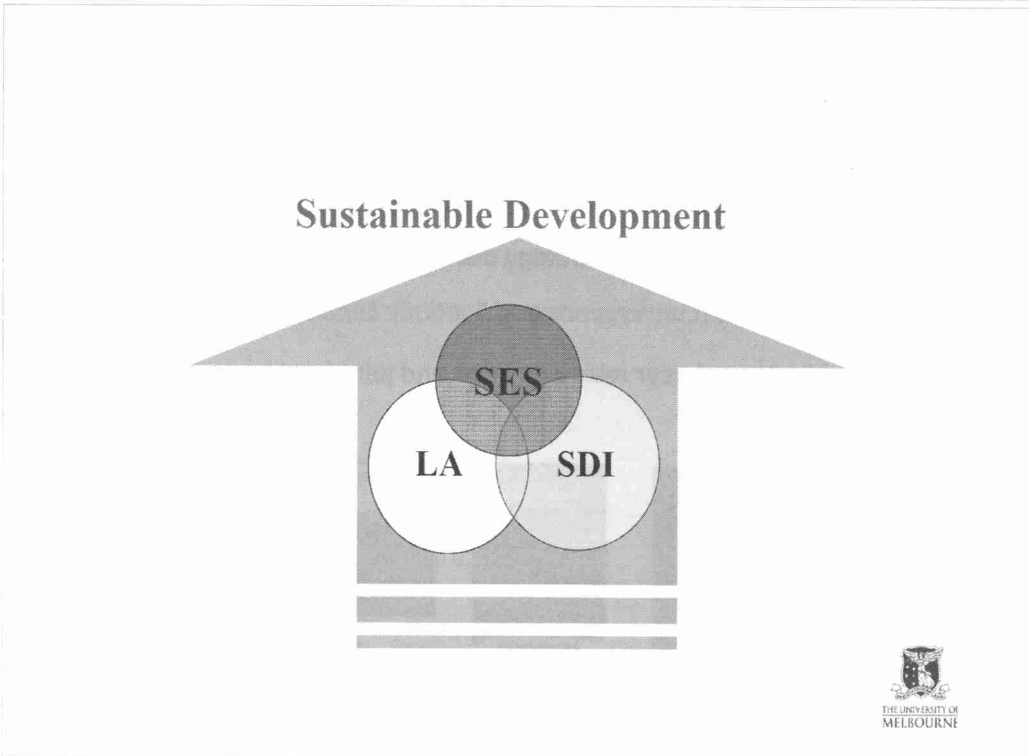
United Nations-FIG Bathurst Declaration on Sustainable Development Melbourne, 1999
Good information
Better policy
Better land administration
Sustainable Development
Policy
Data
data
policies
sharing
national
monitoring
information
public
Information
develop
Land
authorities
possible
cost
environment
environmental
European
need
make
citizens
well
state
use
Sustainability
Transport
policy
available


Sustainable Development
SES
LA
SDI
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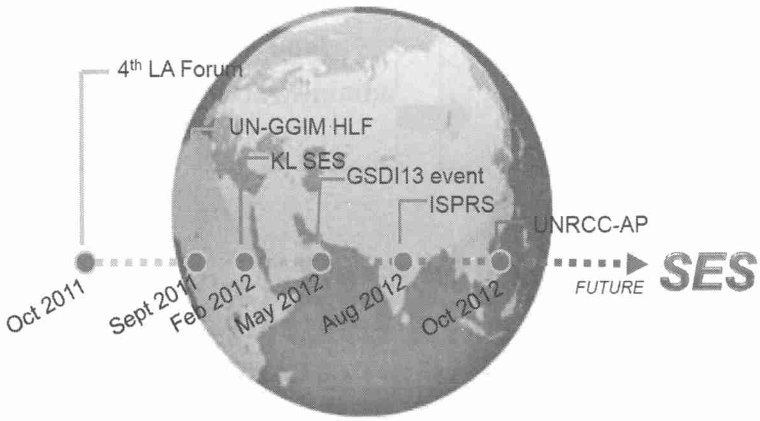
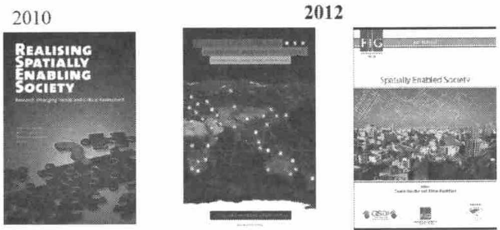
Looking Forward-*SES Major Events*



SES Publications

- Adoption of the GSDI Strategy developed by Executive & Committees (*Convergence and Spatially Enablement*)
- Publication of peer reviewed book and joint booklet

2010 **2012**



Spatial Enablement

Spatial enablement is usually used in a **ubiquitous** and transparent manner by a wide cross section of society.

By its very nature, spatial enablement demands a "**whole-of-government**" approach.

Enhanced Evidence Based Decision making

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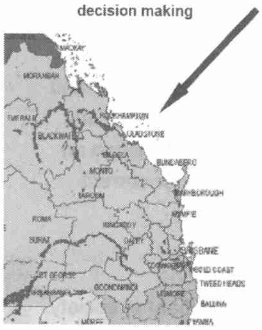
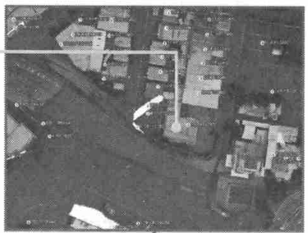
Detailed evidence base to inform decision making

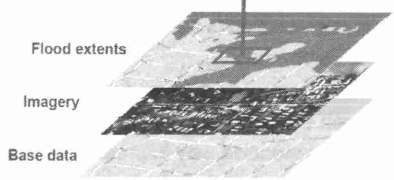


Targeted Government assistance

25 Smith Street = -35.5676, 135.6587

Address	25 Smith Street
Purpose	Residential
Damage	75%
Date	10/01/2011
Event	Flood
Floor Height	0.8 metres
Value	$210,000
Population	4
Assistance	Required





Fundamental location data

(Pigram & Scott 2011)

Spatial Enablement

A society or government can be regarded as **spatially enabled** when spatial information and location are widely used to manage information and processes to encourage more creativity and product development, and they become a ubiquitous part of eGovernment and broader government ICT strategies.

and

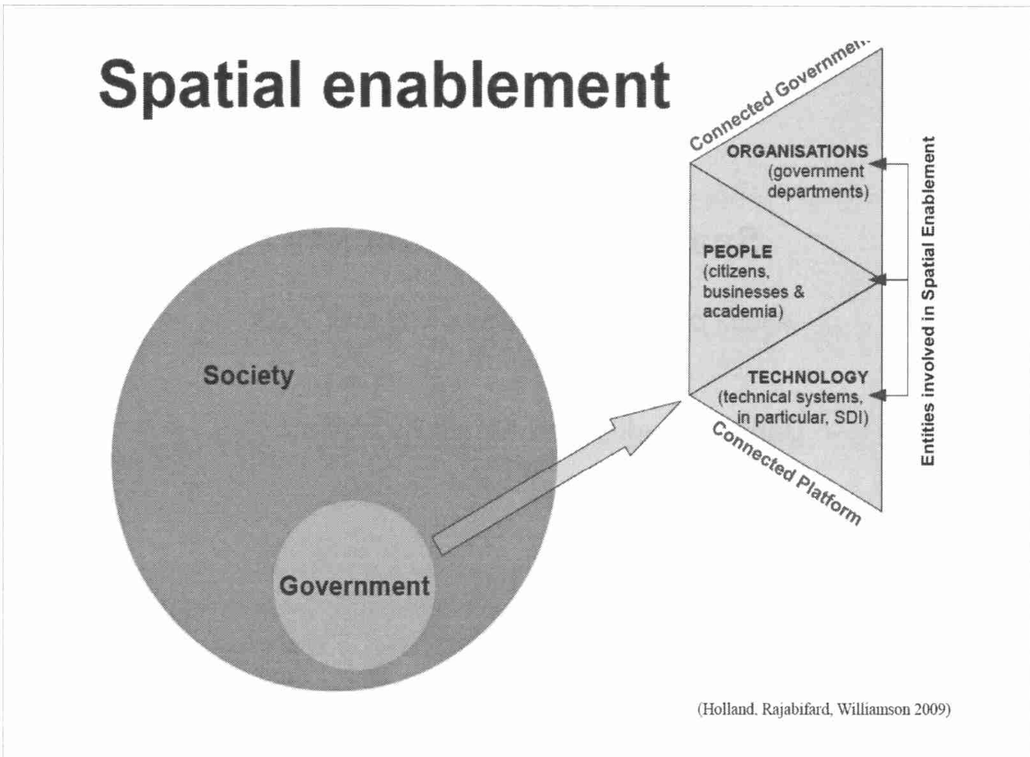
It is also defined as an innovator and enabler across society and a promoter of eDemocracy.

Definition of a Spatially Enabled Society

A spatially enabled society – including its government – is one that makes use and benefits from a wide array of spatial data, information, and services as a mean to organise its land related activities.

Spatial enablement is a concept that adds location to existing information and thereby unlocks the wealth of existing knowledge about the land, its legal and economical situation, its resources, potential use and hazards. Information on landownership is thereby a basic and crucial component to allow for correct decision-making.

Such data and information must be available in a free, efficient, and comprehensive way in order to support the sustainable development of society. It therefore needs to be organized in such a way that it can easily be shared, integrated, and analysed to provide the basis for value-added services.



Spatial Enablement

Spatial enablement contributes to the expansion of **consultative** and **participative** government services to the society such as:

- e-government,
- policy and administration through cost reduction,
- public safety through more efficient emergency services,
- improved utilities infrastructure,
- better management of health services, and
- environmental sustainability.

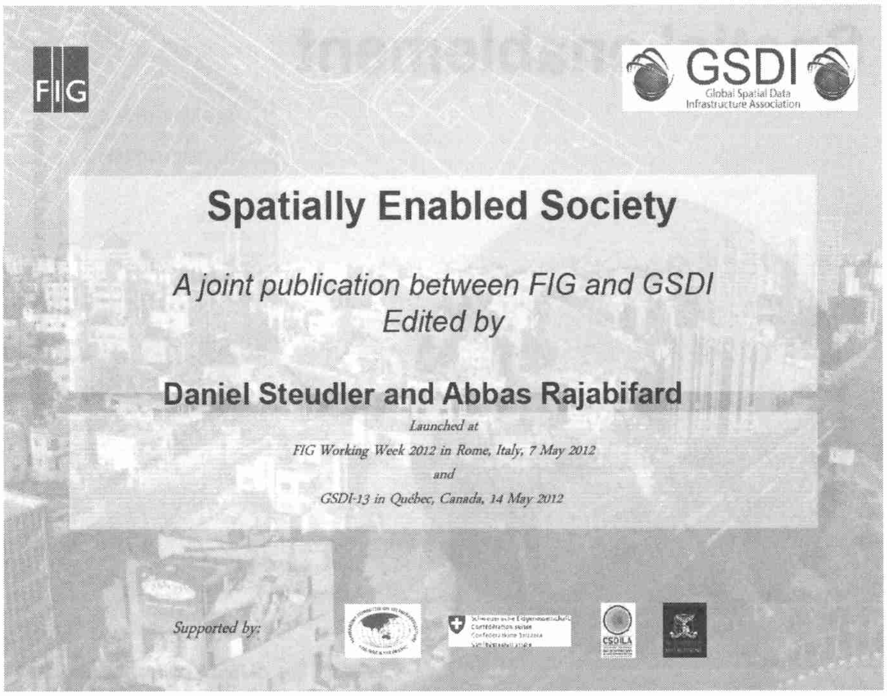
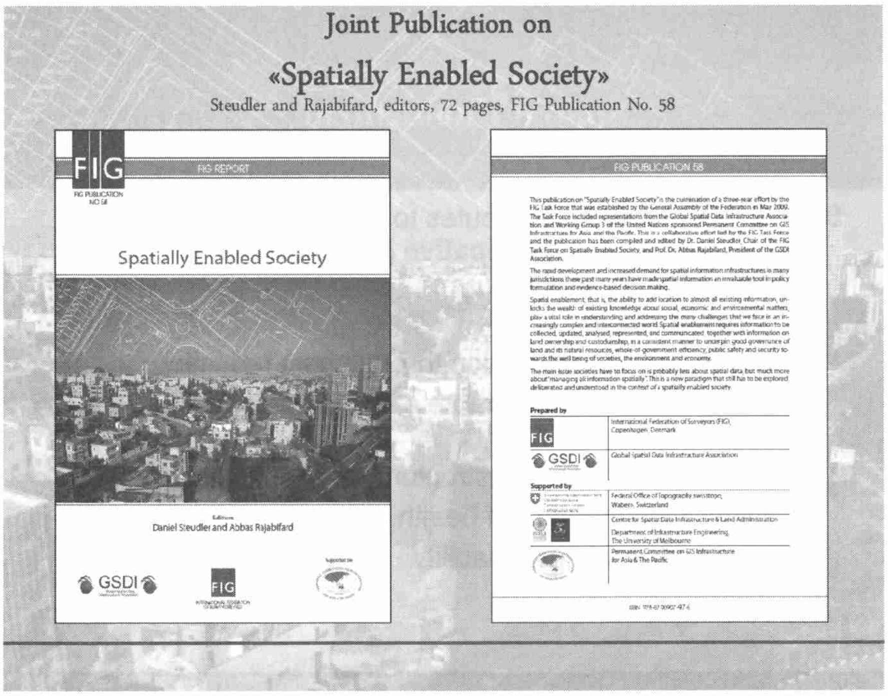


FIG
GSDI
Global Spatial Data Infrastructure Association
Spatially Enabled Society
A joint publication between FIG and GSDI
Edited by
Daniel Steudler and Abbas Rajabifard
Launched at
FIG Working Week 2012 in Rome, Italy, 7 May 2012
and
GSDI-13 in Québec, Canada, 14 May 2012
Supported by:


Joint Publication on
«Spatially Enabled Society»
Steudler and Rajabifard, editors, 72 pages, FIG Publication No. 58
FIG
FIG REPORT
Spatially Enabled Society
Daniel Steudler and Abbas Rajabifard
GSDI
FIG PUBLICATION 58
Prepared by
Supported by

«Spatially Enabled Society»

Contents

Six key Elements for a SES

- **Legal framework** for basic geoinformation;
- **Common Data integration concept:**
  - legal and institutional independence of information (to allow for independent responsibilities);
  - common geodetic reference framework;
  - standardized data modelling concept;
- **Positioning infrastructure** for the common reference framework;
- **Network infrastructure** to enable integration and sharing of spatial data through the spatial data infrastructure SDI;
- **Landownership information** as one of the basic information topics;
- **Data and information:**
  - official, authentic, complete, comprehensive, updated;
  - accessibility of data i.e. public sector information initiatives;
  - volunteered geographic information (VGI), web 2.0 possibilities.

2001–2011 CELEBRATING 10 YEARS CSDILA CENTRE FOR SPATIAL DATA INFRASTRUCTURES & LAND ADMINISTRATION

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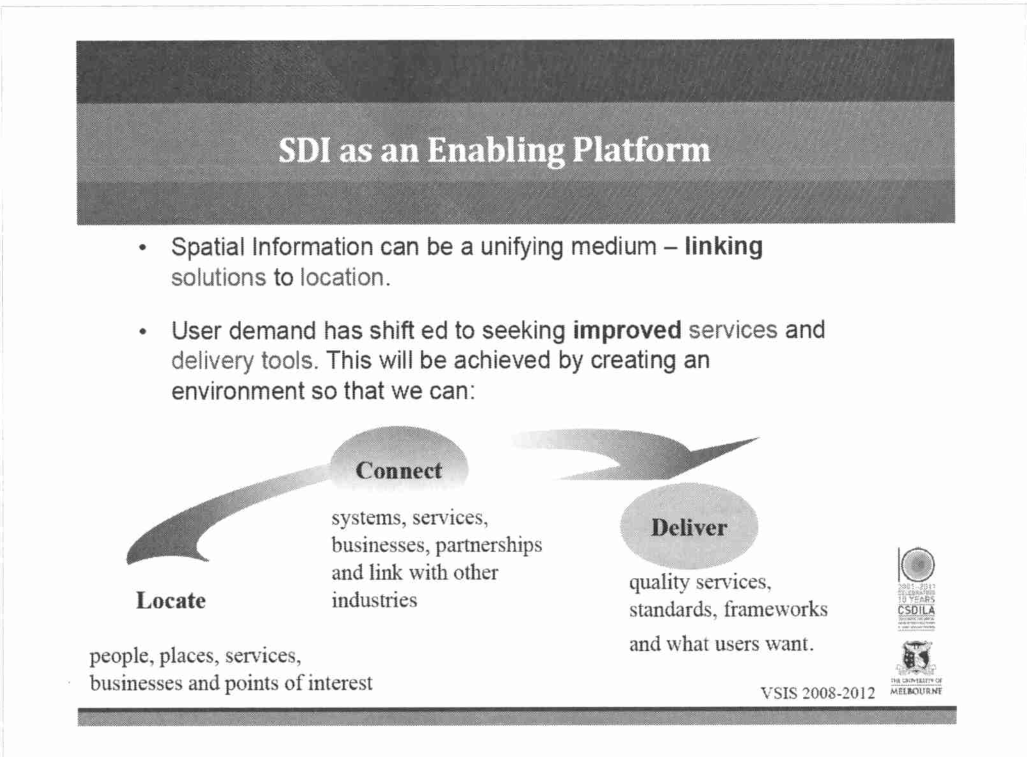
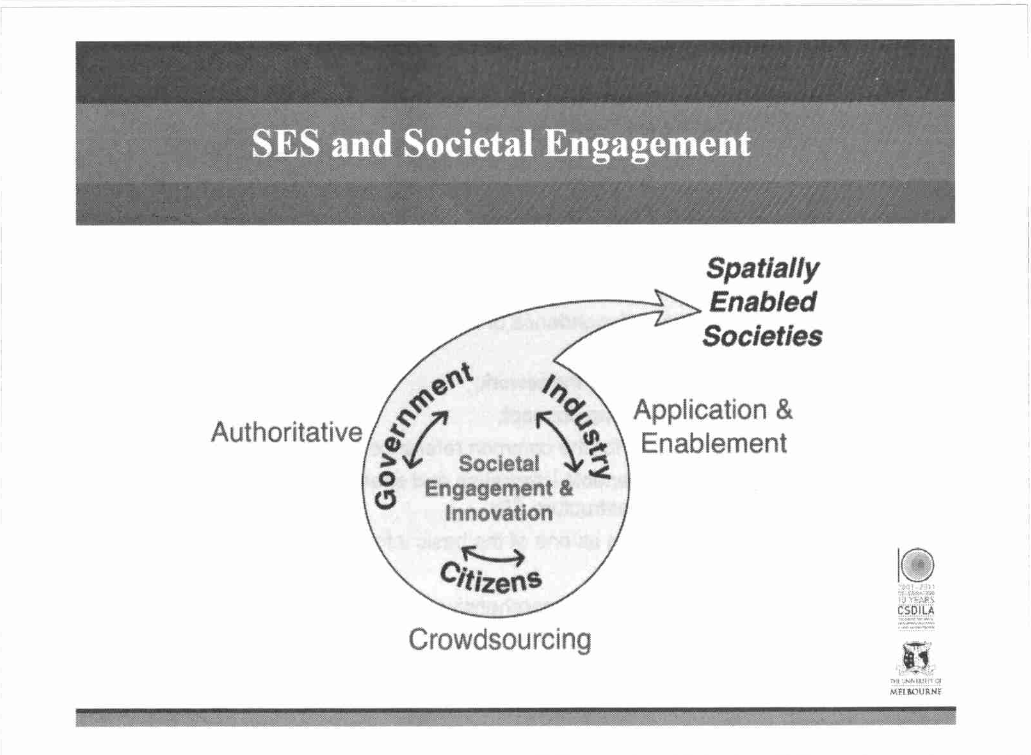

SDI as an Enabling Platform
Spatial Information can be a unifying medium – linking solutions to location.
User demand has shift ed to seeking improved services and delivery tools. This will be achieved by creating an environment so that we can:
Connect
systems, services, businesses, partnerships and link with other industries
Deliver
quality services, standards, frameworks and what users want.
Locate
people, places, services, businesses and points of interest
VSIS 2008-2012


SES and Societal Engagement
Spatially Enabled Societies
Authoritative
Government
Industry
Application & Enablement
Societal Engagement & Innovation
Citizens
Crowdsourcing

Beyond Spatial Enablement

- Current initiatives and activities to achieve spatial enablement
- Activities occurring at different scales – from local government organisations to global institutions like the World Bank
- Worldwide challenges examined and new initiatives considered.

Emerging Trends

- Location = 4th element of decision-making
- High accuracy data ('AAA') vs. other information (incl. crowd-sourced)
- Evolving standards
- Growing awareness for open access to data
- Focus on service delivery
- Future activities need to be **fit-for-purpose**, **ubiquitous**, transparent and **seamless** to user
- *Spatial Enablement* vs. *Spatial Dependency*

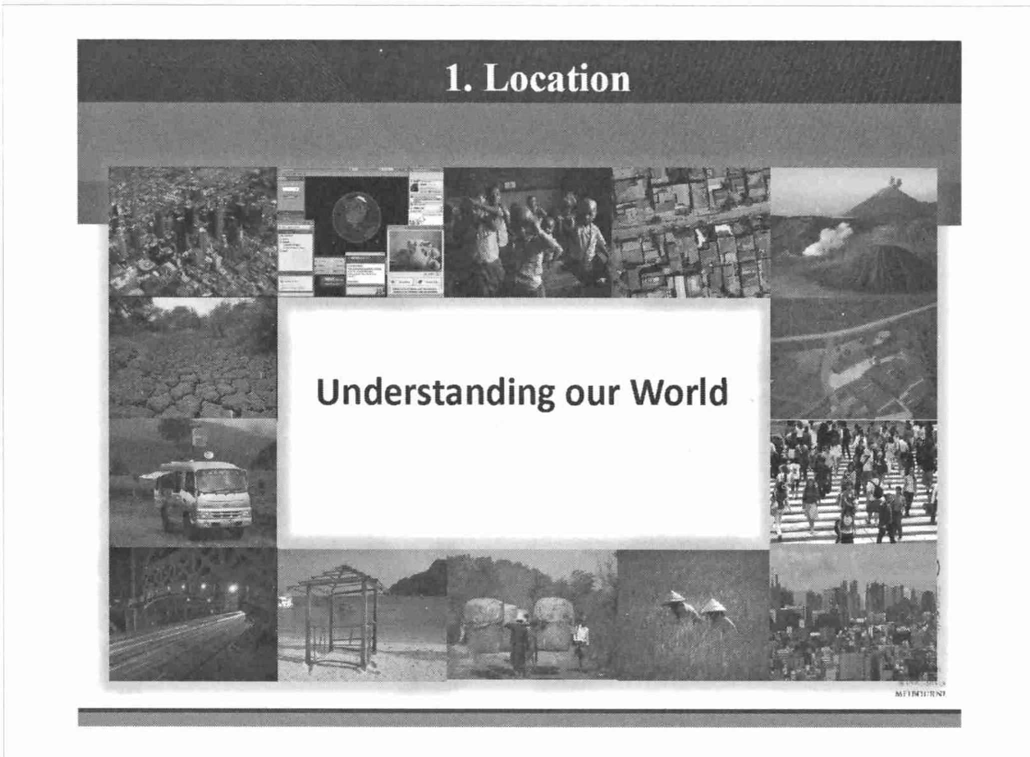
TRENDS = BASIS FOR NEW STRATEGIES

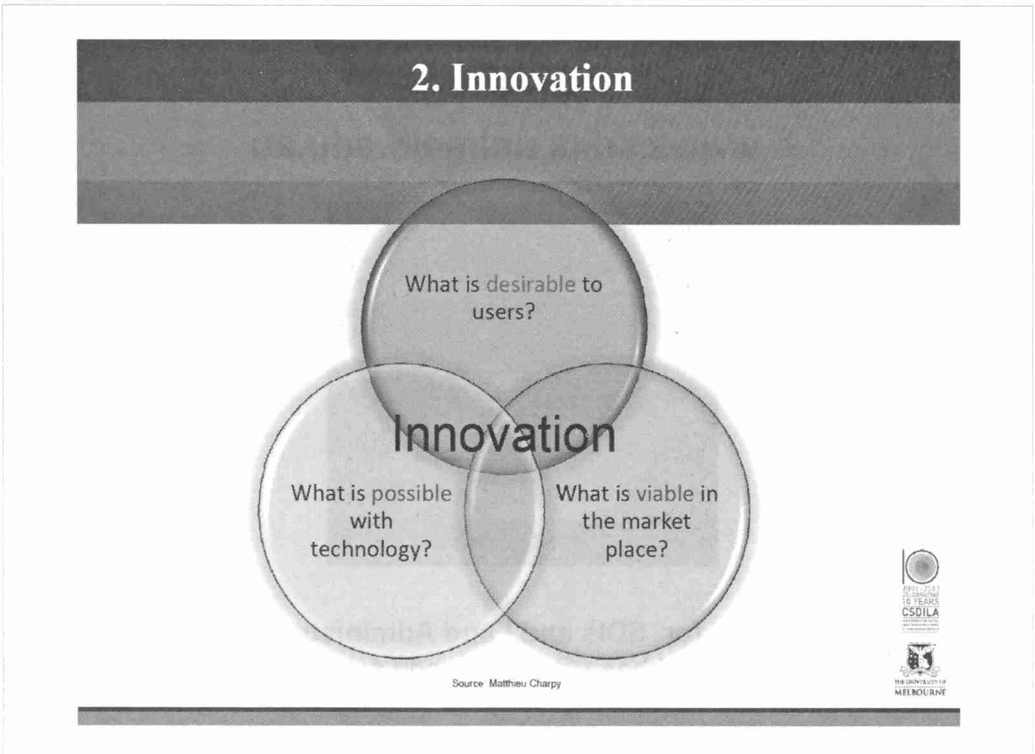
Suggestions

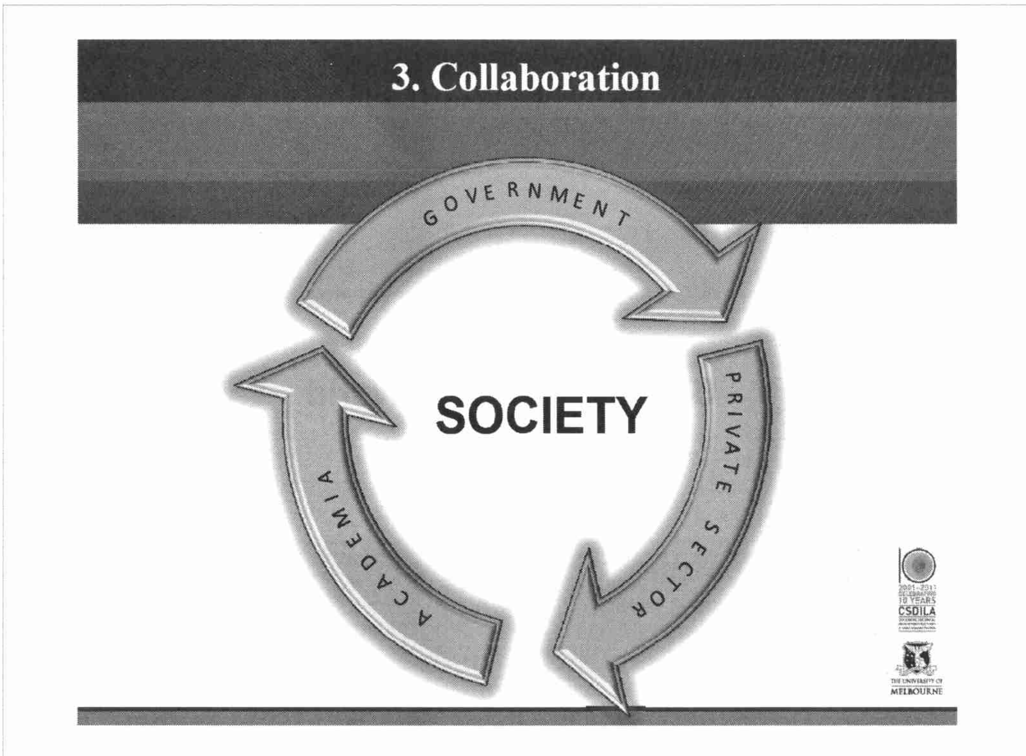
- Promote a **ubiquitous environment** for the use spatial information
- Encourage the **integration of both authoritative and crowd-sourced sources** of information
- Greater focus on **service delivery**
- The role of an **SDI as an enabling platform** to deliver spatial enablement by ***locating, connecting and delivering*** information from different scales, purposes and origins
- Emphasize the importance of the **use of standards** to ensure interoperability.

Moving Forward

1. Importance of location
2. Need for Innovation
3. Collaboration


1. Location
Understanding our World


2. Innovation
What is desirable to users?
Innovation
What is possible with technology?
What is viable in the market place?
CSDILA
MELBOURNE
Source Matthieu Charpy


3. Collaboration
GOVERNMENT
PRIVATE SECTOR
ACADEMIA
SOCIETY


Thank You
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Centre for SDIs and Land Administration
abbas.r@unimelb.edu.au
2001-2011
10 YEARS
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[Keynote Speech]

2

A way to Geo Innovation:
Through a Love Affair between Gaia and Khronos

Dr. Young-Pyo Kim
(KRIHS)

A Way to Geo Innovation: Through a Love Affair between Gaia and Khronos

Young-Pyo Kim

KRIHS, Korea
kyp5208@hanmail.net

Abstract

According to the ancient Greek mythology, the Genesis of the Old Testament, and the 'Huai Nan Tzu', the universe, the largest system , is a frame containing time and space. Removing a layer of the ancient Greek mythology and the Genesis of the Old Testament, it would be thought that Gaia is the mother of space and Khronos is the father of time. God also created time for the first day, space for the second and third day, and Man and entia for the third to sixth day. According to the 'Huai Nan Tzu', the universe is a house which is composed of space and time and which is spatially boundless and temporally eternal. In additions, Buddha classified causality as spatial causality and temporal causality. Buddhism says that all things are linked one another by a cosmic web in terms of space dimension, and all things are impermanent and variable vanity in terms of time dimension. In Addition to time and spac, the ancient Easterners paid attention to human as a representative of entia in the universe. They considered time, space, and human as three fundamental elements in the universe. If we translate them into Chinese, they all have jiān character respectively. So, it means that there are three jiāns in the universe. In the Eastern philosophy, these three jiāns are so called 'Three Essences' in the universe on academic term. Therefore, Gaia and Khronos are personification of two essences in the universe. The universe, the largest system, is constituted of 'Three Essences'. Accordingly, three jiāns should be the fundamental factors for a system to be a complete system in the real world. Ultimately, most systems seek for the harmony of three jiāns. The harmony and

completeness of a system can be gotten by unifying spatio-temporal-human integrated factors through a love affair between Gaia and Khronos. We define such a concept as the harmony principle of 'Three Essences'.

The best technology for the spatial analysis and modeling is Geographic Information System (GIS), the best way to construct the dynamic model with time concepts is System Dynamics (SD), the most suitable way for the human decision making is Optimal Control (OC) method, and the most suitable simulation for the actions and interactions of autonomous agents is Agent-based Model (ABM).

The world is an interrelated complex system of three jiāns like a web. Therefore, GIS technique should take technological fusion and combination with other techniques such as SD, OC, and ABM to deal effectively with complex systems and to find solutions comprehensively. This is the way to innovate on GIS technique and to approach to the harmony principle of 'Three Essences' However, the three technologies of GIS, SD, and OC are not sufficient enough to completely construct the Three Jiāns Integrated System. SimCity, of existing game engines, is the most similar to the one that this paper pursues in the long run. SinCity makes it possible to deal simultaneously with three Jiāns factors in a system and to simulate a real city, integrating GIS, SD, and OC techniqes. Therefore, ideas of SimCity is a way to Geo innovation which fields of GIS and SD should aim at.

Keywords: space, time, GIS, System Dynamics, Optimal Control, Agent-based Model, SimCity, Gaia, Khronos

1. Gaia as Mother of Space and Khronos as Father of Time

According to the ancient Greek mythology in the *Theogony* written by Hesiod, history of the world begins with Chaos, a yawning nothingness. Out of the void Chaos, emerged the Gaia(Earth) and several primary divine being, that is, the Eros(Love), the Erebus, and the Abyss. The Gaia herself without any male assistance gave birth to the Uranus(Sky) who later fertilized her. By the union of the Gaia and the Uranus, the twelve Titans, six males and six females, were born first.

More specifically, the Gaia was the goddess or personification of Earth or Land in the ancient Greek religion, one of the Greek primordial deities. Gaia was the great mother of all: the heavenly gods, the Titans, and the Giants were born from her union with

Uranus(sky), while the sea-gods were born from her union with Pontus(sea). Her equivalent in the ancient Roman pantheon was Terra. Some of the current English words whose etymological root is *gaia/geo* include geography, geology, geometry, geopolitics, and geodynamics.[1] Thus we can analogize all the space out of the Gaia.

Additionally, in the ancient Greek mythology, pre-Socratic philosophy, and later literature, Khronos(Chronos) was the Protogenos[2] of Time, a divinity who emerged self-formed at the beginning of creation in the cosmogonies.

More specifically, Khronos was the personification of Time. Khronos was imagined as a god, serpentine in form, with three heads - those of a man, a bull, and a lion. He and his consort, serpentine Ananke (Inevitability), circled the primal world egg in their coils and split it apart to form the ordered universe of earth, sea and sky. He was depicted in Greco-Roman mosaics as a man turning the ZodiacWheel. Khronos, however, might also be contrasted with the deityAionasEternalTime. Khronos is usually portrayed through an old, wise man with a long, grey beard, such as 'FatherTime'. Some of the current English words whose etymological root is *Khronos/chronos* include chronology, chronometer, chronic, chronicle, and anachronism.[3]

Now removing a layer of the ancient Greek mythology, however, one runs into quite a interesting philosophycal concept. Comprehensively in essence, it would be thought that Gaia is the mother of space and Khronos is the father of time.

On the other hand, according to the Genesis of the Old Testament[4], "In the beginning God created the heaven and the earth. And the earth was without form, and void; and darkness was upon the face of the deep. And the Spirit of God moved upon the face of the waters. And God said, Let there be light: and there was light. And God divided the light from the darkness. And God called the light 'Day' and the darkness he called 'Night'. -- the first day. And God said, Let there be a firmament in the midst of the waters, and let it divide the waters from the waters. … God called the firmament Heaven. -- the second day. … And God called the dry land Earth and the gathering together of the waters called he Seas. … grass … fruit tree … -- the third day. And God made two great lights. … He made the stars also. … -- the fourth day. And God said … the moving creature … fowl … great whales … -- the fifth day. And God said, …cattle, and creeping thing, and beast of

1) Wikipedia: Gaia,September17,2012.
2) The primeval god
3) Khronos is not to be confused with the Titan Kronos(Cronus). Wikipedia: Chronos,September17,2012.
4) King James Version, *OldTestament* - Genesis 1:1~31

the earth …So God created man in his own image, in the image of God created he him; male and female created he them. …And God saw everything tha the had made, and, behold, it was very good. -- the sixth day."

2. Eastern Thought and Systems Thinking

2.1 Universe as a System

The Eastern philosophy and religion have the simillar thought concerning creation of time and space. In the Eastern philosophy, the universe was defined by the 'Huai Nan Tzu'[5] written in early Han dynasty around 2,100 years ago. According to the 'Huai Nan Tzu', the universe(宇宙, Yǔ-Zhòu) was defined as follows. Yǔ(宇) is three dimensional space[6] and Zhòu(宙) is time flow networked by past-present-future[7]. Therefore, the universe is a house which is composed of space and time.

In addition, the 'Thousand-Character Text'[8] (a primer of Chinese characters) contains process of the universe creation and characteristics of space and time. This book is the poem one containing exactly one thousand unique characters, 250 phrases of 4 characters each. The book was composed by Zhou Xingsi in the Liang dynasty, one of the ancient Chinese countries around 1500 years ago. The book includes important contents for human life such as cosmogony[9], provision of nature, human geography, history, ethics, politics, and economics. For example, the first phrase, "heaven-earth is black and yellow"[10] contains the secret of the universe creation. 'Heaven-earth' means the chaos, not yet divided into heaven and earth, before the big bang. And 'black and yellow' implies the status and the color of the chaos. The second phrase of the 'Thousand-Character Text' is written as "the universe is voluminous and coarse"[11] which can be interpreted more detail as follows: "The universe is spatially boundless and temporally eternal". First two phrases in the 'Thousand-Character Text' explain the meaning of the chaos before the big bang and the universe after the big bang.[12]

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5) Huai Nan Tzu (淮南子) is a compilation of various schools of thought made by the around 3,000 guests attached to the court of Liu An (劉安, died 122 B.C.), Prince of Huai-nan, in the Former Han Dynasty.

6) 四方上下

7) 古往今來

8) 千字文

9) It is accord with current scientific explanations.

10) 天地玄黃

11) 宇宙洪荒

12) Young-Pyo Kim, et al., 2001, *Cyber Territory Construction in Digital*, KRIHS. [Korean]

2.2 Central Theme of Buddhism

Buddhism says that all compounded things in the universe are impermanent and network as an inseparable and cosmic web of relations. Accordingly, central theme of the Buddhism is concerning with not only unity of all things but also interrelation of all things and events in the universe. Buddhism stresses on causality by which all things arise and pass away. Earlier, Buddha classified causality as spatial causality and temporal causality. For example, all things are linked one another by a cosmic web in terms of space dimension[13], and all things are impermanent and variable vanity in terms of time dimension[14]. In additions, Buddha taught that all lives are the oneness. So, we should have love and compassion on all lives.

2.3 Thought of Three Essences

In Addition to time and space, the ancient Easterners paid attention to human as a representative of entia in the universe. They considered time, space, and human as three fundamental elements in the universe. If we translate them into Chinese, time is Shí-jiān(時間), space is Kōng-jiān(空間) and human is Rén-jiān(人間). They all have jiān(間) character respectively. So, it means that there are three jiāns[15] in the universe.

By the way, in the Eastern philosophy, Heaven(天) corresponds to time, Earth(地) namely Gaia to space, and Man(人) to human. These three terms, Heaven, Earth, and Man, are so called 'Three Essences'[16] in the universe on academic term. The ideological system based on 'Three Essences' is called 'Thought of Three Essences'.[17] Therefore, Gaia and Khronos are personification of two essences in the universe.

2.4 The Harmony of Three Essences through a Love Affair between Gaia nad Khronos

The universe, the largest system, is constituted of 'Three Essences'. Accordingly, three jiāns should be the fundamental factors for a system to be a complete system in the real world. There are various systems in the fields such as politics, economics, sociology, culture, science, technology, literature, art, or religion. In the process of modeling such systems for

13) 諸法無我
14) 諸行無常
15) 三間
16) 三才
17) 三才思想

the experiment and the analysis of real world, it is necessary to consider 'temporal factors' for the prediction of the future, 'spatial factors' for the analysis of spatial locations, distributions, and connections, and 'human factors' for the decision making of finding the best strategies in given conditions. Therefore, being the operation of gathering various factors of time, space, and human in one framework based on the cause-effect rule, modeling can be the procedure of creating the micro-cosmos.

Ultimately, most systems seek for the harmony of three jiāns. The harmony and completeness of a system can be gotten by unifying spatio-temporal-human integrated factors through a love affair between Gaia and Khronos. We define such a concept as the harmony principle of 'Three Essences'. Therefore, this paper considers time, space, and human, or the 'Three Essences', as the fundamental and essential factors of every system.

3. GIS as Space-based, SD as Time-based, OC as Human-based, and AMB as Simulation-based Approach

The best technology for the spatial analysis and modeling is 'Geographic Information System(GIS)', the best way to construct the dynamic model with time concepts is 'System Dynamics(SD)', the most suitable way for the human decision making is 'Optimal Control(OC)' method, and the most suitable simulation for the actions and interactions of autonomous agents is 'Agent-based Model(ABM)'. It is not easy to integrate and to utilize all four approaches because of the time consuming and large effort to learn and understand each approach even though each approach is excellent.

However, the world is an interrelated 'Complex System'[18] of three jiāns like a web. Therefore, in order for a clear examination and effective measure on the present situation of the world, what is required is an integrated model utilizing simulation technologies such as the game engine, as well as the approach to the consilience that deals with the three jiāns altogether. In the past, technical problems and obstacles made difficulties to find solutions or to construct systems similar to this integrated model. With the help of theoretical foundations and technical progress, the model and system are now feasible to be

18) Complex System is constituted of many components and these components interact with each other. More than the independent unique characteristics of each component, the interaction with each other in the system can produce new micro phenomena and cosmos. Components in one complex system produces constitute the other complex system and adapts to that system continuously. The interrelationship with each component is usually 'non linear' relationship and it constitute feedback loop. And, complex system is open system to connect the outside world. Therefore the boundary of complex system is sometimes vague.

constructed through combining various approaches.

3.1 Geographic Information System (GIS) : Space-based Approach

GIS is the most suitable tool to treat problems of spatial dimension. It is the computer based technique and methodology to collect, manage, analyze, modeling, and visualize spatial data. Spatial data include the geographic information to show locations and related attribute data. GIS is the technique and method to apply comprehensively and academically to many space related fields such as geography, computer science, remote sensing, demography, education field, spatial planning, geology, engineering, ecology, water resource fields, geodesy, archeology, and marketing.

In the early year, GIS technology focused simply on Informatization of maps. As GIS related technology developed, the usefulness of GIS is widely known. Supported by space related academic fields, GIS achieved the fame as the excellent spatial analysis tool.

Recently, GIS focused on the methodology development for 3D spatial visualization and analysis including the natural color and 3D visualization of spatial information, the construction of virtual cities, the simulation of urban management analysis, the construction of cyber territory, and the analysis of local investment policies.

It is possible to construct the GIS Application System in every field dealing with spatial geographic information. The largest number of GIS application systems is applied to establish underground facility management system and land management information systems. The Korea Planning Support Systems (KOPSS) is considered as a successful project in Korea which improves the standard of GIS application systems. KOPSS provides multi-dimensional analysis model, urban renewal/regeneration model, land use planning model, urban facility supply suitability assessment model, public facility location allocation model, and landscape planning model.

There are a lot of GIS spatial analyses from simple overlay, map algebra, and buffer to more complicated spatial analysis such as proximity analysis, spatial operation, location analysis, location-allocation analysis, land use-transportation analysis, and dynamic model of regional population growth.

However, GIS technique should take technological fusion and combination with other techniques such as SD, OC, and ABM to deal effectively with complex systems and to find solutions comprehensively. This is the way to innovate on GIS technique and to approach to the harmony principle of 'Three Essences'

3.2 System Dynamics (SD) : Time-based Approach

With the background of the mathematics including simultaneous calculus equations and control theories, SD is the approach to comprehensively understand dynamic systems constituted of many complicated variables. The formulating process of simulating modeling with SD is seven steps as follows: ①Problem analysis, ②Drawing the causal relationship loop, ③Drawing the system flow diagram, ④Formulating model, ⑤Behavior analysis of the model, ⑥Validity evaluation of the model, and ⑦Policy analysis and decision making.

There are many approaches to estimate and to prospect the future of national societies such as time series analysis. In general, however, SD is known for the most comprehensive and practically useful method. The reason of the usefulness for the future prospect is because this method contains all variables including level or state variables, rate variables, and auxiliary variables as not x type but x(t) type. The most important strength of SD is to estimate the prospect of every variable in the model. Therefore, SD can be possible to estimate various prospects and comprehensive outlooks.

The simulation model based on SD can estimate not only the future prospect of previous policies but also the future prospect of new policy. So, by SD, we can estimate the efficiency of new policy through the comparative study of previous and new policy. We also prospect the ripple effect in each point of time in the future.

3.3 Optimal Control (OC) : Humane-based Approach

In general, there are two kinds of approaches to analyze certain phenomena. They are static approach method and dynamic approach method. In case of solving optimization problems for decision making, depending on approaches, they are also classified by static optimization problem without considering time factor and dynamic optimization problem of distributing resources with considering time flow for matching objectives of decision makers.

The former approach is called as mathematical programming problem and the latter approach is called as optimal control problem. Optimal control problems are usually found in socio-economic phenomena. For example, problems such as regional investment policy, agricultural product price policy, regulation of the money supply, control of the interest rate, and reasonable maintenance cost and removal time of apartment house problem are included in optimal control problem.

Usually, optimal control problems are constituted of time factor, condition variables, control variables, equations of motion, the end of time duration, and objective function. The function relation of these components is formulated in the form of system of objective integral and differential equations. Approaches to solve various optimal control problems have three kinds of different ways. They are so called as calculus of variation[19], dynamic programming[20], and maximum principle[21].

Among them, maximum principle approach is more useful one than other two approaches. The optimal decision-making available on some of SD software, for example, PowerSim, is none other than the application of this maximum principle.

3.4 Agent-based Model (ABM) : Simulation-based Approach

An agent-based model (ABM) is a class of computational models for simulating the actions and interactions of autonomous agents[22] with a view to assessing their effects on the system as a whole. It combines elements of game theory, complex systems, emergence, computational sociology, multi-agent systems, and evolutionary programming. Monte Carlo Methods are used to introduce randomness.

Most ABMs are composed of numerous agents specified at various scales, decision-making heuristics, learning rules or adaptive processes, an interaction topology, and a non-agent environment. The three ideas central to ABMs are agents as objects, emergence, and complexity. ABMs consist of dynamically interacting rule-based agents. The systems within which they interact can create real-world-like complexity. These agents are: ① Intelligent and purposeful, ② Situated in space and time. They reside in networks and in lattice-like neighborhoods. The location of the agents and their responsive and purposeful behavior are encoded in algorithmic form in computer programs. ABMs can explain the emergence of higher-order patterns, that is, network structures of tourist agencies and the Internet, power-law distributions in the sizes of traffic jams, wars, and stock-market crashes, and social segregation that persists despite populations of tolerant people.[23]

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19) Calculus of variation is the field of mathematics that was first developed through the procedure of the problem solution for the brachistochrone by G. Galileo in 1630s. J. Bernoulli expanded this to a theory in 1696.

20) Dynamic programming was developed by R. Bellman in 1950s.

21) Maximum principle was developed by L.S. Pontryagin in 1950s.

22) They can be individual or collective entities such as organizations or groups.

23) Wikipedia: *Agent-based model*, September 26, 2012.

4. Approach to Construct a Three Jiāns Integrated System

4.1 World Interrelated with Time-Space-Human

Technological progress in computer and communication head the society towards the ubiquitous[24] world ultimately. The ubiquitous world can be defined as a world where all the communications of 'person to person(P2P)', 'person to things (P2T)', 'things to things (T2T)' would be able to be unrestricted with perfect freedom in the future, overcoming the limitations of time and space factors, as shown in Fig. 1a. To make a country come to the ubiquitous world, first of all, they should put built in sensor of 'system on chip' in geographic features, important locations and facilities on the physical territory. Besides, they should build a cyber-geospace(territory), similar to the physical territory, which will be filled with every possible information about the features, location and facilities. In this paper, we define cyber-geospace as "the dynamic second territory of Korea not only to manage the land systematically and deal with administrative services for the people in aspect of public sector, but also to contain economic activities of corporations and the citizens' everyday lives in aspect of private sector, in a virtual reality made by digitizing various facilities and buildings as well as the entire territory including ground, underground and even the sea." Therefore, such a cyber-geospace will be a fundamental national information infrastructure for the ubiquitous world in the near future.

On the other hand, three jiāns integrated technology should be supported in order to establish the cyber-geospace. That is why the harmony of three jiāns leads to the most natural and the perfect result in constructing human society.

Fig. 1b shows the conceptual diagram of three jiāns integrated system. There are two different ways to get the links. The links can be achieved from the Excel or from the software development kit (SDK). Excel is one of the most popular software for data management. Therefore, if a software can input and output Excel type data, then the software with Excel as mediation can construct the integrated or connected system.

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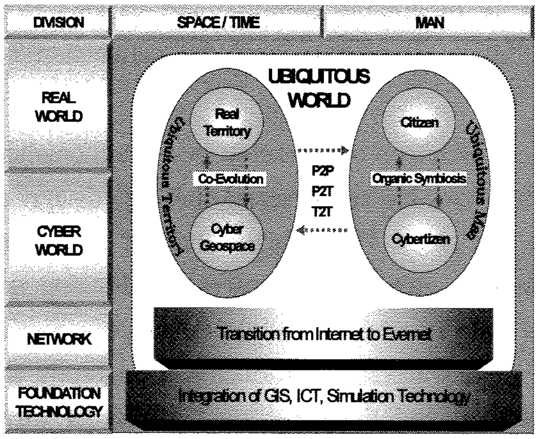
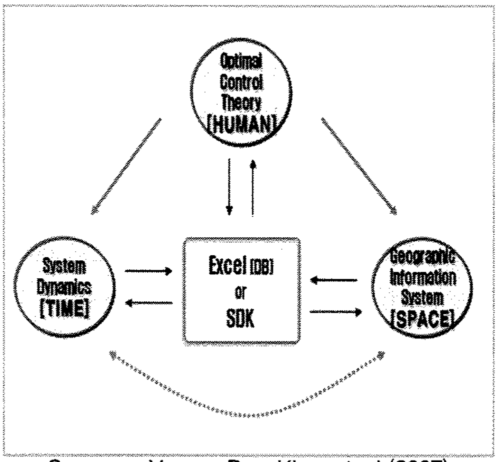
24) It means that god exists everywhere at the same time.



Source : Young-Pyo Kim(2003. 9)
Figure 1a. Diagram of the Ubiquitous World



Source : Young-Pyo Kim, et al.(2007)
Figure 1b. Diagram of Three Jiāns Integrated System

4.2 SimCity : A Target for Geo Innovation

The three technologies of GIS, SD, and OC are not sufficient enough to completely construct the Three Jiāns Integrated System. In addition to the three techniques and technologies, we need the 3D expression technique and the game engine. SimCity, of existing game engines, is the most similar to the one that this paper pursues in the long run.

SimCity is a strategy simulation game of city management, which designs, constructs, and manages a city. Users should design roads, traffics, water supply and drainage, electric power, and land use as if they constructed a real city. As time goes by, they should manage the city through the decision-making process on tax, law, exchange, consultation, and statistics.

SimCity has been developed in 1989 by Will Wright, the founder of game development company Maxis and game designer. He started to develop SimCity based on the great interest in various, impromptu, and complex behavior patterns of people using simple system. Jay Forrester, the originator of SD, centered on time serial change of complex system and inspired him to develop SimCity. Forrester was an MIT professor who was independent of urban planning. However, he served as a cornerstone of modern computer simulation through the work Urban Dynamics published in 1969, trying to simulate a city with different variables including population, birthrate, real estate, crime, and pollution. Wright intended to make the city simulation, while Forrester tried out a kind of game. On the basis of such SD, he planned to make SimCity by linking complex and various factors occurring in cities such as tax, law, crime, pollution, population, and the connection with other cities, as time has gone by.

On the other hand, Christopher Alexander, an architect of Berkeley and mathematician, was another influential person in the SimCity creation. He emphasized the city design and development based on interaction between men and cities. These factors helped to construct developmental cities through the interaction between computers and users by allowing users to receive the various information and statistical data on the city while developing SimCity. Besides these theoretical factors, Wright has got more interest in producing topography since the mid-development. The rapid progress of computer and the subsequent advent of various software enabled SimCity to represent the space in virtual reality similar to the real world. It naturally drew attention to topography production, the basic factor for city construction. It allowed users to design their desired city by providing different topography of cities in the world. Moreover, it has attained the stage in which they produce and edit the topography with their own hands by applying GIS.

The game goal of SimCity is not to simply construct and design a city, but to manage the city as a mayor. Users need to have strategies and goals for what kind of city will be constructed, designing a city, managing it through the analysis and monitoring on various external factors.

The user becomes a mayor, official, city planning expert, architecture, or landscape architecture and then manages the city issues on traffic, environment, finance, facilities, and disaster prevention. Sometimes he, as a citizen, constructs the city and lives there at the same time. Eventually, the ultimate goal of SimCity is to construct a city with enough finance and excellent environmental conditions, and competitiveness through the differentiation from other cities, as all the cities nowadays dream. Thus, the advent of SimCity has had repercussions in the game industry, and had an effect on the urban-related fields at the same time. The urban planning related theory and the simulation applying it made possible indirect experience of city construction and management, which was applied to urban planning related study and research simulation at universities in the world[25].

SimCity makes it possible to deal simultaneously with three Jiāns factors in a system and to simulate a real city, integrating GIS, SD, and OC techniqes. Therefore, ideas of SimCity is a way to Geo innovation which fields of GIS and SD should aim at.

25) Kim Yeon Joon, *Characteristics and Practical Use of SimCity*, Proceeding of International Seminar, 2008. 9.

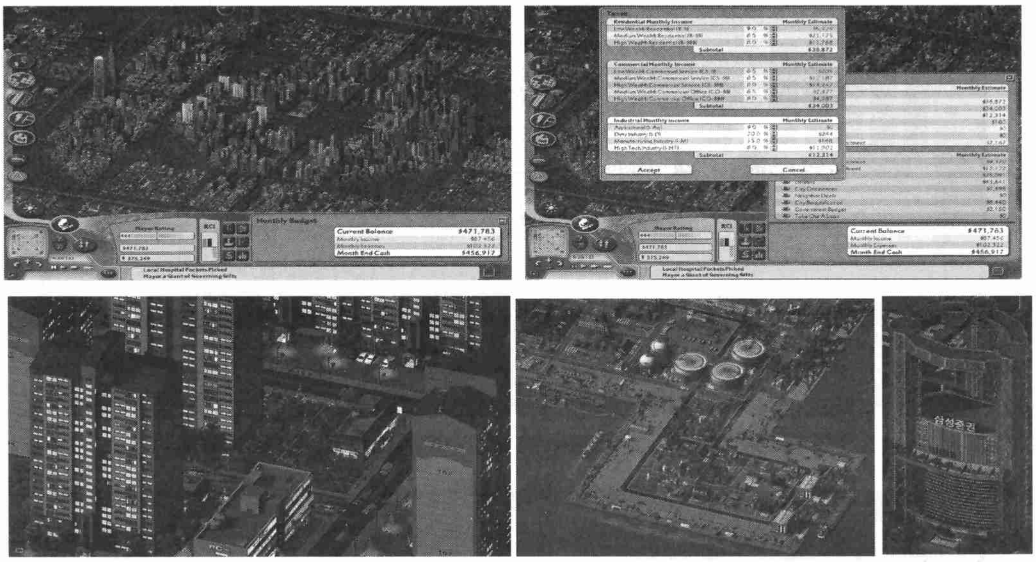


Figure 2. SimCity - 3D, Topography, Sims, Traffic, Construction, Management

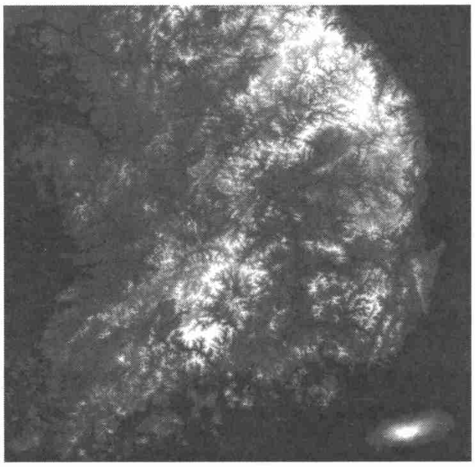


Figure 3a. DEM of Korea

Figure 3b. SimCity - Topography Produced by DEM

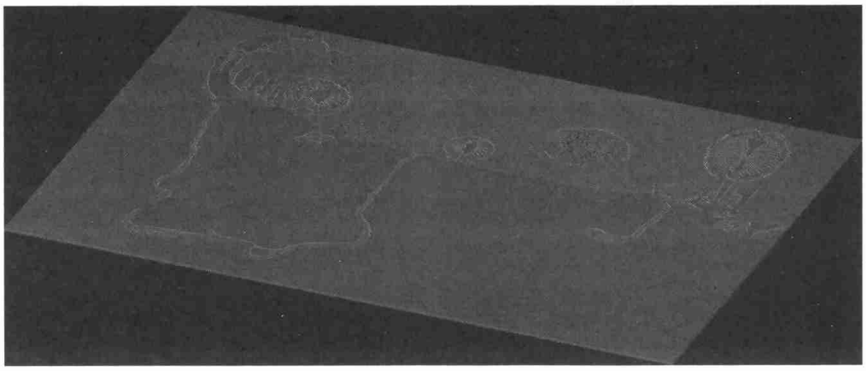


Figure 4. SimCity - Topography Selection of Dubai

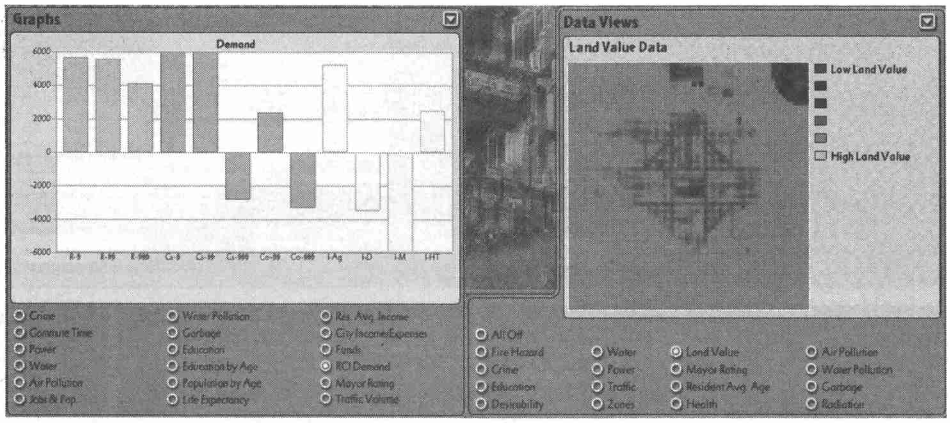


Figure 5. SimCity - Operation and Management of Land Use

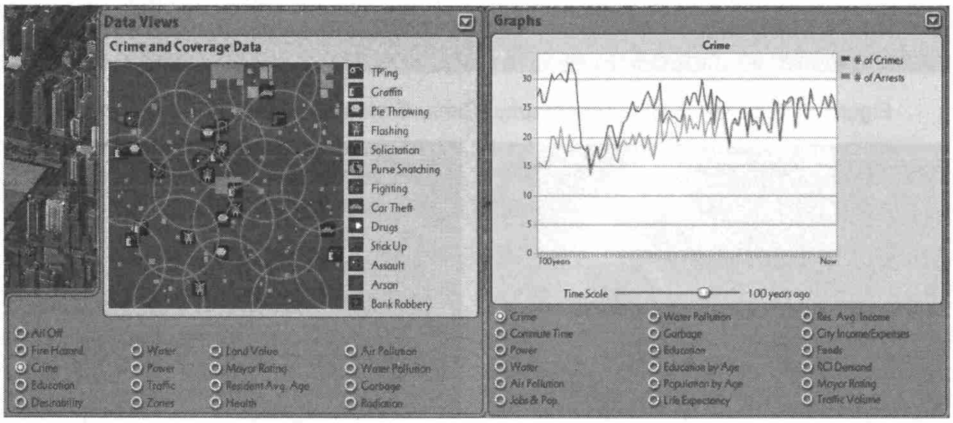


Figure 6. SimCity - Operation and Management of Public Facility

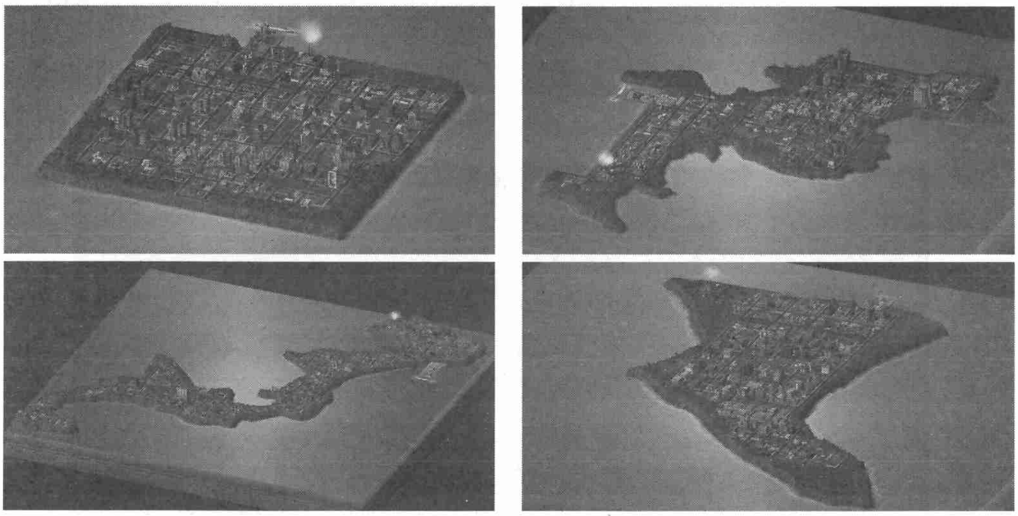


Figure 7. SimCity - Urban Planning Scenario Comparison

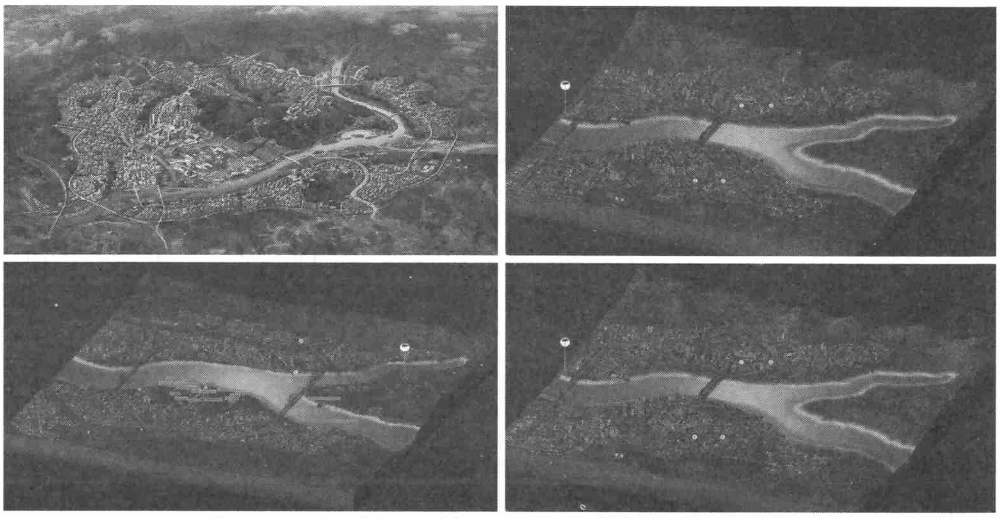


Figure 8. SimCity - Model Simulation of Sejong City

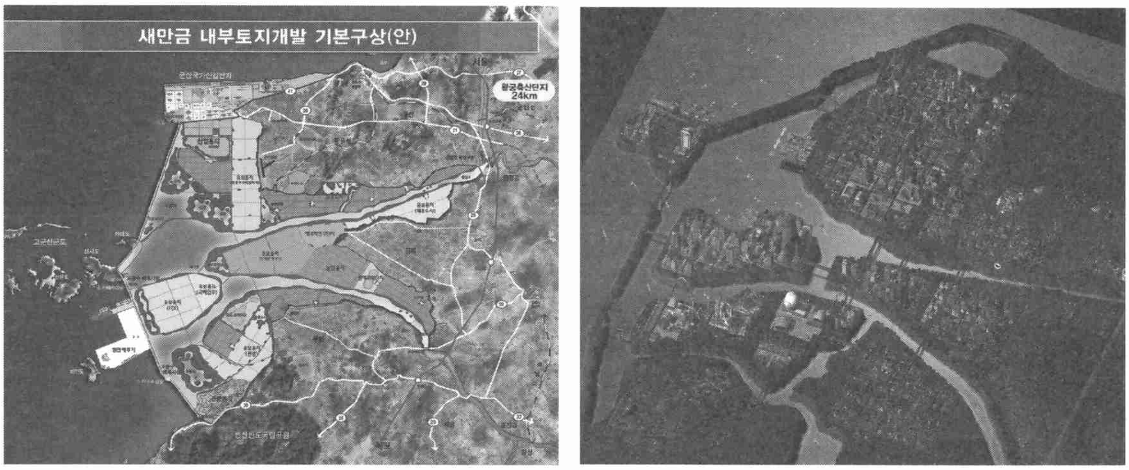


Figure. 9: SimCity - Model Simulation of Saemangeum

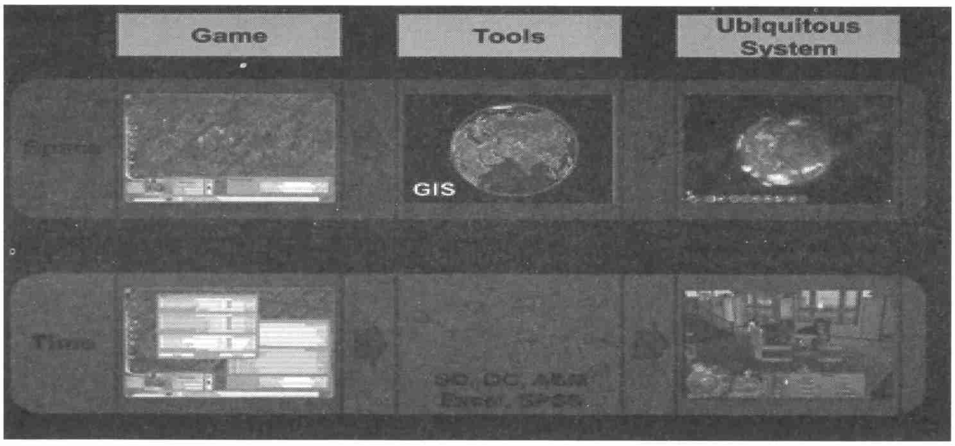


Figure 10. A Way to Construct a Three Jiāns Integrated System

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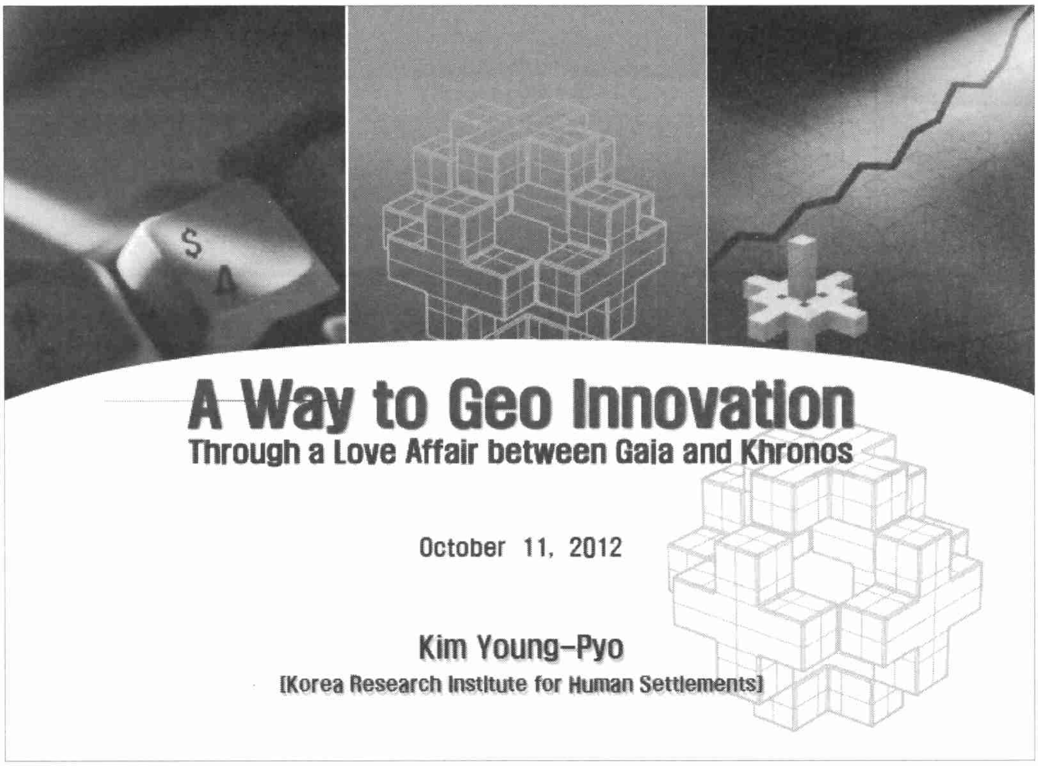
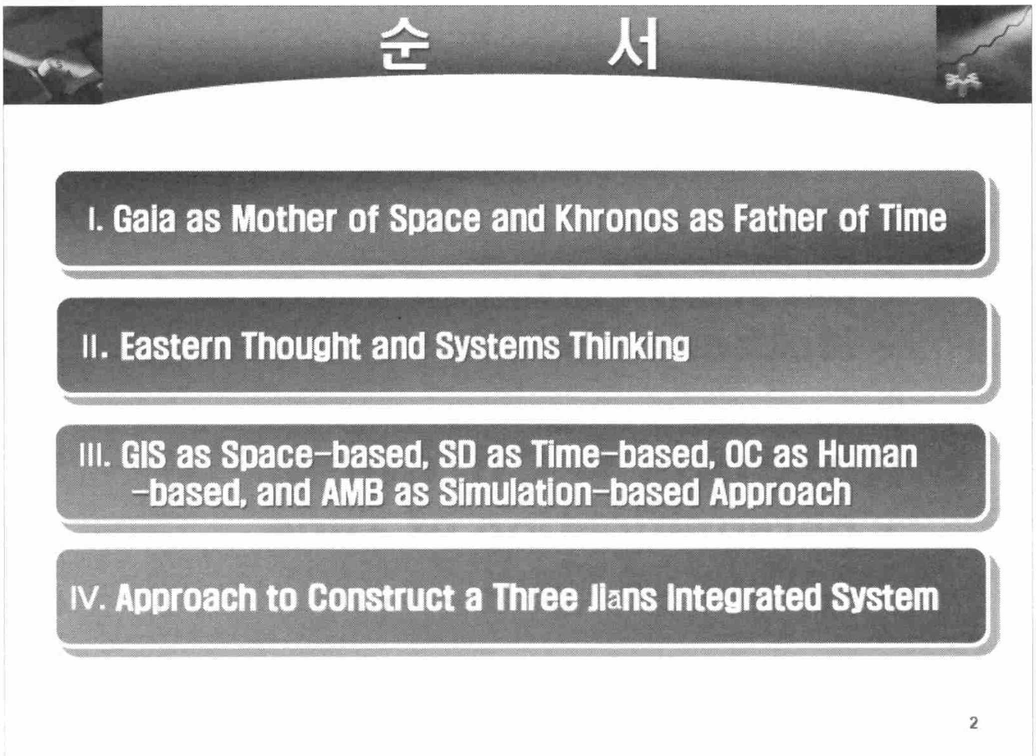

A Way to Geo Innovation
Through a Love Affair between Gaia and Khronos
October 11, 2012
Kim Young-Pyo
[Korea Research Institute for Human Settlements]


순 서
I. Gaia as Mother of Space and Khronos as Father of Time
II. Eastern Thought and Systems Thinking
III. GIS as Space-based, SD as Time-based, OC as Human -based, and AMB as Simulation-based Approach
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I. Gaia as Mother of Space and Khronos as Father of Time

3

Gaia and Khronos

- **Gaia**
  - personification of Earth or Land
  - Mother of Space
- **Khronos = Chronos**
  - personification of Time
  - Father of Time

4

Genesis of the Old Testament

1st Day	2nd~3rd Day	3rd~ 6th Day
TIME	Space	Human & entia

Genesis I

In the beginning God created the heaven and the earth… God called the light Day, and the darkness he called Night… *[the first day]*

… Let there be a firmament in the midst of the waters... divided the waters under the firmament… the waters above the firmament… God called the firmament Heaven… *[the second day]*

… God called the dry land Earth; and the gathering together of the waters called he Seas… grass…fruit tree… *[the third day]*

…God made two great lights… he made the stars also… *[the fourth day]*

… moving creature… fowl…great whales… *[the fifth day]*

… cattle, and creeping thing, and beast of the earth… So God created man… male and female… *[the sixth day]*

5

II. Eastern Thought and Systems Thinking

6

Universe as a System

- Universe ≡ 宇宙(Yǔ-Zhòu)
  ➡ The Largest System
- Huai Nan Tzǔ [淮南子]
  - 宇(Yǔ) ≡ 四方上下 (3D Space)
  - 宙(Zhòu) ≡ 古往今來 (Time Flow)
- Universe is a frame containing Time and Space

Huai Nan Tzǔ

A compilation of various schools of thought made by the around 3,000 guests attached to the court of Liu An(劉安), Prince of Huai-nan(died 122 B.C.), in the Former Han Dynasty

7

Central Theme of Buddhism

- Central theme of the Buddhism
  - Unity of all things and events
  - Interrelation of all things and events
- Buddhism stresses on Causality
  - All things arise and pass away by causality
- Spatial Causality and Temporal Causality
  - All things are linked one another by a cosmic web [諸法無我]
  - All things are impermanent and variable vanity [諸行無常]
- All life is the oneness
  - We should have love and compassion on all life

8

Thought of Three Essences

- In addition to Time and Space, the ancient Easterners paid attention to Man as a representative of entia in the Universe
- Three Essences in the Universe

- Three Jiān(間)s in the Universe
  - Time (時間 Shí-jiān)
  - Space (空間 Kōng-jiān)
  - Human (人間 Rén-jiān)

9

The Harmony of Three Essences

- Three Jiāns(三間) should be the fundamental factors for a complete system
- Harmony Principle of Three Essences

> A system can get completeness
> by unifying spatio-temporal-human integrated factors through a love affair between Gaia and Khronos
> and ultimately seeks for
> the Harmony of Three Jiāns

10

III. GIS as Space-based Approach
SD as Time-based Approach
OC as Human-based Approach
AMB as Simulation-based Approach

11

GIS and SD

GIS

Geographic Information System
Space-based Approach

SD

System Dynamics
Time-based Approach

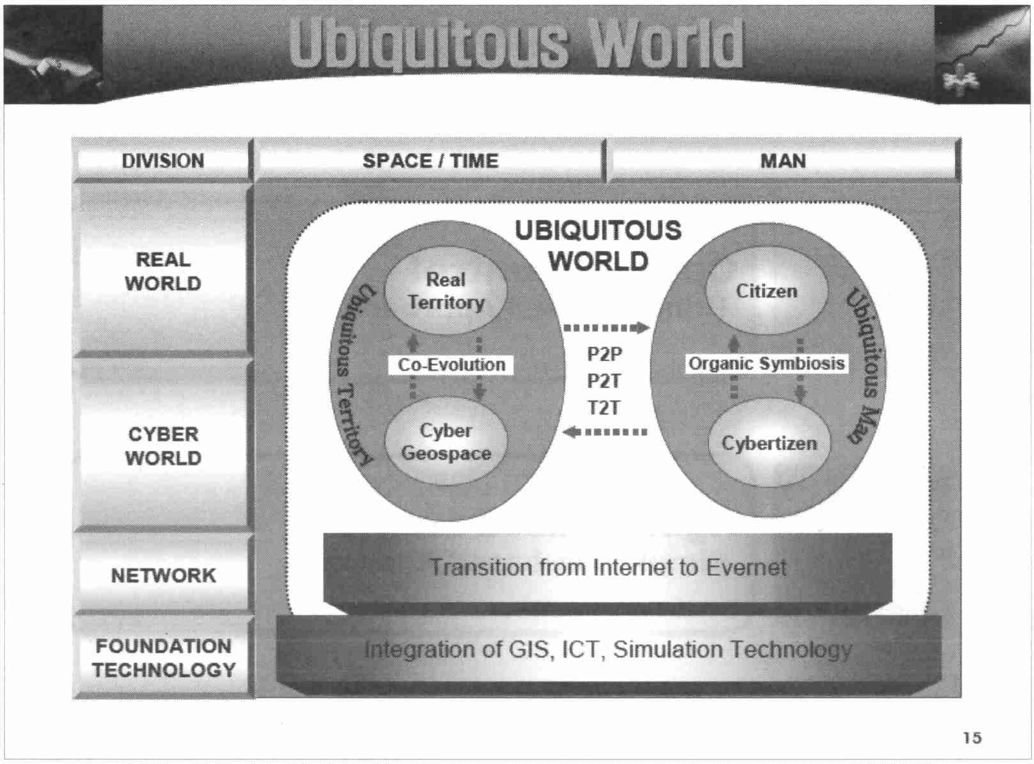
12

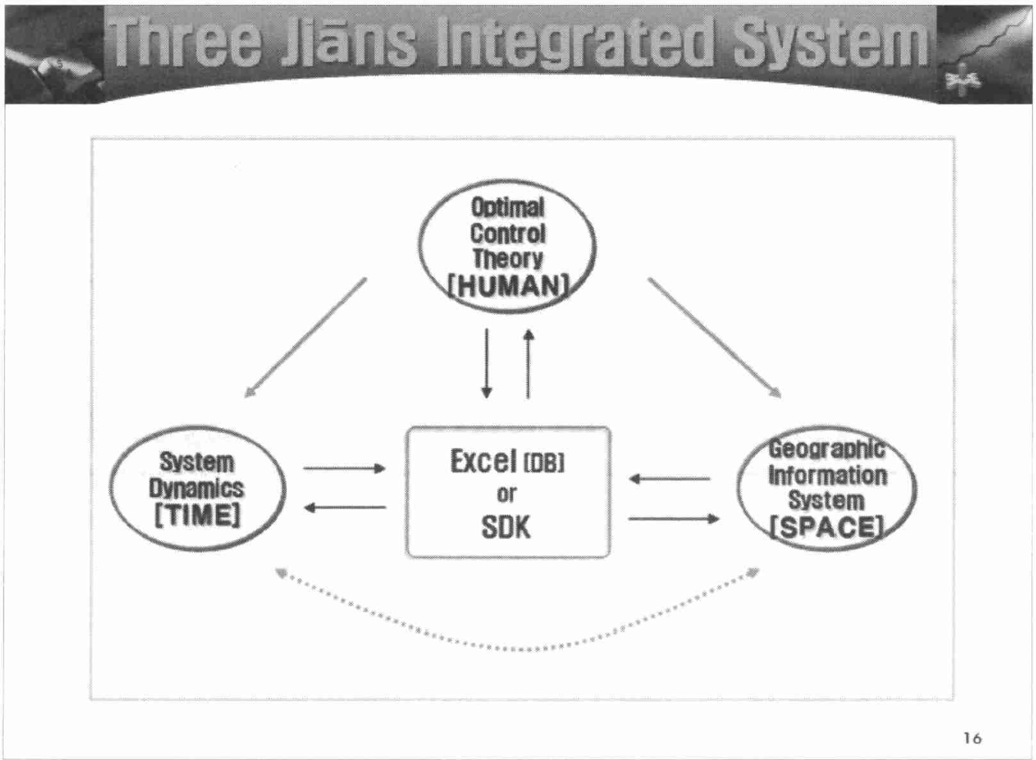
OC and ABM

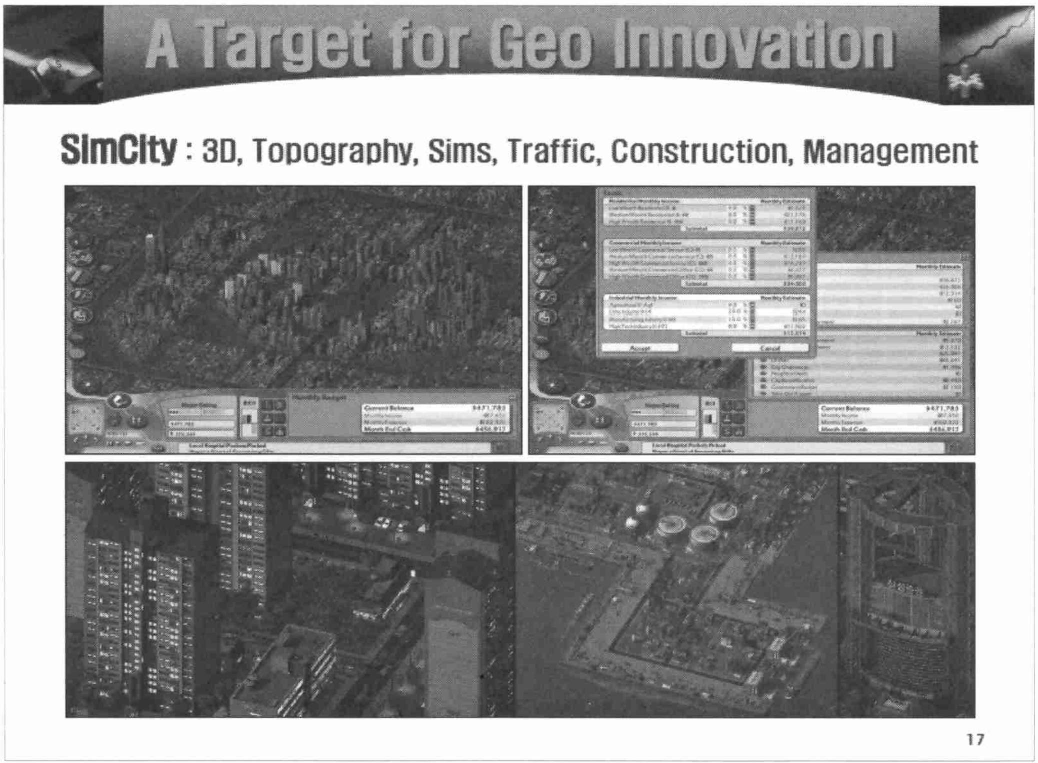
OC — **Optimal Control**
Human-based Approach

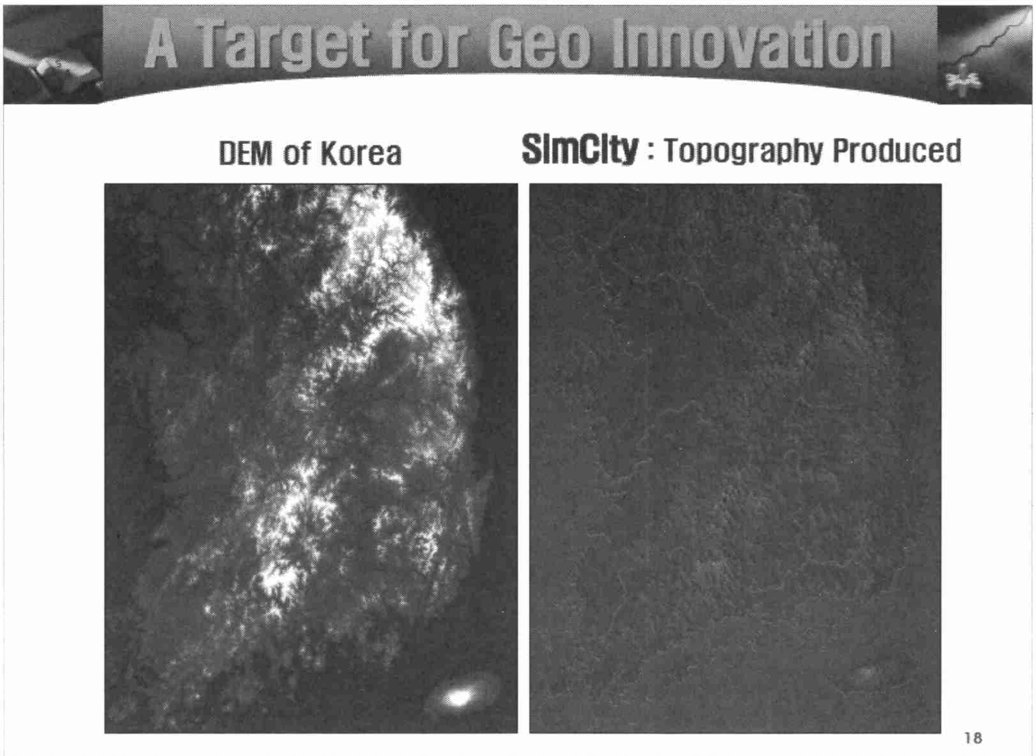
ABM — **Agent-based Model**
Simulation-based Approach

IV. Approach to Construct a Three Jiāns Integrated System


Ubiquitous World
DIVISION
SPACE / TIME
MAN
REAL WORLD
CYBER WORLD
NETWORK
FOUNDATION TECHNOLOGY
UBIQUITOUS WORLD
Ubiquitous Territory
Real Territory
Co-Evolution
Cyber Geospace
P2P
P2T
T2T
Citizen
Organic Symbiosis
Cybertizen
Ubiquitous Man
Transition from Internet to Evernet
Integration of GIS, ICT, Simulation Technology
15

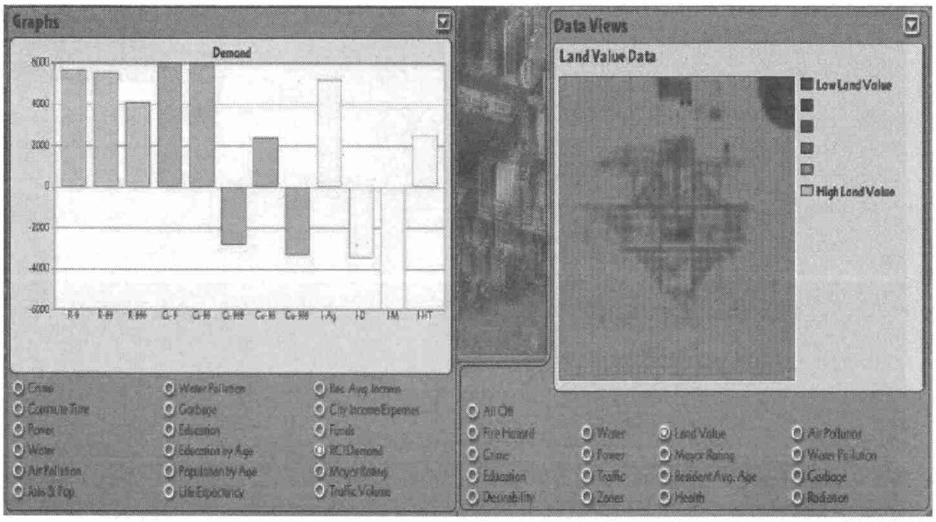

Three Jiāns Integrated System
Optimal Control Theory [HUMAN]
System Dynamics [TIME]
Excel [DB] or SDK
Geographic Information System [SPACE]
16


A Target for Geo Innovation
SimCity : 3D, Topography, Sims, Traffic, Construction, Management
17


A Target for Geo Innovation
DEM of Korea
SimCity : Topography Produced
18

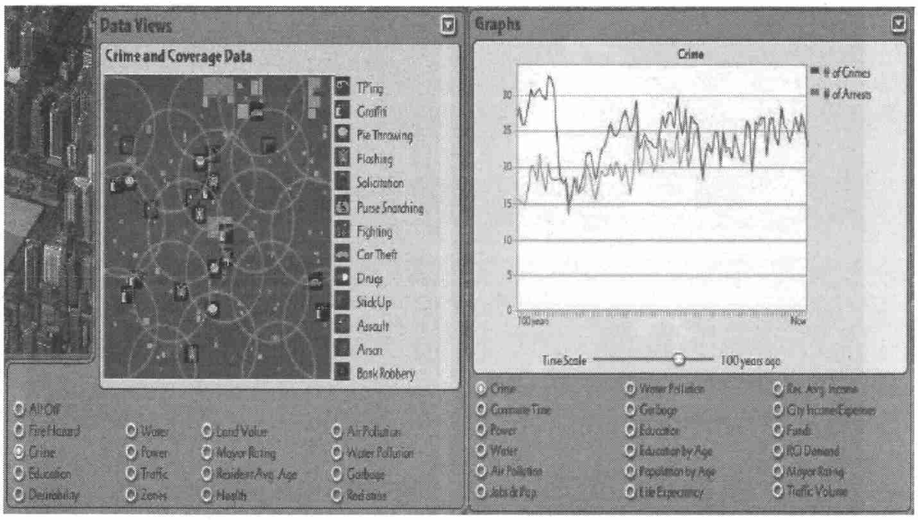
A Target for Geo Innovation

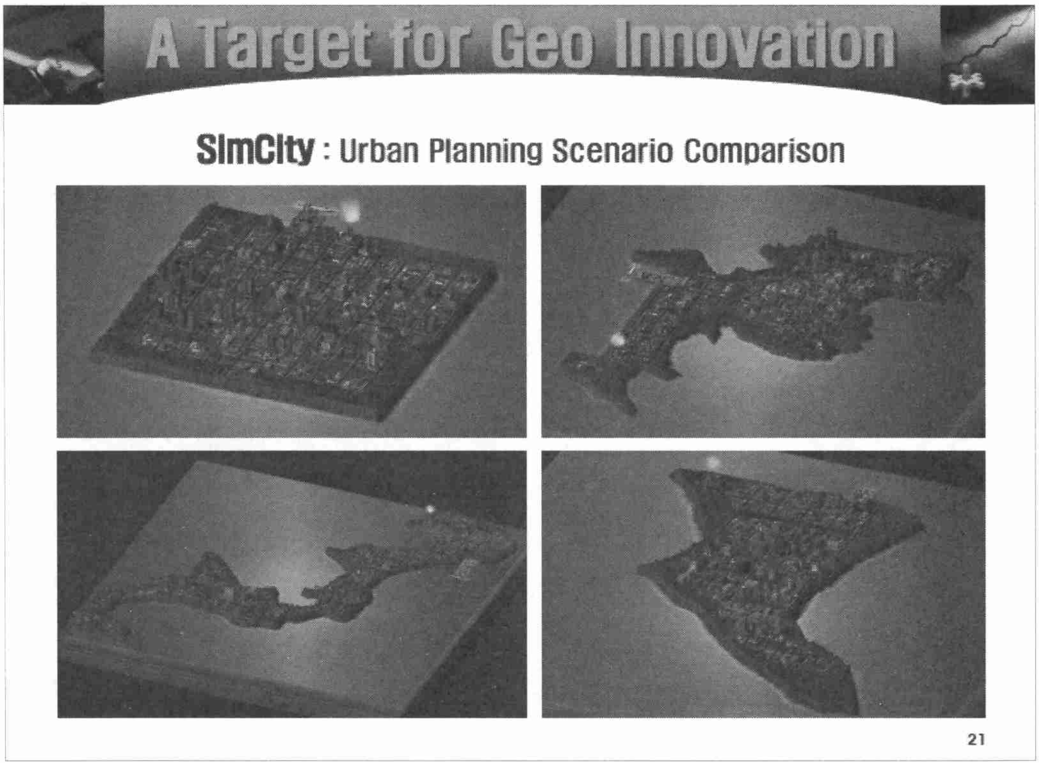
SimCity : Operation and Management of Land Use

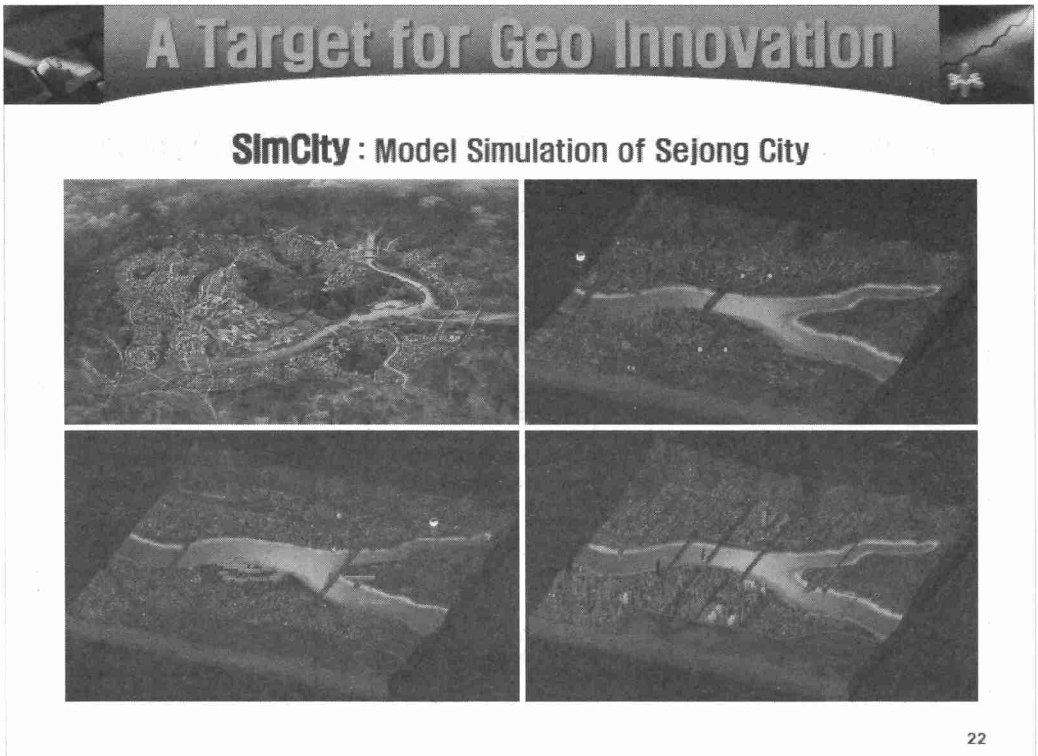


A Target for Geo Innovation

SimCity : Operation and Management of Public Facility

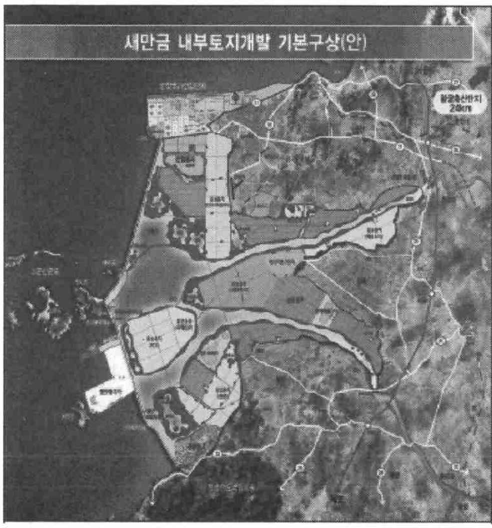


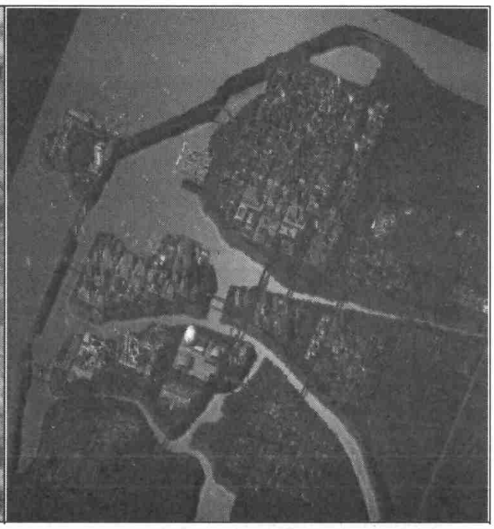

A Target for Geo Innovation
SimCity : Urban Planning Scenario Comparison
21


A Target for Geo Innovation
SimCity : Model Simulation of Sejong City
22

A Target for Geo Innovation

SimCity : Model Simulation of Saemangeum





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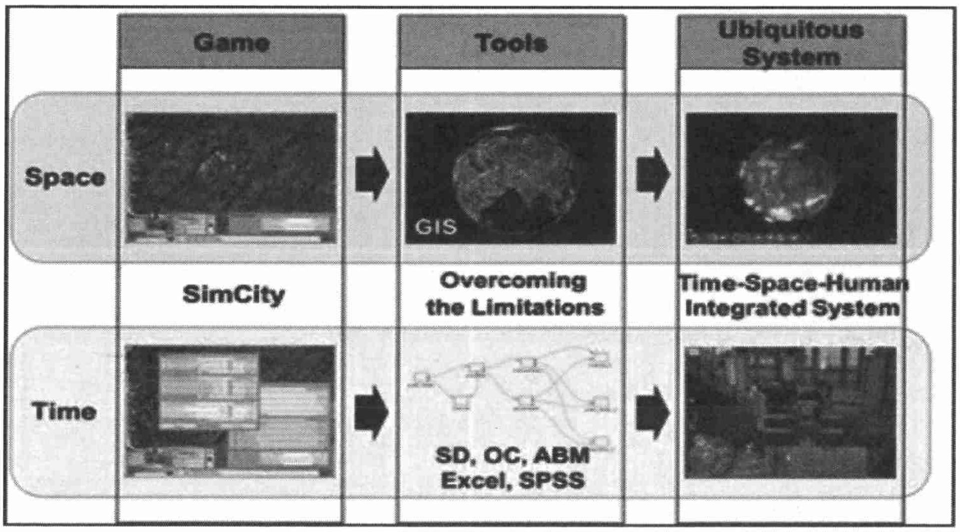
A Target for Geo Innovation

A Way to Construct a Three Jiāns Integrated System



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Thank You !!
(kyp5208@hanmail.net)
25


Thank You !!
(kyp5208@hanmail.net)
25

[Session 1]

Geo Innovations and Supporting Policies in East Asian Countries

3

NSDI, Location Intelligence and Business Geographics in Japan

Prof. Hiroyuki Kohsaka

(Nihon University, Japan)

ICG-TEK 2012

International Conference on sharing Geospatial Technology, Experience and Knowledge

NSDI, Location Intelligence and Business Geographics in Japan

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Abstract

This paper considers present situation of NSDI in Japan and three kinds of location intelligences that are brought from NSDI and Japanese GIS society pays attention to. Because Japan aims at establishing safe, reliable, and prosperous society, NSDI must be provided sequentially and used widely by administrative, academic and business worlds.

Keywords: NSDI, location intelligence, business geographics, Japan

1. Present Situation of NSDI in Japan

1.1 Definition of NSDI

The definition of NSDI(National Spatial Data Infrastructure) is defined as the technology, policies, standards, and human resources necessary to acquire, process, store, share, distribute, and improve utilization of geospatial data(Presidential Documents, 1994; Kohsaka, 1995).

The purpose of NSDI is to avoid wasteful duplication of effort and promote effective and economical management of spatial data by national and local governments. Namely, collect once and reuse many times.

There are two stages of generation in the development of NSDI(Fu and Sun 2011, 173-179). The first generation of NSDI is data-duplication-based NSDI, that is called NSDI 1.0. User has to obtain duplicate copies of geospatial data that are transfered onto CD-ROM or DVD. The second generation of NSDI is web-services-based NSDI as NSDI 2.0. Geospatial data are maintained locally, closest to source, and then shared with the nation through online services.

1.2 Digital Geospatial Data on Web

Most of digital geospatial data are available from HP of GSI(The Geographical Survey Institute, Ministry of Land, Infrastructure, Transport and Tourism; MLIT) http://www.gsi.go.jp/kiban/index.html.

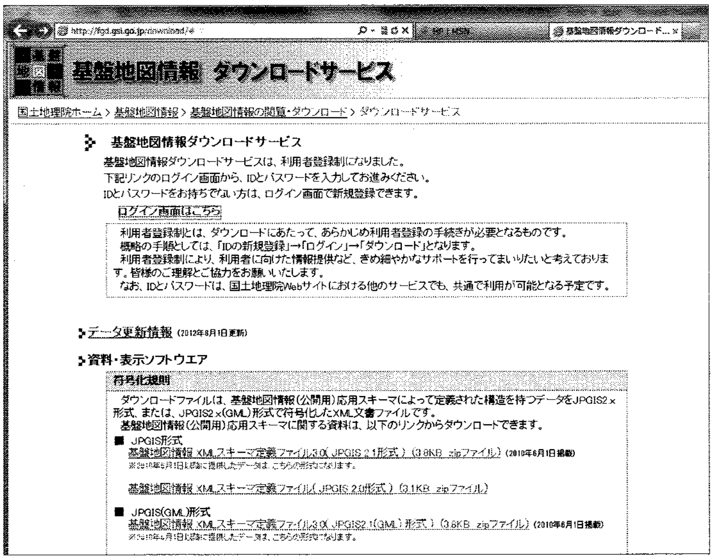

Figure 1-1. Download Service for Digital Basic Map by GSI

Figure 1-1 shows the download service for Digital Basic Map by GSI. There are four kinds of download services. Those are Digital Basic Maps with scales 2500 and 25000, DEM, control points, and boundary of block (Figure 1-2).

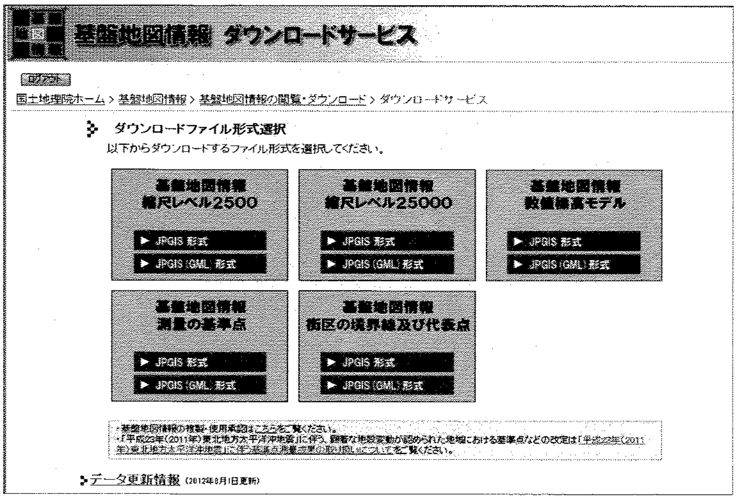

Figure1-2. Maps with scales 2500 and 25000, DEM, control points, and boundary of block

Figure 1-3 shows layers of Digital Basic Map with scale 25000. Line features are coast line, water, rail road, road edge. Polygon is administrative area and building. Point is elevation. It is necessary to use a converter to construct layers of shape format by ESRI. Figure 2 shows Digital Basic Map 2500 on ArcMap.

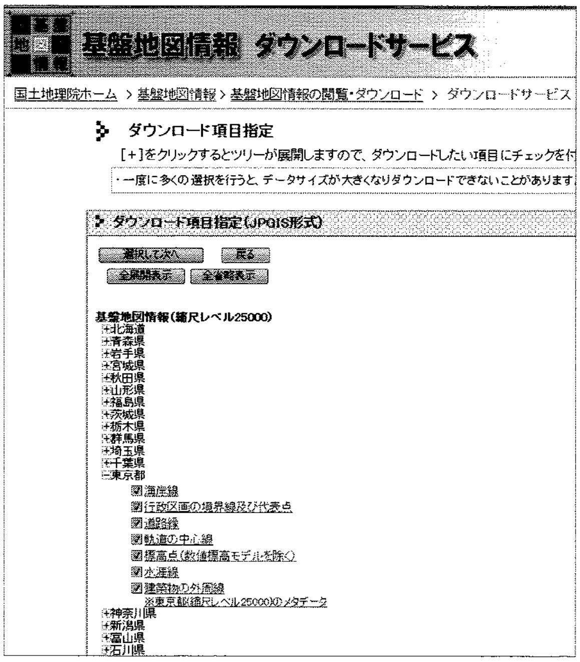

Figure 1-3. Layers of Digital Basic Map

Figure 2. Digital Basic Map 2500 on ArcMap

1.3 Digital Statistics on Web

The statistics collected by national government are available from e-Stat (http://www.e-stat.go.jp/SG1/estat/eStatTopPortal.do). Figure 3 is Population Census 2010 on e-Stat.

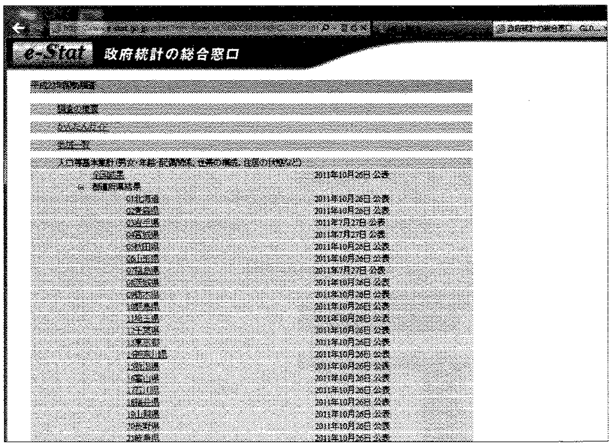

Figure 3. Population Census 2010 on e-Stat

Census geography in Japan is represented in Table 1. There are four spatial levels. Japan at finest level consists of about 240,000 small areas called chocho-aza.

Table 1. Census geography in Japan

spatial scale	number
nation	1
prefecture	47
city, ward, town, village	1,719
chocho-aza	240,000

The population census for small area (chocho-aza level) is downloadable from e-Stat as shown in Figure 4. The survey themes in population census are population, household, housing, industry and migration (Table 2). The survey items in population census.survey items amount to 475.

Figure 4. Population census for small area (chocho-aza level)

Table 2. The survey themes and items in population census

theme	items
population	114
household	85
housing	163
industry	174
migration	24
total	475

Table 3. Digital population data for chocho-aza in Tokyo

都道府県	市区町村	大字・町名	字・丁目	総数	男	女
東京都	千代田区	神田神町	2丁目	939	463	476
東京都	千代田区	神田神保町	3丁目	425	201	224
東京都	千代田区	三崎町		769	354	415
東京都	千代田区	三崎町	1丁目	27	13	14
東京都	千代田区	三崎町	2丁目	483	209	274
東京都	千代田区	三崎町	3丁目	259	132	127
東京都	千代田区	西神田		1141	554	587
東京都	千代田区	西神田	1丁目	66	34	32
東京都	千代田区	西神田	2丁目	749	347	402
東京都	千代田区	西神田	3丁目	326	173	153

Table 3 is one example of population census, that shows digital population data for chocho-aza in Tokyo. This table is linked to the boundary layer of chocho-aza to draw population distribution map for small area as shown in Figure 5.

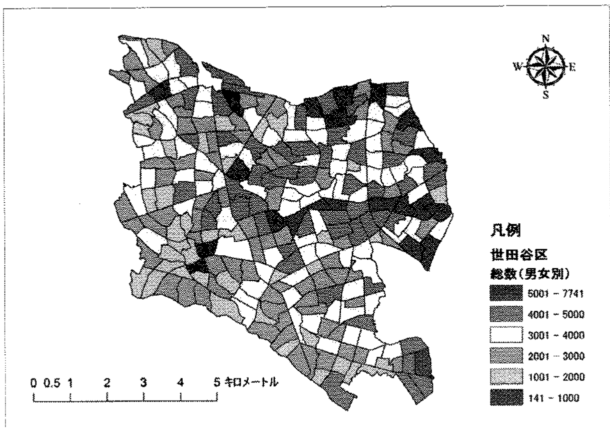

Figure 5. Population distribution for small areas in Setagaya ward, Tokyo

1.4 Problems of NSDI in Japan

Geospatial data produced by governments are not indexed consistently. Buildings, blocks, chocho-aza(small areas) have not always consistent and unique identifiers. As an example, the identifier of chocho-aza consists of 11 digit numbers, but two kinds of identifiers are distributed.

2. Location Intelligence

What is intelligence? Data is row of alphanumeric characters like 10b00111aaaa. Information is fact such as the wind blows. Knowledge is rule: If the wind blows, the bucket makers prosper. Intelligence is activity: As there are many days when the wind is strong, therefore I will become bucket maker.

GI technology produces location intelligence. Location intelligence is defined as the intelligence on a location which is useful for person or firm to make a decision making.

GIS society in Japan pays attention to three kinds of location intelligence. The first is location intelligence for safety. This is useful for natural and technological disasters. The second is location intelligence for accessibility. For example, this type of intelligence is useful when road is blocked for passing. The third is location intelligence for business opportunity. This is used to make a decision of retail location.

3. Location Intelligence for Safety

3.1 Hazard Map

The Eastern Japan Earthquake occurred on March 11, 2011. The highest tsunami of 37.9 meters attacked Taro, Miyako City, Iwate Prefecture. Figure 6 shows the distribution of height of the tsunami.

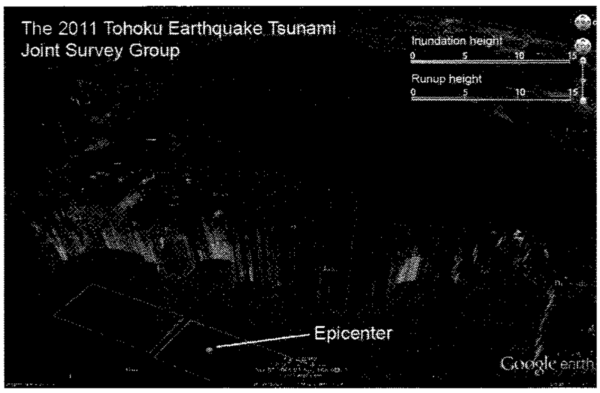

Figure 6. Height of tsunami by the 2011/03/11 Tohoku Earthquake
Source : Quick estimation on tsunami by the earthquake in off the Pacific coast of Tohoku region by joint survey group (http://www.coastal.jp/ttjt/ (April 30, 2011)

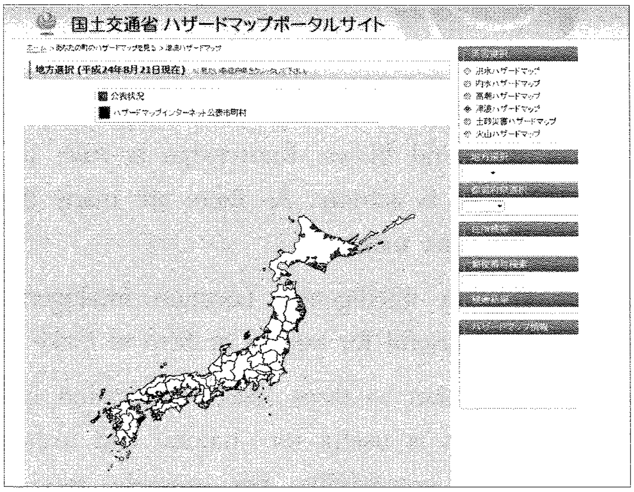

Figure 7. Portal site of hazard maps for tsunami on MLIT

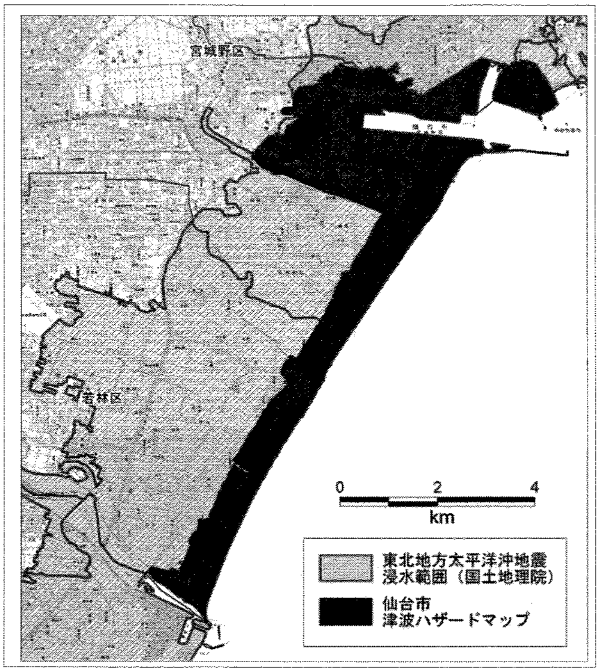

Figure 8-1. Flooded area on hazard map of Sendai City

Hazard maps have been published by local governments for various natural disasters such as tsunami, earthquake, flood and volcanic disaster. Figure 7 is the portal site of hazard maps for tsunami on MLIT. Figure 8-1 shows the hazard map of tsunami in Sendai City, in which a large number of dead and missing people occurred by the Eastern Japan

Earthquake. Most of people in this area believed that this area was safe for tsunami on the basis of information from the hazard map. Therefore people did not escape from this area, even if major earthquake occurred. The flooded area by the East Japan Earthquake was too large outside an assumption of hazard map (Figure 8-1). Ironically, hazard maps let damage spread. New hazard map was published as shown in Figure 8-2, but it is too late. In this way, unfortunately, hazard maps could not convey the location intelligence for safety.

Figure 8-2. New hazard map of Sendai City

3.2 Super Bank

Topographic map 25000 can be seen on Digital Japan Portal Web Site (See Figure 9-1). If we take a look at topographic map 25000 of Taro, Miyako City (Figure 9-2), we can find that Taro was protected by super bank. Height of the super bank was 10 meters and its length was 2.4 kilometers (Figure 10-1).

People at Taro believed that tsunami does not run over the super bank. However, the super bank was destroyed by the tsunami 2001 as shown in Figure 10-2. The super bank also was useless for the safety of location.

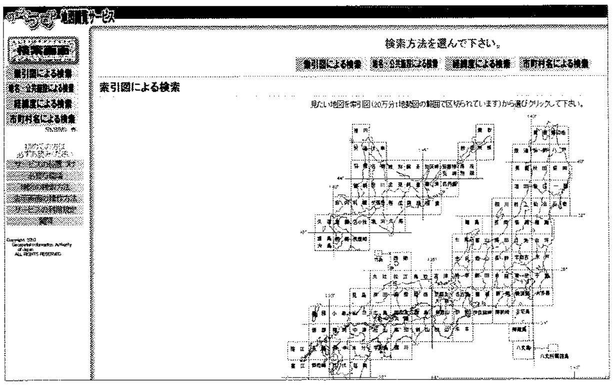

Figure 9-1. Topographic map 25000 on Digital Japan Portal Web Site

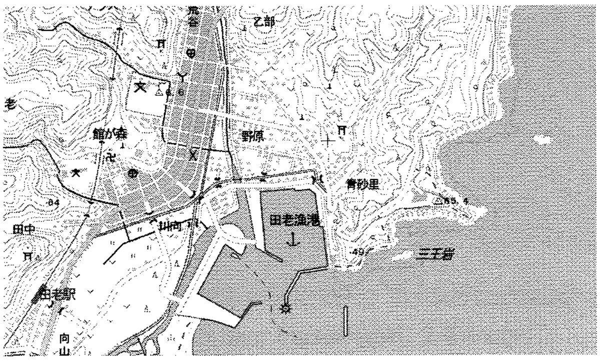

Figure 9-2. Topographic map 25000 of Taro, Miyako City

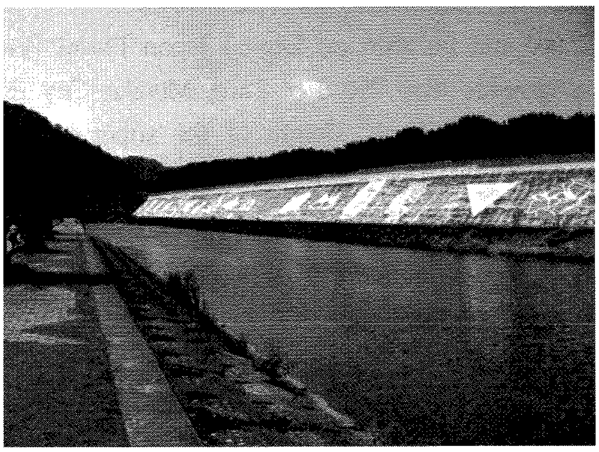

Figure 10-1. Super bank at Taro, Miyako City

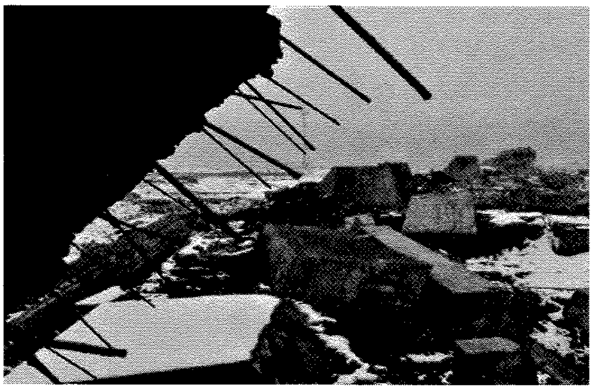

Figure 10-2. Super bank destroyed by Tsunami 2011
super bank destroyed by Tsunami 2011 at Taro, Miyako City: Sankei News , March 16, 2011
http://yoiotoko.way-nifty.com/blog/2011/03/post-f16e.html

3.3 Tsunami Monument

The coast of Eastern Japan has been attacked constantly by large tsunami. A large number of tsunami monuments were built along the coast line (Figure 11).

Figure 11. Distribution of tsunami monuments

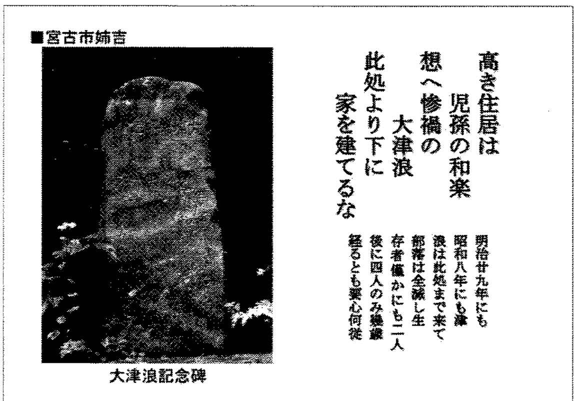

Figure 12. Lesson that the tsunami memorial talks about

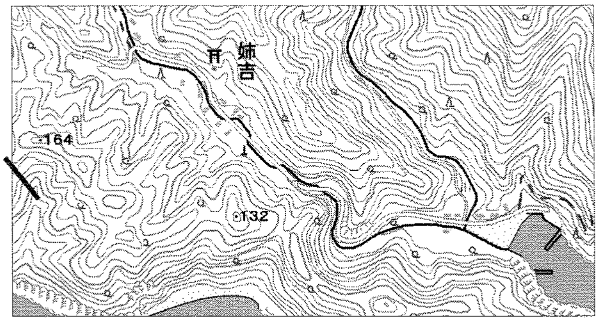

Figure 13. Location of the tsunami monument at Aneyosi Village in Miyako City

Figure 12 is one of tsunami monuments, Miyako City. The lesson that it talks about is that do not build any houses below this. Actually, tsunami approached the 50 meters this side of the monument (shown as red line in Figure 13).

What tell us location intelligence for safety? Hazard map and the super bank are no. Tsunami monuments tell us location intelligence for safety.

4. Location Intelligence for Accessibility

The Eastern Japan Earthquake occurred at 14:46:18 of March 11, 2011. The road network in Tohoku region was cut apart and it became the trouble for a rescue operation.

HONDA collected and analyzed probe data from car navigation users (1.3 million users) on March 12 and analyzed road sections where is accessible by car. On the basis of this data, Google constructed car traffic map for crisis response on March, 14. Figure 14 presents the car traffic map, in which red and pink routes are traffic jam, blue routes are travelable for vehicles, and gray routes have no information, that mean the routes may be blocked for passing.

The car traffic map received 2011 Good Design Award on November 9, 2011. Award-winning reason is creative application of probe data which shows clearly future way of manufacturing in Japan. This map was useful for rescue and recovery operations, because it told us location intelligence for accessibility.

Figure 14. Car traffic map
http://car.watch.impress.co.jp/docs/news/20111109_489640.html

5. Business Geographics

Integration of GIS with business intelligence (BI) software is expected as one of potential application areas in GIS. This area is called as business geographics, or geobusiness (Pick 2008) and is applied to business operation and decision making. The representative examples are posting of advertisement leaflets in the area delimited using GIS and site selection, respectively. This section introduces recent progress in site selection of retailers using GIS.

Site selection is related with location intelligence for an opportunity of the business. Retailer wants to know whether the management of retail store is established. There are three major factors to influence business opportunity at a location: demand, supply, and environment. The site selection system is built by considering these factors.

5.1 Demand

The demand for a retail store occurs from neighboring resident, worker, and transit people. In analyzing the location of retail store with small trade area (500 meters radius) like convenience store, spatial variation of population at large (fine) scale has to be considered in the site selection system.

Figure 15 shows population distribution represented by 25m mesh, which is produced using the layer of population aggregated at block level and the building layer with the attribute data on number of floors and area.

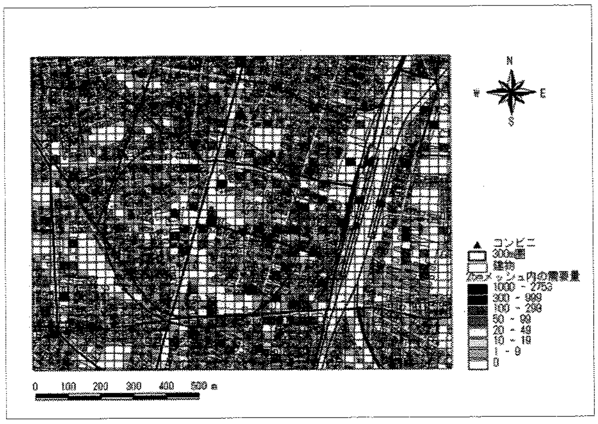

Figure 15. Population distribution represented by 25m mesh

5.2 Supply

The distribution of supply of goods and service is represented as a map of retail agglomeration such as shopping streets constructed at individual stores. Figure 16 is supply geography in Toshima ward, Tokyo (Kohsaka 2011). The competitors are especially important in site selection.

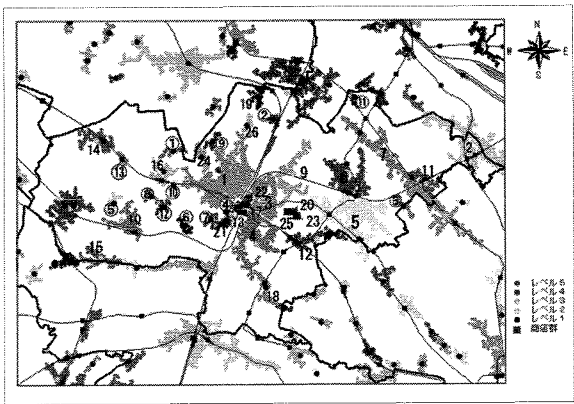

Figure 16. Supply geography in Toshima ward, Tokyo

5.3 Environment

Stations of rail ways and shopping streets act as an attractor of customers for retail stores. On the other hand, river, rail way, major street, big facility, and topography act as a barrier. Figure 17 shows major road as barrier for customer.

To let business geographics succeed, it requires access to comprehensive, accurate, and current data. Shortage of data for business applications becomes a central issue.

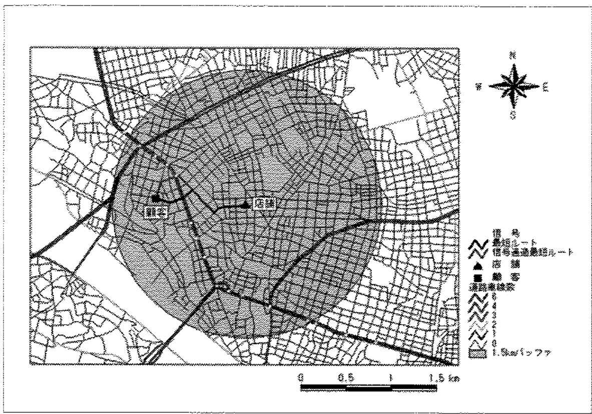

Figure 17. Main road as barrier for customer

6. Conclusions

NSDI should be used for producing location intelligences. Namely, location intelligences tell us whether this location is safety, whether we can go to this location by car, or whether retail store can be open at this location.

Japan aims at establishing safe, reliable, and prosperous society. To achieve this purpose, NSDI must be provided sequentially by governments and used widely by administrative, academic and business worlds.

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NSDI, Location Intelligence and Business Geographics in Japan

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Nihon University
Tokyo, Japan

Content of presentation

Ⅰ Present Situation of NSDI in Japan
Ⅱ Location Intelligence
Ⅲ Business Geographics
Ⅳ Future of NSDI

1. Present Situation of NSDI in Japan

1.1 Definition of NSDI

- The technology, policies, standards, and human resources necessary to acquire, process, store, share, distribute, and improve utilization of geospatial data.
- The purpose of NSDI:
- Collect once and reuse many times.

Generation of NSDI

- The first generation of NSDI: NSDI 1.0 (Fu and Sun 2011)

Data-duplication-based NSDI

User has to obtain duplicated copies of geospatial data that are transfered onto CD-ROM or DVD.

- The second generation of NSDI: NSDI 2.0

Web-services-based NSDI

Geospatial data are maintained locally, closest to source, and then shared with the nation through online services.

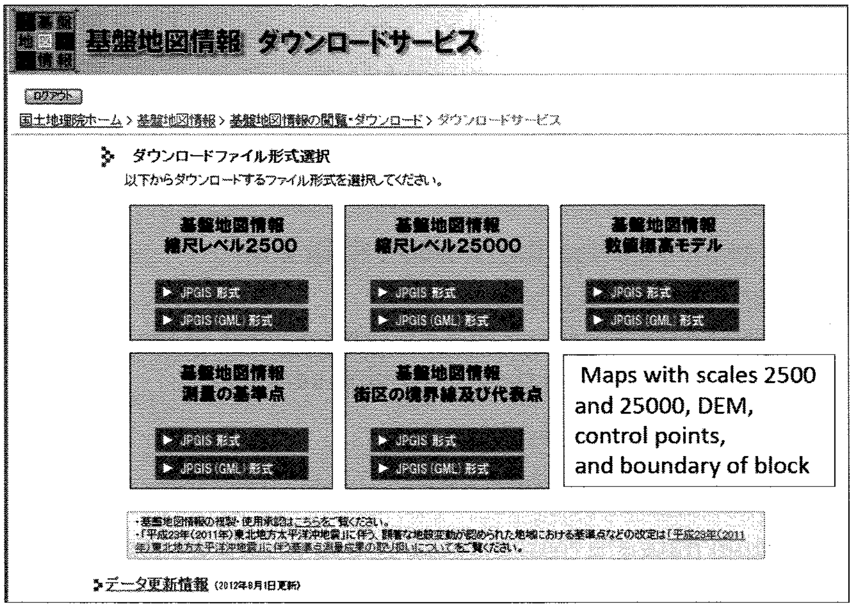
- The third generation: NSDI 3.0

Web GIS-based NSDI

Geospatial data are manipulated and analyzed on Web GIS to provide on demand services by user.

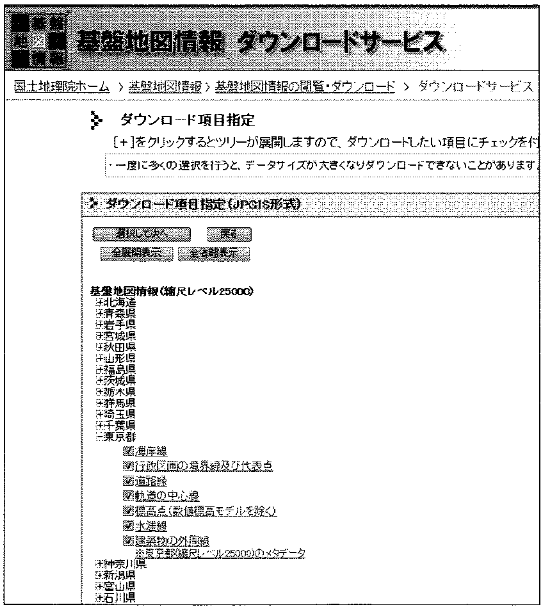
1.2 Digital Geospatial Data on Web

Fig. 1-1 Download Service for Digital Basic Map by GSI



Maps with scales 2500 and 25000, DEM, control points, and boundary of block

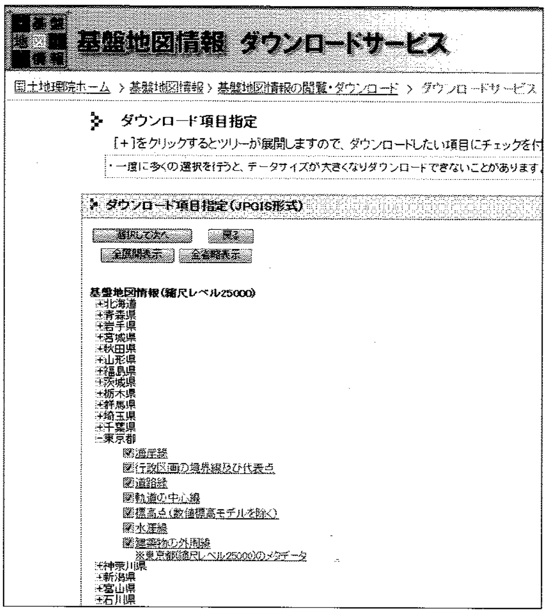
Fig. 1-2 Layers of Digital Basic Map



Digital Basic Map with scale 25000

(1) Line
Coast line
Water
Rail road
Road Edge
(2) Polygon
Administrative area
Building
(3) Point
Elevation

Fig. 1-3 Layers of Digital Basic Map



Digital Basic Map with scale 25000

(1) Line
Coast line
Water
Rail road
Road Edge
(2) Polygon
Administrative area
Building
(3) Point
Elevation

Fig. 2 Viewer and Converter for Digital Basic Map

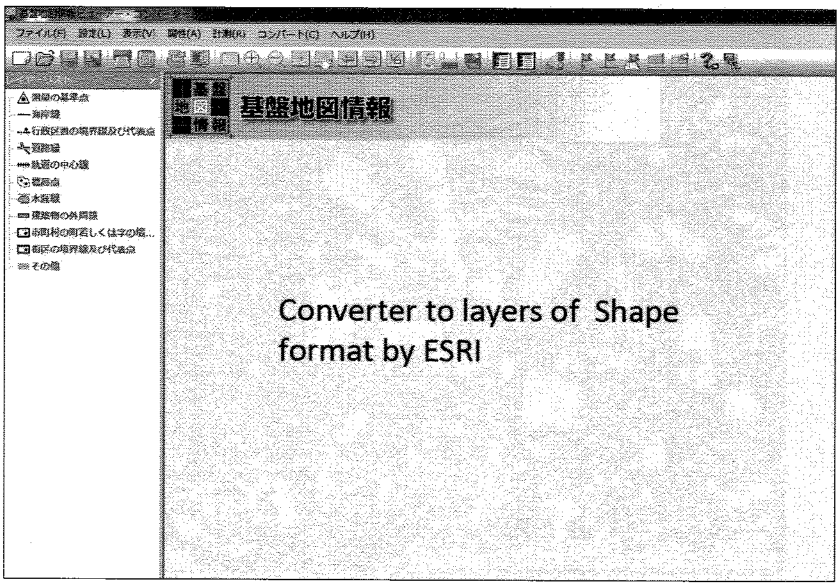


Fig. 3-1 Digital Basic Map 25000 on ArcMap

Fig. 3-2 Digital Basic Map 2500 on ArcMap

1.3 Digital Statistics on Web

Fig. 4-1 Population Census 2010 on e-Stat

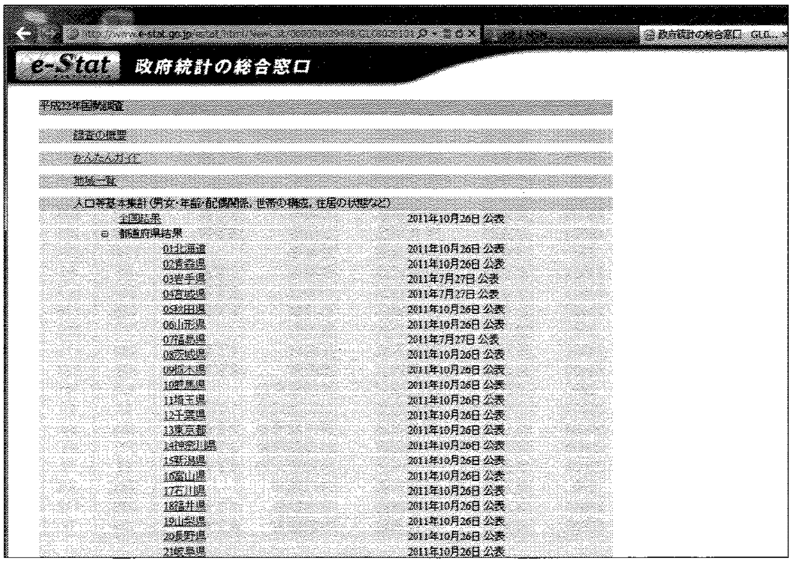


Fig. 4-2 Population census for small area (chocho-aza)

e-Stat 政府統計の総合窓口

各行にある Excel CSV PDF DB のボタンを押すと該当データが表示されます。
平成22年国勢調査 > 小地域集計 > 13東京都

2012年5月29日公表

表番号	統計表	
人口等基本集計に関する集計		
1	男女別人口及び世帯数 －基本単位区	
	13101千代田区～13111大田区	CSV
	13112世田谷区～13119板橋区	CSV
	13120練馬区～13205青梅市	CSV
	13206府中市～13421小笠原村	CSV
2	男女別人口及び世帯数 －町丁・字等	CSV
3	年齢(5歳階級)，男女別人口(総年齢，平均年齢及び外国人―特掲) －町丁・字等	CSV
4	配偶関係(3区分)，男女別15歳以上人口 －町丁・字等	CSV
5	世帯の種類(2区分)，世帯人員(7区分)別一般世帯数，一般世帯人員，1世帯当たり人員，施設等の世帯数及び施設等の世帯人員 －町丁・字等	CSV
6	世帯の家族類型(6区分)別一般世帯数，一般世帯人員及び1世帯当たり人員(6歳未満・18歳未満・65歳以上世帯員のいる一般世帯数，65歳以上世帯員のみの一般世帯数及び3世代世帯―特掲) －町丁・字等	CSV
7	住居の種類・住宅の所有の関係(6区分)別一般世帯数，一般世帯人員及び1世帯当たり人員 －町丁・字等	CSV
8	住宅の建て方(7区分)別住宅に住む主世帯数，主世帯人員及び1世帯当たり人員 －町丁・字等	CSV
9	住居の種類・延べ面積(7区分)別一般世帯数，一般世帯人員及び1世帯当たり人員 －町丁・字等	CSV
産業等基本集計に関する集計		
10	労働力状態(2区分)，男女別15歳以上人口 －町丁・字等	CSV
11	従業上の地位(3区分)，男女別15歳以上就業者数 －町丁・字等	CSV
12	産業(大分類)，男女別15歳以上就業者数 －町丁・字等	CSV
13	居住期間(6区分)，男女別人口 －町丁・字等	CSV
14	在学か否かの別・最終卒業学校の種類(6区分)，男女別15歳以上人口 －町丁・字等	CSV
15	在学学校・未就学の種類(7区分)，男女別在学者数及び未就学者数 －町丁・字等	CSV
移動人口の男女・年齢等集計に関する集計		
20	5年前の常住地(6区分)，男女別人口(転入) －町丁・字等	CSV

▲ページの先頭へ

spatial scale	number
nation	1
prefecture	47
city, ward, town, village	1,719
chocho-aza	240,000

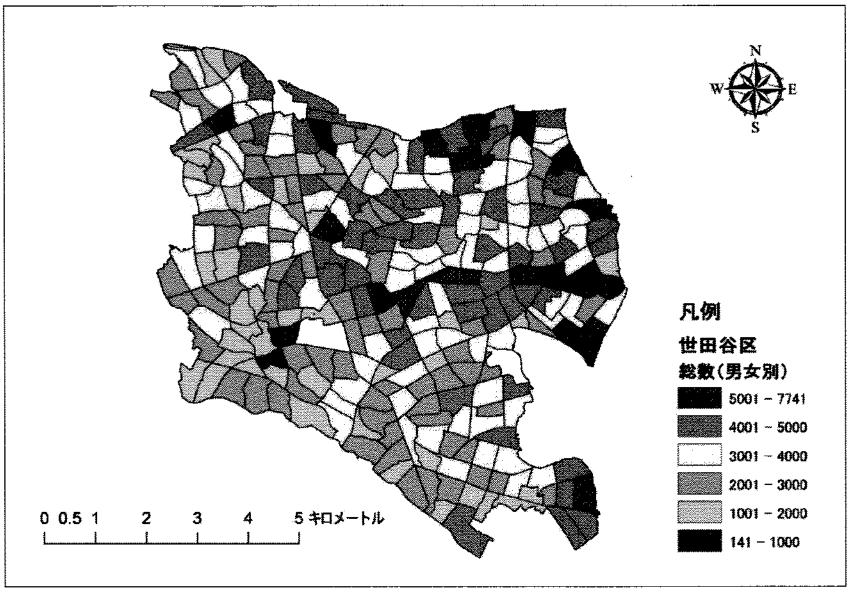
theme	items
population	114
houshold	85
housing	78
industry	174
migration	24
total	475

Table 1 Digital population data for chocho-aza in Tokyo

平成22年国勢調査　小地域集計　（総務省統計局）
第2表　男女別人口及び世帯数 －町丁・字等

市区町村コード	町丁字コード	都道府県名	市区町村名	大字・町名	字・丁目名	総数	男	女	世帯数
13101	21002	東京都	千代田区	神田神保町	2丁目	939	463	476	597
13101	21003	東京都	千代田区	神田神保町	3丁目	425	201	224	228
13101	220	東京都	千代田区	三崎町		769	354	415	393
13101	22001	東京都	千代田区	三崎町	1丁目	27	13	14	12
13101	22002	東京都	千代田区	三崎町	2丁目	483	209	274	230
13101	22003	東京都	千代田区	三崎町	3丁目	259	132	127	151
13101	230	東京都	千代田区	西神田		1141	554	587	596
13101	23001	東京都	千代田区	西神田	1丁目	66	34	32	42
13101	23002	東京都	千代田区	西神田	2丁目	749	347	402	361
13101	23003	東京都	千代田区	西神田	3丁目	326	173	153	193
13101	240	東京都	千代田区	猿楽町		715	390	325	405
13101	24001	東京都	千代田区	猿楽町	1丁目	243	113	130	99
13101	24002	東京都	千代田区	猿楽町	2丁目	472	277	195	306
13101	250	東京都	千代田区	神田駿河台		485	161	324	340
13101	25001	東京都	千代田区	神田駿河台	1丁目	64	37	27	40
13101	25002	東京都	千代田区	神田駿河台	2丁目	288	68	220	246
13101	25003	東京都	千代田区	神田駿河台	3丁目	101	41	60	40
13101	25004	東京都	千代田区	神田駿河台	4丁目	32	15	17	14
13101	260	東京都	千代田区	神田錦町		741	403	338	514
13101	26001	東京都	千代田区	神田錦町	1丁目	306	170	136	228
13101	26002	東京都	千代田区	神田錦町	2丁目	134	71	63	70

Fig. 5 Population distribution for small areas in Setagaya ward, Tokyo



1.4 Problems of NSDI in Japan

- Geospatial data produced by governments are not indexed consistently.
- Buildings, blocks, chocho-aza(small areas) have not consistent and unique identifiers.

Example:

- The identifier of chocho-aza consists of 11 digit numbers, but two kinds of identifiers are distributed.

2. Location Intelligence

What is intelligence ?

- Data

  row of alphanumeric characters : 10b00111aaaa

- Information

  fact : the wind blows

- Knowledge

  rule : If the wind blows, the bucket makers prosper

- Intelligence

  activity : As there are many days when the wind is strong, therefore I will become bucket maker

GI technology produces location intelligence

■ location intelligence :
intelligence on a location which is useful for person or firm to make a decision making

(1) location intelligence for safety
natural and technological disasters

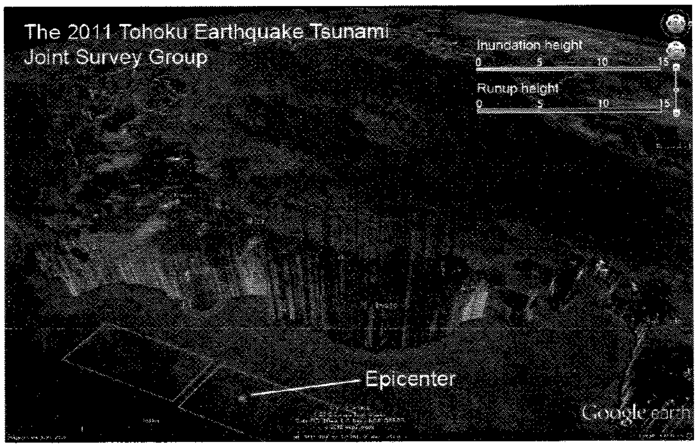
(2) location intelligence for accessibility
road is blocked for passing

(3) location intelligence for business opportunity
decision making of retail location

3. Location Intelligence for Safety

3.1 Hazard Map

Fig.6 Height of tsunami by the 2011/03/11 Tohoku Earthquake



Taro, Miyako City
Max = 37.9m

Source : Quick estimation on tsunami by the earthquake in off the Pacific coast of Tohoku region by joint survey group (http://www.coastal.jp/ttjt/) (April 30, 2011)

Fig. 7-1 Portal site of hazard maps on MLIT

http://disapotal.gsi.go.jp/

Fig. 7-2 Portal site of hazard maps for tsunami

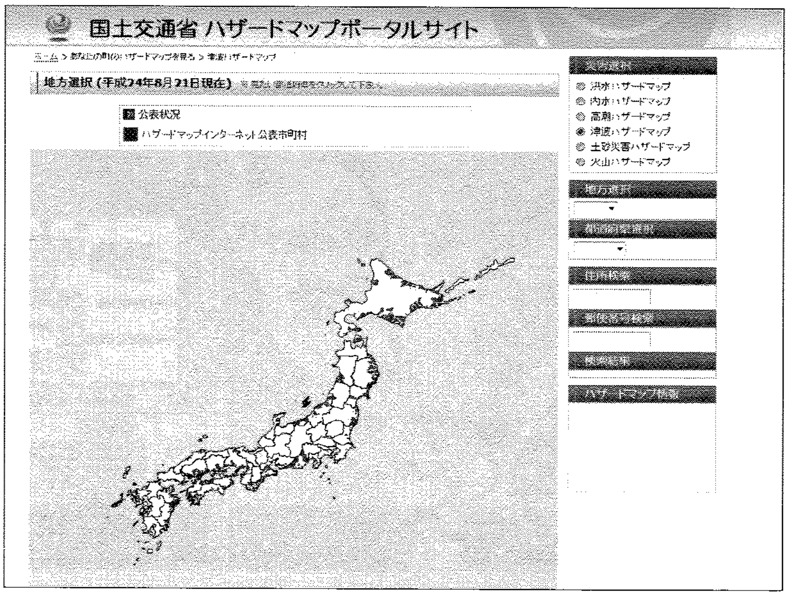
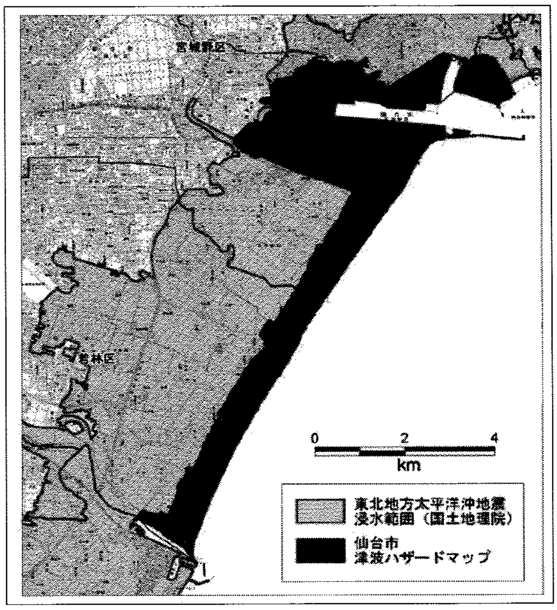


Fig. 8-1 Flooded area on hazard map of Sendai City



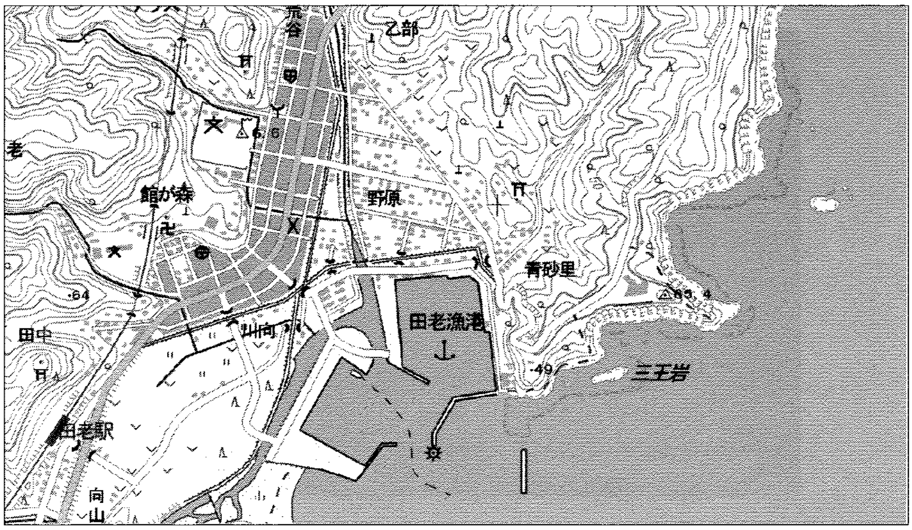
http://www.bousai.go.jp/jishin/chubou/higashinihon/1/3-2.pdf

Fig. 8-2 New hazard map of Sendai City

http://www.city.sendai.jp/s-map/bousai.html

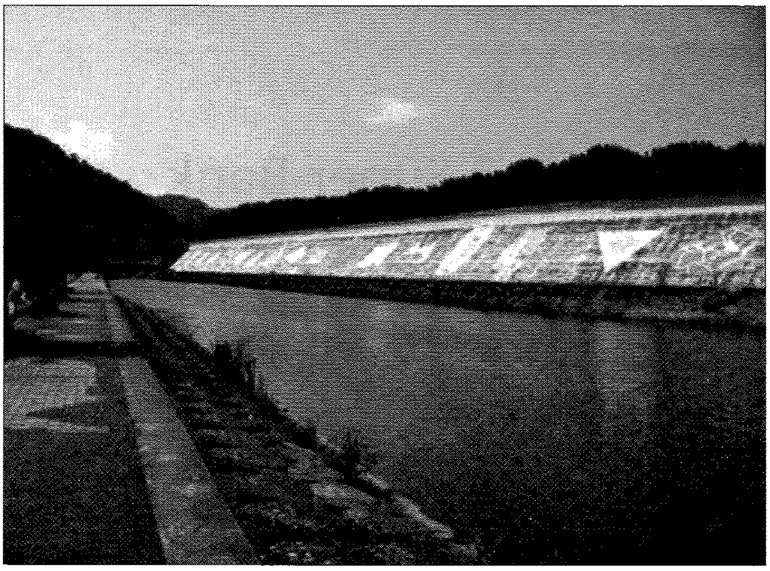
3.2 Super Bank

Fig. 9 Topographic map 25000 of Taro, Miyako City on Digital Japan Portal Web Site



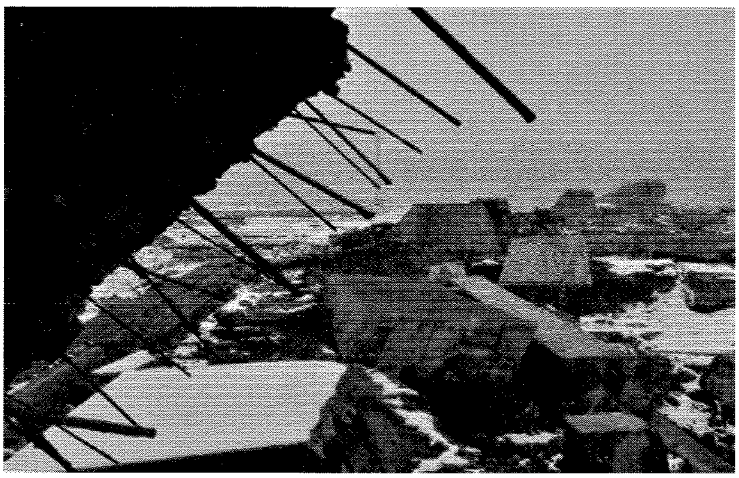
http://watchizu.gsi.go.jp/watchizu.html?meshcode=59414705

Fig. 10-1 Super bank at Tato, hight=10m, length=2.4km



http://umineko.net/fuukei/img/taro3.jpg

Fig. 10-2 Super bank destroyed by Tsunami 2011



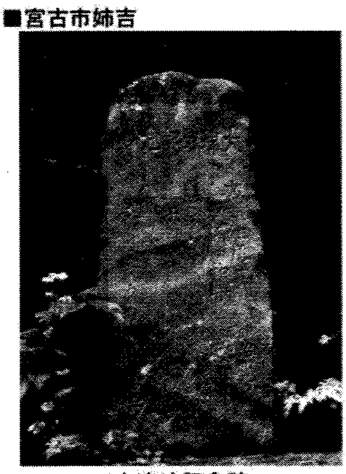
「Super bank destroyed by Tsunami 2011 at Taro, Miyako City」Sankei News , March 16, 2011
http://yoiotoko.way-nifty.com/blog/2011/03/post-f16e.html

3.3 Tsunami Monument

Fig.11-1 Distribution of tsunami monuments

Fig.11-2 Lesson that the tsunami memorial talks about

■宮古市姉吉



大津浪記念碑

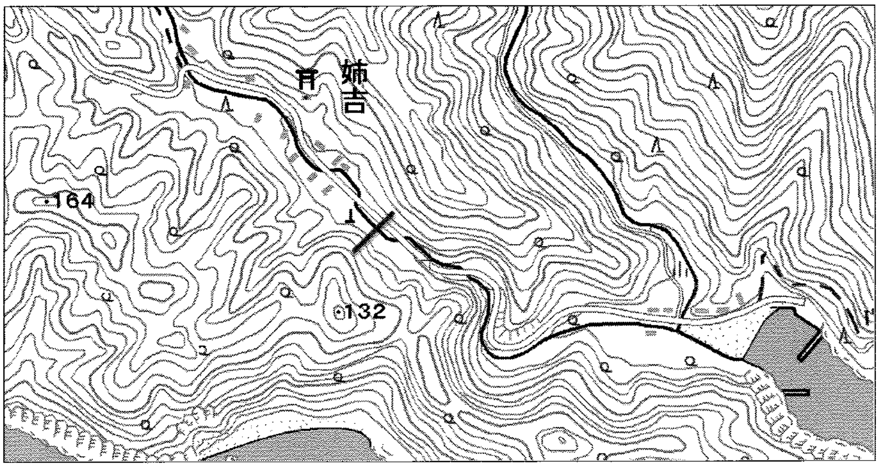
高き住居は
児孫の和楽
想へ惨禍の
大津浪
此処より下に
家を建てるな

明治廿九年にも
昭和八年にも津
浪は此処まで来て
部落は全滅し生
存者僅かにも二人
後に四人のみ幾歳
経るとも要心何従

Do not build a house below this.

http://blog.libertytimes.com.tw/kang1021/2011/05/09/90150

Fig. 12 Location of the tsunami monument at Aneyosi Village in Miyako City



Tunami approached the 50m this side of the monument

What tell us location intelligence for safety ?

- Hazard map ⇒ No geography
  Criticism against hazard map:
  Hazard map immobilizes the estimation of damage
  Put too much confidence in hazard map
- Super bank ⇒ No civil engineering
  seismology
- Tunami monument ⇒Yes history

4. Location Intelligence for Accessibility

Car traffic map for crisis response

- the 2011 Tohoku Earthquake:2011/03/11/14/46/18
- Probe data from Honda car navigation users (1.3 million users) : 2011/03/12/10/30
- Google car traffic map: 2011/03/14
- Receive 2011 Good Design Award: 2011/11/09
- Award-winning reason: creative application of probe data which shows clearly future way of manufacturing in Japan
- Increasing invisible design

Fig. 14 Car traffic map

Red and pink: traffic jam
Blue: travelable
Gray: no information

⇒You can see location intelligence for accessibility on this map

http://car.watch.impress.co.jp/docs/news/20111109_489640.html

5. Business Geographics

Business Geographics

- Integration of GIS with business intelligence (BI) software
- Geobusiness(Pick 2008)

(1) Business operation

- Posting of advertisement leaflets

(2) Decision making

- Site selection
- location intelligence for an opportunity of the business
- Retailer wants to know the location where the management of retail store is established

5.1 Demand

- Three demand sources

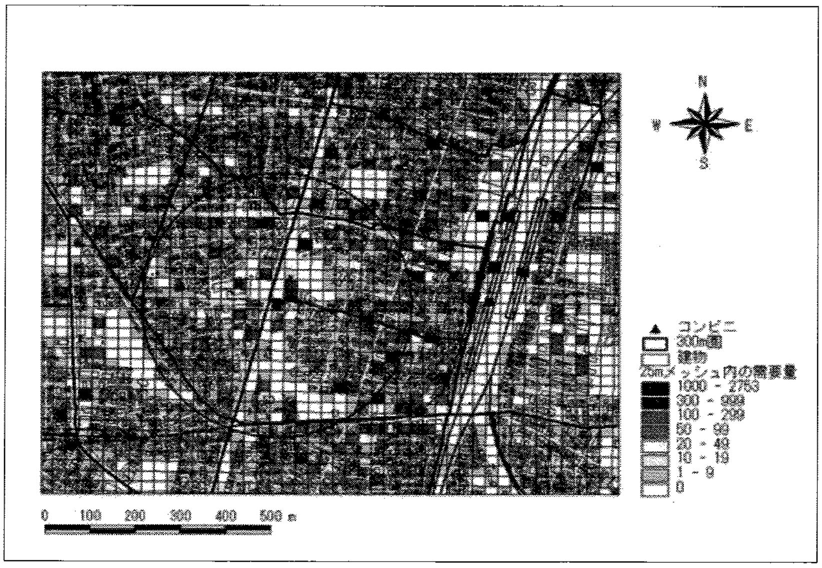
(1) Resident = population at night

(2) Worker = population at day time

(3) Transit = The people who happened to pass by chance, e.g. traveler

- In analyzing the location of retail store with small trade area (500 meters radius) like convenience store, spatial variation of population at large (fine) scale has to be considered in the site selection system.

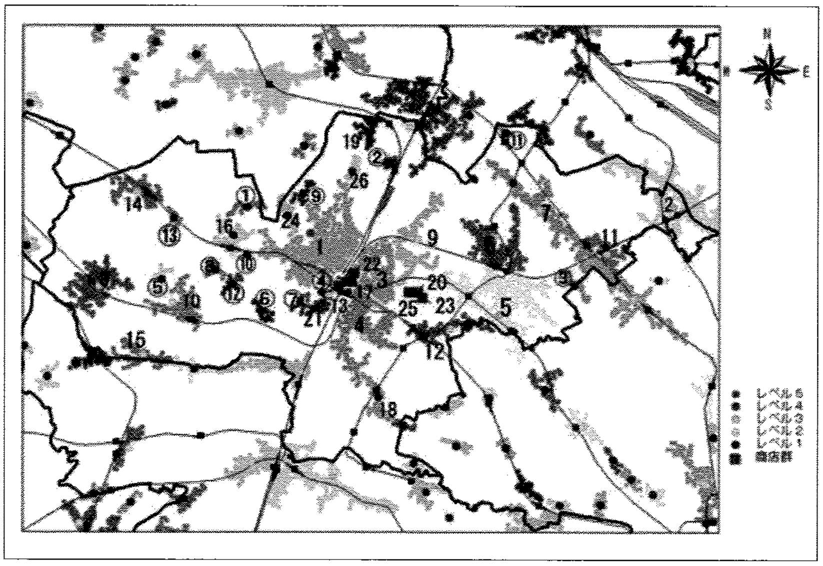
Fig.15 Population distribution represented by 25m mesh



5.2 Supply

- The distribution of supply of goods and service is represented as a map of retail agglomeration such as shopping streets constructed at individual stores.
- The competitors are especially important in site selection.

Fig.16 Supply geography in Toshima ward, Tokyo



5.3 Environment

(1) Attractor:
- Station of rail way
- Shopping street
- Big facilities:

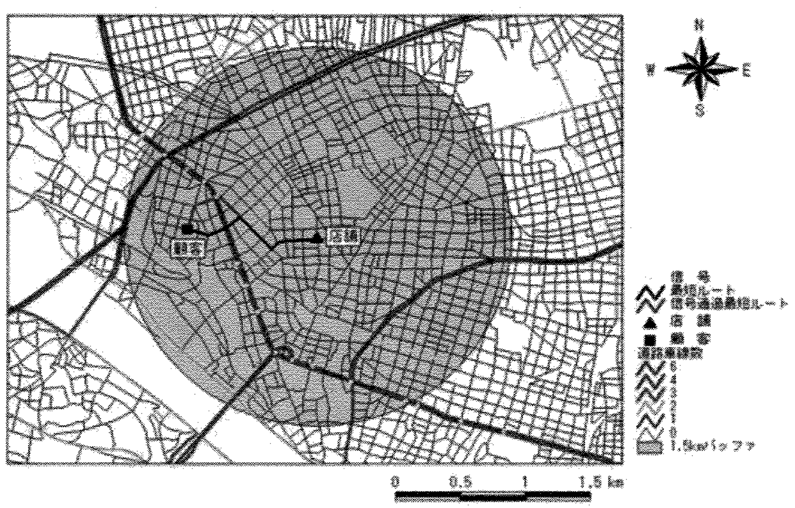
  Super market,

  University

(2) Barrier:
- River,
- Major street,
- Rail way,
- Topography,
- Big facilities

  Park, Graveyard

Fig.17 Main road as barrier for customer



Spatial decision support system for retail location

- SDSS for retail location is build by considering these factors.
- To let Geobusiness succeed, it requires access to comprehensive, accurate, and current data.
- Shortage of data for business applications becomes a central issue.

6. The third generation of NSDI

- Web GIS-based NSDI

Geospatial data are manipulated and analyzed on Web GIS to provide on demand services by user.

- The tentative examples
- Web GIS constructed by Nihon University

1) Historical Web GIS on the railroad network
2) Web GIS on the urbanization of population

Fig. 18 Historical Web GIS on the railroad network of the Tokyo metropolitan area

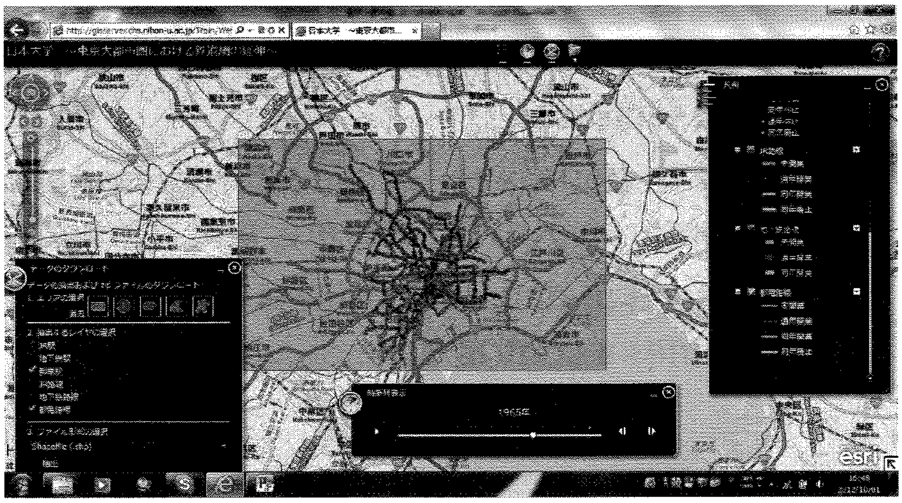


Fig. 19-1 The railroad network of JR in 1894

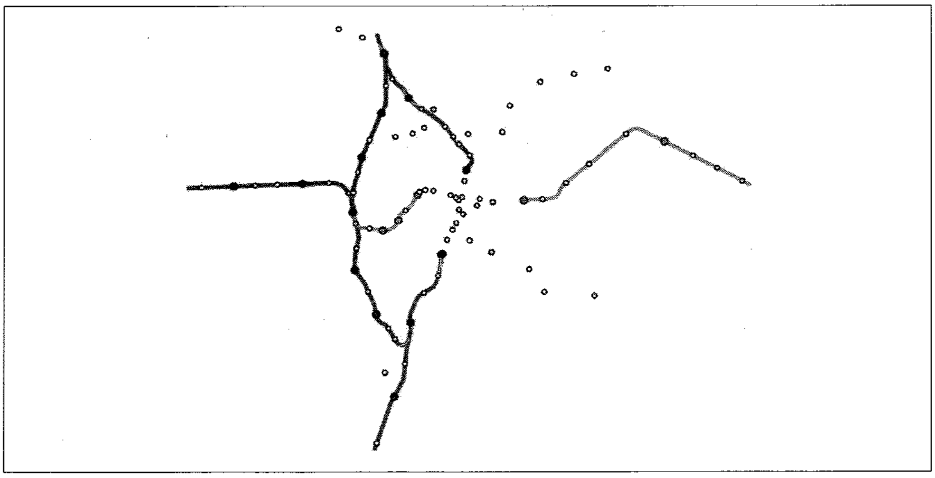
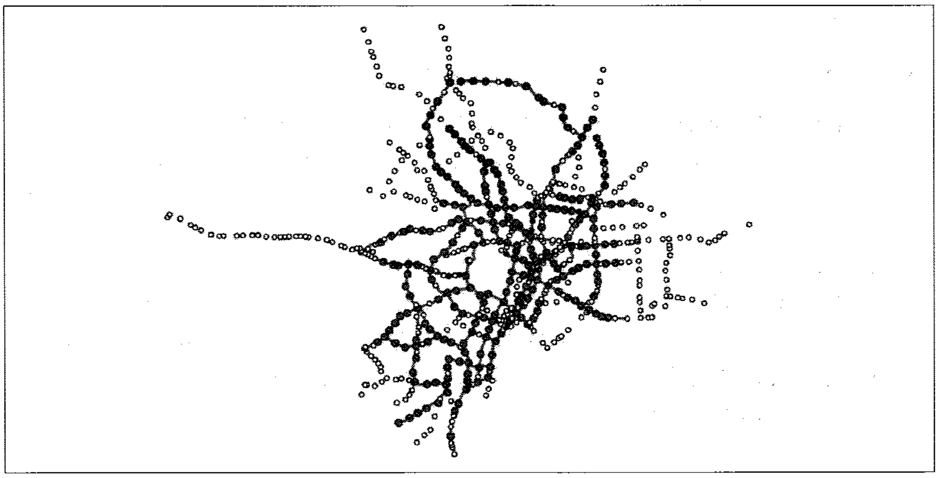
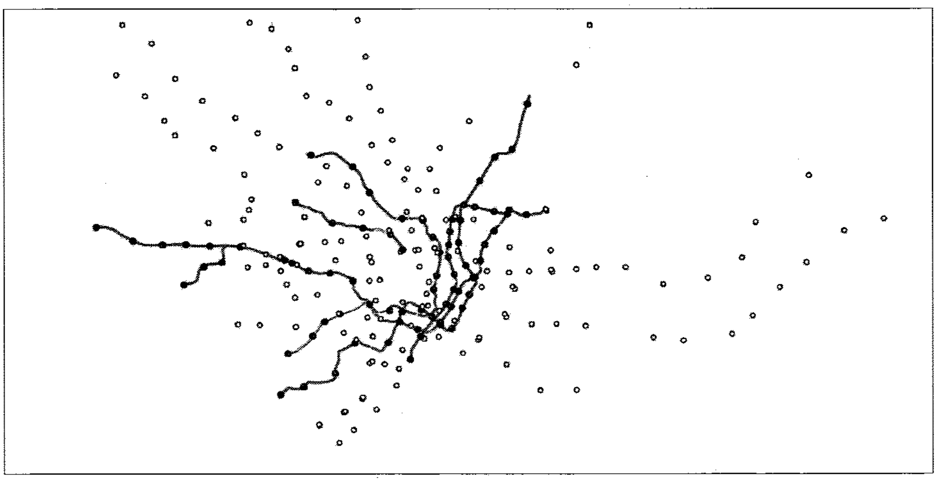


Fig. 19-2 The network of Tokyo tramcar in 1915



1915(大正4)年は、永井荷風の「日和下駄」が刊行された。

Fig. 19-3 The network of underground railway in 1965



7. Conclusions

- NSDI will be constructed on Web GIS to produce location intelligences as well as to provide geospatial data.
- Whether this location is safety.
- Whether we can go to this location by car.
- Whether retail store can be open at this location.

- Japan aims at establishing safe, reliable, and prosperous society. To achieve this purpose, NSDI must be provided sequentially by governments and used widely by administrative, academic and business worlds.

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[Session 1]

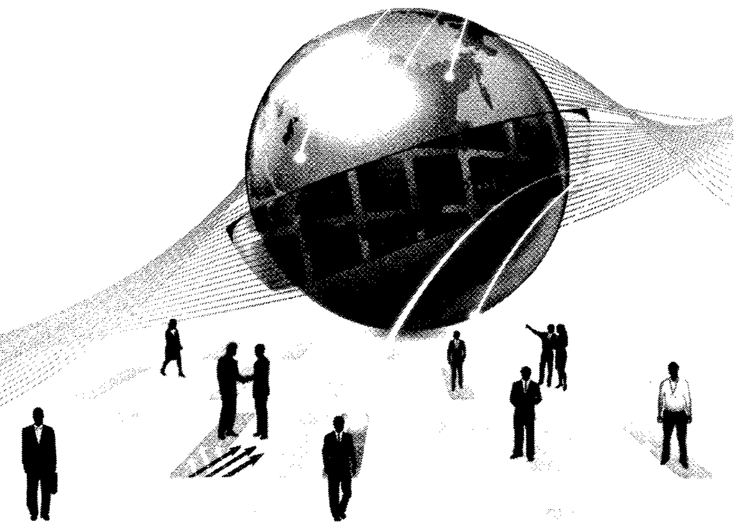
Geo Innovations and Supporting Policies in East Asian Countries

4

Web-based Geospatial Information Sharing Platform and Its Application in China

Prof. Jianya Gong

(Wuhan University, China)



ICG-TEK 2012

International Conference on sharing Geospatial Technology, Experience and Knowledge

Web-based geospatial information sharing platform and its application in China

Geospatial Service Web : Concepts, Architecture and Key Technologies

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Abstract

With the advancement of Web Service technology, services deployed and distributed in the Internet are not only services of data, implied information and static knowledge, but also geospatial processing services and their combinations, which generate user-induced information and dynamically growing knowledge. Meanwhile, semantic tools help the interaction between service and service, and between user and service. Based on this background, a new concept, Geospatial Service Web (GSW), is proposed in this paper to umbrella the basic framework of the future of geospatial information technology. While data, information and knowledge services are still essential bricks of this Web, the focus of GWS is atomic and composite processing services that automatically collaborate to simulate, deduce and predict geographic phenomena, processes and results. This new concept also extends the reach of geospatial connection from both spatial and temporal dimensions. In the data source rim, this Web extends its antenna from static database to all data collecting sensors ranging from satellite-based, airborne to ground and mobile. In the application end, this Web supports applications from visualization to real-time automatic decision support. All new combinations of geospatial processing services can be deployed, registered and included in the geographic model repository. This paper outlines the concepts, framework, technologies and standards of GSW. Some examples show the key technologies for the implementation of this Web and potential capacities for regional and global applications.

Keywords: Geospatial Service Web (GSW), Sensor Web, Geospatial data service, Geospatial processing service, Geospatial knowledge service

Published in 《Geospatial Technology for Earth Observation (Editor : Deren Li, Jie Shan, Jianya Gong) 》, Springer Press, 2009

1 Introduction

It is estimated that 80% of the events, phenomena occurred in the world are related to certain geospatial locations. With the advancement of Earth Observation (EO) and information technologies, the recent years witnessed a great improvement of the capabilities of collecting, transferring, processing and sharing geospatial data and information. The exploding number of distributed sensors constructs huge sensor resources to provide real-time and near real-time observation data. For example, the United States (US) National Aeronautics and Space Administration (NASA)'s Earth Observing System (EOS) alone collects about 3.5 terabytes of data each day. While data sources are steadily increasing, and computing resources are abundantly growing over the Web, no evidence shows that these data and computing sources can be conveniently organized to exploit great potential of geospatial data and information.

Basic geospatial data can not only describe the earth surface, but also provide a foundation for other non-geospatial information to anchor. All events like point of interest (POI), road network, fields, areas and their connections, are associated with specific locations. At a more abstract level, statistical data are also semi-locational, for example, productivity is about a region, country, province or a unit in other zoning system. All these data together become the whole family of geospatial data.

Geospatial data are not the only way of describing the status and changing process of earth surface. Theoretical models, process models or behavior models are developed to turn data into information. For example, there are a lot of algorithms available to extract information from remote sensing images. Meanwhile, with complicated models driving or with the accumulation of human experiences, these information and their spatial and temporal patterns form a repository of geographic knowledge. These models construct the abundant resources for processing geospatial data. Besides the geospatial data resources, models and their derived geospatial-related information and knowledge are also ways of describing earth surface, its status and its dynamic changing process. With the stable growth of the Internet, all these geospatial resources, generated by various organizations, are archived at globally distributed locations. The workflow from data to information and then to knowledge is shown in Fig.1.

Generally, a geospatial-related decision needs more than one data resource and one processing model to support, and most problems need the assistance of various information and knowledge. Therefore, how to share the distributed resources and integrate them efficiently together to meet the requirements of a specific application is the urgent mission of geospatial area at the present Internet age. For this purpose, it can be envisioned that an integrated and distributed Space-Earth information system is a necessity to cover the lifecycle of geospatial-related application, i.e. from the collection of geospatial data to the end of user-oriented applications. This will significantly enhance the efficient and effective sharing of geospatial data, information and knowledge.

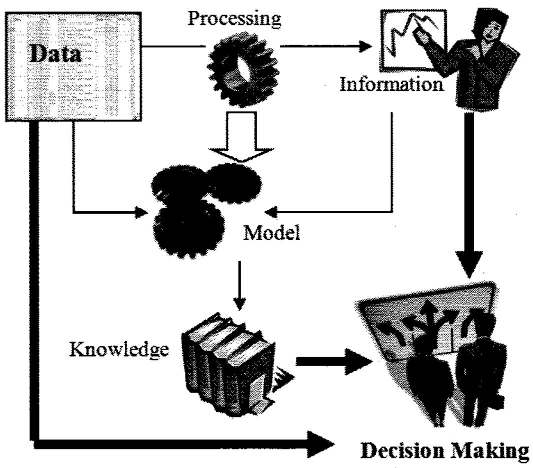

Figure 1. Information Extracted from Data and Generates Knowledge to Support Decision Making

The Web shows a promising prospect for supporting an integrated and distributed Space-Earth system. The growth of the Web has resulted in the Web-based sharing of distributed resources. The Web has become a platform where data, information and knowledge can be published, discovered and retrieved. One of the important trends is to increase the intelligence of the Web that moves the Web to a universal medium for data, information and knowledge exchange.

Web Service technologies are already widely used in geospatial domain for distributed geospatial data sharing, such as the U.S. Department of Energy's Earth System Grid (ESG) (Bernholdt et al., 2005), U.S. National Science Foundation (NSF) funded GEONGrid (GEON, 2003) and the UK e-science program (Hey and Trefethen, 2005). The geospatial data obtained from the diverse sources are often incompatible in terms of the temporal and spatial coverage, resolution, format, and map projections. Processing distributed geospatial data into information and knowledge requires interoperability among diverse data providers.

This necessity led to the development of a set of standard interfaces for geospatial web services, and a number of interoperable services have been available in the geospatial community, most notably the Open Geospatial Consortium (OGC) standard-compliant services.

Service-Oriented Architecture (SOA) provides an effective way to implement the Web involvement, in which the information tools and applications are encapsulated as services, Web Service, being accessible through standard interfaces and protocols. With the standard foundation for Web Service, multiple services can be discovered and integrated automatically on the Web. The results of integration can be even themselves accessible as new services. The service-oriented applications and its potential have been claimed, e.g., to increase individual and collective scientific productivity by making powerful information tools available to all, and thus enabling the widespread automation of data analysis and computation (Forster, I., 2005).

In terms of the vast audience and the social participation of public 2D/3D geospatial information services over the Internet, those Geobrowsers and related software are considered as a Geospatial Web (Arno and Klaus, 2007). Geospatial Web shapes a new type of media platform that distinguishes itself from the traditional media such as newspaper, radio, television etc., for delivering location related information. However, with the Web Service technology advancing, the services deployed and distributed in the Internet are not only services of data, implied information and static knowledge, but also geospatial processing services and their combinations, which are generating user-induced information and dynamically growing knowledge.

Based on SOA, this paper proposes a universal architecture, Geospatial Service Web (GSW), to make all distributed geospatial resources discoverable, accessible, interoperable, and "plug-in-and-play"-able by using Web Service technologies. Specifically, through geoprocessing service and its automatic composition, GSW is intelligent, adaptive and self-growing. Section 2 defines the logical concepts of GSW and Section 3 introduces the architecture and key technologies of implementing GSW. A prototype implementation for GSW is illustrated in Section 4. A brief conclusion is given is Section 5.

2. Logical Concepts of Geospatial Service Web

Geospatial Service Web (GSW) is a virtual geospatial infrastructure based upon the Internet, which integrates various geospatial-related resources including increasing data, derived information and growing knowledge. GSW unifies the functions of geospatial acquisition system, data transformation system, distributed spatial data collection, high-capability server system, large volume storage system, remote sensing and GIS system. These functions are implemented by Web services and communicated through the standardized protocols of the Internet. Fig.2 shows the logical components of GSW. With GSW, it becomes possible to describe, organize, manage, manipulate, interchange, search and release geospatial-related resources in a unified way.

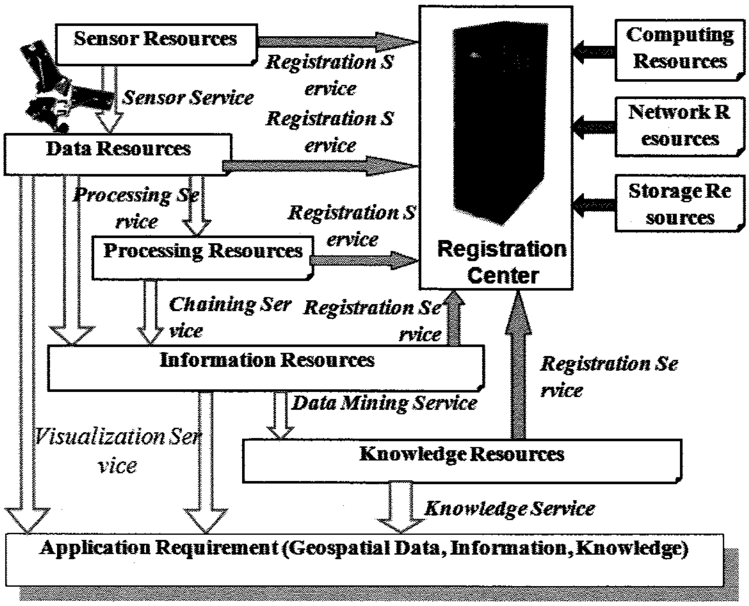

Figure 2. Logical components of GSW from sensor to knowledge

A registration center is the core of GSW. It accepts and archives registration information of all resources. Thus, all the information of the geospatial resources can be queried, searched, acquired and accessed through this center. Sensor resources cover all kind of sensors for real-time data acquisition including space-borne sensors, air-borne sensors and handheld sensors. The original Earth Observation data acquired by sensor resources constructs huge geospatial data resources. Processing resources are collections of theoretical models, process models and behavior models, which are responsible to pre-process, transform, compact, project, generalize, visualize geospatial data for a specific application context. In many cases, these models can be composed orderly into an integrated model to implement a complex function and further to derive potential information and knowledge in datasets. Finally, all of the resources are combined by associated Web services and provide services as a whole for geospatial-related applications. In addition to the resources of geospatial domain, the general resources, including computing resources, network resources and storage resources, are also indispensible for GSW, but they are beyond the theme of this paper.

The mission of GSW is to:

- acquire global spatial data for all season, all day and all directions by all kinds of sensors on satellite, aircraft and surface.
- chain the whole process seamlessly from sensors to application services by unified information networks, including satellite communicate, data relay network and wired or wireless computer communication networks.
- register sensors, computing resources, storage resources, internet resources, manipulate software and spatial data on internet, and process spatial data online quantitatively, automatically, intelligently and real-timely.
- provide geospatial services, compose virtual service chains and transmit user-required information with the most effective and efficient ways.

GSW is featured by the following characteristics:

- While data, information and knowledge services are still essential bricks of this web, the focus of GWS is atomic and composite processing services that automatically collaborate to simulate, deduce and predict geographic phenomena, processes and results.
- GSW expands the reach of geospatial connection from both spatial and temporal dimensions. In the data source rim, this Web extends its antenna from static database to all data collecting sensors ranging from satellite-based, airborne to ground and mobile. In the application end, this Web supports applications from visualization to real-time automatic decision support.
- GSW has a native mechanism of rule-based growing. All new combinations of geospatial processing services can be deployed, registered and included in the geographic models repository.
- GSW is an intelligent Web that integrates semantic rules and reasoning that are applied in searching, chaining, combining services, which finally turn data and information into new knowledge.

3. Architecture and Key Technologies

GSW integrates and communicates various space-earth data resources acquired by using various earth observation technologies such as satellite, airplane and radar. The application areas of GSW are diverse, covering meteorology, agriculture, forestry, transportation and digital city. Because of the heterogeneity of data resources and the diversity of application areas, GSW is built upon open, consensus-based standards for correctly transporting data, communicating information and evaluating results between the components of the framework. The standards cover international geographic information standards issued by ISO or OGC, Web service standards released by W3C and other relative standards. Based on appropriate standards, the framework provides the "plug-in-and-play" of community-developed, standard-compliant components and services. Fig.3 shows the physical view of GSW architecture.

(1) Sensor Web Service Platform

Sensor Web service platform provides interfaces to register, plan and monitor various space-borne, air-borne and ground sensors. Sensor Web technologies will play an important role towards the implementation of this platform. The sensor planning mechanism enables dynamic and live operations on sensor resources.

(2) Geospatial Service Center

Geospatial service center is a geospatial resource registration, search, locating, binding, scheduling and allocation platform. The platform is a type of application software designed to discover user-specified geospatial information over the Web. Users' requests are decomposed into programmatic requests with filtering conditions to Web-based metadata catalogue services or internet search engines to answer users' requests. The decomposition requires the semantic information in requests to be correctly understood and processed. Technologies and tools for natural languages understanding by machines and semantic information processing including Semantic Web technologies will be used. In addition, the responses from metadata catalogue services or internet search engines will be processed and integrated based on the correct understanding of users' requests.

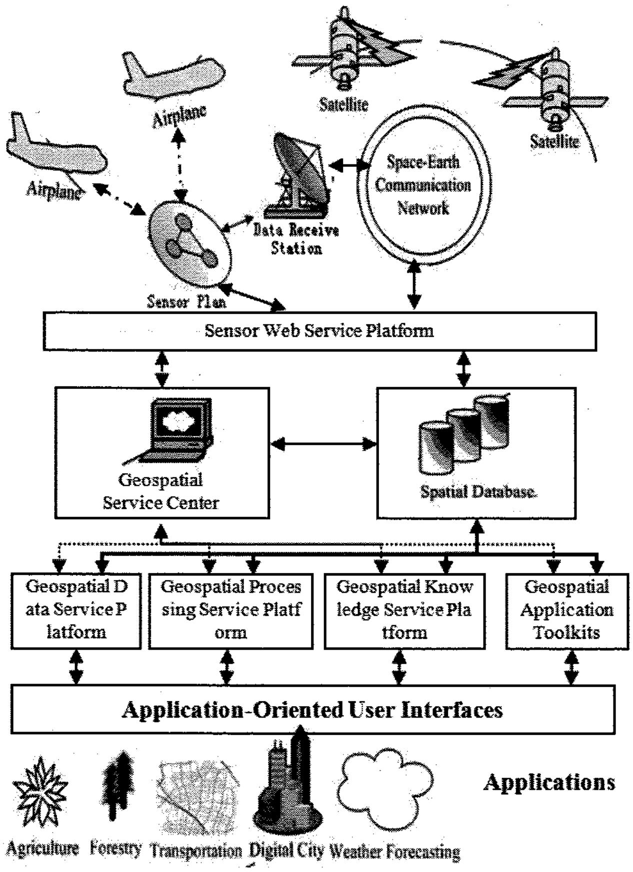

Figure 3. Physical View of GSW Architecture

(3) Spatial Database Management Platform

Spatial database management platform provides interfaces to access and manipulate various geospatial data. The data management components in a grid environment help to index data replicas and manage reliable file transfer. The information services and execution scheduler help to employ high-performance computing (HPC) resources in a coordinated manner to achieve a computationally hard geospatial task, thus moving the grid-computing from concepts to operations. Spatial database management technology is mature. However, some new technologies such as peer-to-peer (P2P) and distributed database management technologies will be used.

(4) Geospatial Data Service Platform

Geospatial data service platform can provide the finding and access of heterogeneous data in diverse data archives, ranging from small data providers to multiple-petabyte EOS data pools. With the enablement of Sensor Web, it can further acquire real-time or near real-time data in all-weather, all-wave, day and night conditions. The most promising approach for this platform implementation is to use OGC Web Data Services Specifications including WFS, WCS, WFS, SOS and CSW. These specifications are widely accepted and allow seamless access to geospatial data in a distributed environment, regardless of the format, projection, resolution, and the archive location.

(5) Geospatial Processing Service Platform

Geospatial processing service platform includes geospatial processing service middleware and services integration environment. Geospatial processing service middleware is a type of software warehouse. Various geospatial processing components are developed according to the interface specification of Web service and registered in geospatial service center. Some geo-processing tasks are always complex and time-consuming. Geo-computing service middleware will provide HPC power for intensive geo-processing tasks while at the same time hide the underlying complexity as much as possible from the users of geospatial services. Geo-processing tasks, such as geospatial buffer operation, overlay analysis, network analysis, terrain analysis, statistical analysis, image processing and data mining, involve large volumes of data and require high performance computational resources. Thus the middleware needs to work with the geospatial resource locating, binding, scheduling and allocation platform to support data-intensive and computer-intensive geospatial applications, for example, running a large number of parallel jobs on a computer cluster.

(6) Geospatial Knowledge Service Platform

Geospatial knowledge service platform provides some toolkits to describe and modeling geospatial knowledge, manage and access knowledge base, and register and search geospatial knowledge in a Web service environment. The design of geospatial knowledge services is highly related with the current progress of knowledge management, AI and Semantic Web technologies. For example, geospatial ontology represented using the Web Ontology Language (OWL) from the Semantic Web are organized in the knowledge base using elements following the Resource Description Framework (RDF) triple form: subject-predicate-object, because RDF, the basis of OWL, provides a flexible model for describing Web resources and relations among these resources. Different ontologies can be aggregated into distributed triple store, backed up by inference engines, shared and accessed using SPARQL Protocol And RDF Query Language (SPARQL), a standard query language for RDF.

(7) Geospatial Application Toolkits

Geospatial application toolkits provide tools, library and APIs that can be used to develop GSW architecture and applications. They bring the power of distributed data and other computational resources to the users' desktop, manipulate these resources as if they are local resources, and allow users to integrate these resources conveniently. The users are able to plug in any geospatial data resources and processing functions as they want. For example, a geospatial service module development environment is included in the toolkit that includes a set of libraries for handling the interface protocols, data encoding and decoding, and general utility functions. By using those libraries, Web Service modules developed by users will be standard-complaint, interoperable and easy to plug into GSW.

(8) Application-Oriented User Interfaces

GSW will provide a set of user interfaces to perform various tasks, such as a client to allow users to develop and test the service chain visually, or to "drill-down" into subchains, to animate service chain execution, to check intermediate results, etc. Since geospatial services in GSW are standard-compliant and different standards exist, e.g., WFS, WCS, WMS, an integrated, multiple-protocols client is also needed to provide access to all geospatial data and other resources in GSW.

The implementation of GSW requires a series of key technologies, e.g. Semantic Web, automatic service discovery, automatic service chaining, quality assurance of geospatial service, geospatial standards.

(1) Semantic Web

The Semantic Web is an extension of the current Web, where information is given well-defined meaning, better enabling computers and people to work in cooperation. The first steps in weaving the Semantic Web into the structure of the existing Web are already under way. In the near future, these developments will usher in significant new functionalities as machines become much better to process and "understand" the data, the abilities that they merely display at present.

(2) Automatic Service Discovery

Because there are many services types and for each type of service, there may be numerous service instances deployed in the Internet, finding the best service available is a key issue for a successful service-oriented application. Each service has its own specific parameters and each parameter has its own format. The registration center is required to not only store registered metadata, but also provide internal high-performance algorithm for fast retrieval. Creating a fine index is a most common way. Fuzzy matching, caching, distributed computation etc. are possible ways to improve the efficiency.

Registration metadata reflect the status when a service is registered, but for a planned-to-call service, its metadata should be up-to-date. Some strategies may apply for this. One mechanism is that service providers expose its notification service that constantly send message about the service to the registration center. Another mechanism is that registration center constantly examines services registered and updates their information. The former one needs standardization and cooperation of service providers, and the later one costs a lot of computing resources.

(3) Automatic Service Chaining

Individual services can be reused to construct different geo-processing workflows for geospatial knowledge discovery, geospatial information visualization and value-added data production. In a distributed data and information environment such as the World Wide Web, there are many independent data and service providers. Complex geo-processing workflows may be scattered among multiple service providers. Therefore, service chaining is important for geo-spatial processing and services integration. Service chaining is defined as a sequence of services where, for each adjacent pair of services, occurrence of the first action is necessary for the occurrence of the second action (ISO/TC 211, 2005). When services are chained, they are combined in a dependent series to larger tasks.

Three types of chaining are defined in ISO 19119 (ISO/TC 211, 2005): user-defined (transparent) - the human user defines and manages the chain; workflow-managed (translucent) - the human user invokes a service that manages and controls the chain and is aware of the individual services in the chain; aggregate (opaque) - the human user invokes a service that carries out the chain, and has no awareness of the individual services in the chain. The transparent and translucent chainings involve the human control. The opaque chaining performs without human control, thus Artificial Intelligence (AI) approaches are needed. The logical and semantic representation of geospatial services plays an important role when applying AI approaches. geospatial chaining service in GSW will support all three types of service chaining through providing approaches from manual construction of service chain to automatic or semi-automatic chaining of geospatial services.

(4) Quality Issues of GSW

Considering how GSW supports real applications, it is a two-dimensional field. One dimension is the data contents, information quantity, knowledge abundance, architecture and functions that are provided by GSW. Another dimension is how good these data, information and functions fit the requirements of the final users. While the former is the GSW functions themselves, the later is the quality issue of GSW, which acts as an umbrella to cover all non-functional aspects of GSW. This is very similar to the commercial area where customers buy merchants. In one hand, the quality of the merchant is very important; in another hand, the quality of service for the trade itself is also very important.

Quality of Geospatial Information Service (QoGIS) is defined as the degree to which a set of inherent characteristics of how a service fulfils customer's requirements. However, geospatial information service is a special product, and the most important is to create the element model of QoGIS. Geospatial information service is a many-faced product and has several levels of customers and hence qualities.

The first level is those who use geospatial information service as a software tool. It is installed, deployed, maintained and upgraded. From this aspect, QoGIS is the same as software quality. ISO/IEC 9126 and ISO/IEC 14598 specify the software quality by six major elements, i.e., functionality, reliability, usability, efficiency, maintainability and portability.

The second level is the quality of a geospatial information service as an executing instance. This quality depends on the computing and networking environment when the instance is executed. For this quality, customer's requirements include five elements, i.e., security, transaction, stability, performance and usability.

The third level is the quality of a service's result, whose element tree depends on the function of the service. The result can be a map, a transformed data set, a best route, a spatial decision or other processing results. Taking WMS as example, the result is a raster map, so its quality elements can be but not limited to resolution, color schema, information delivered, label, legend etc.

(5) Geospatial Standardization

Geospatial data is the core of geospatial service. The acquisition, transmission, storage, representation, management and sharing of geospatial data are main tasks of geospatial services. In order to make geospatial services provided by different developers harmoniously working together, it is important to standardize general characteristics and behaviors related to geospatial data. For this reason, many organizations such as ISO/TC211, OGC and FGDC have proposed a series of geographic information standards.

Fig 4 shows these standards departed into five groups, general standards on geospatial data, Standards on Geospatial Data Acquisition, standards on geospatial data service and standards on geospatial processing service and Standards on Geospatial Application. The standards in each group are not exhaustive enumerations but a few examples. Besides the three groups, more types of standards have been developed. For example, OGC proposed standards on sensors like Sensor Model Language (SensorML), Sensor Observation Service and Sensor Planning Service. There are still some blank areas of standards like knowledge service, composing service and visualization service.

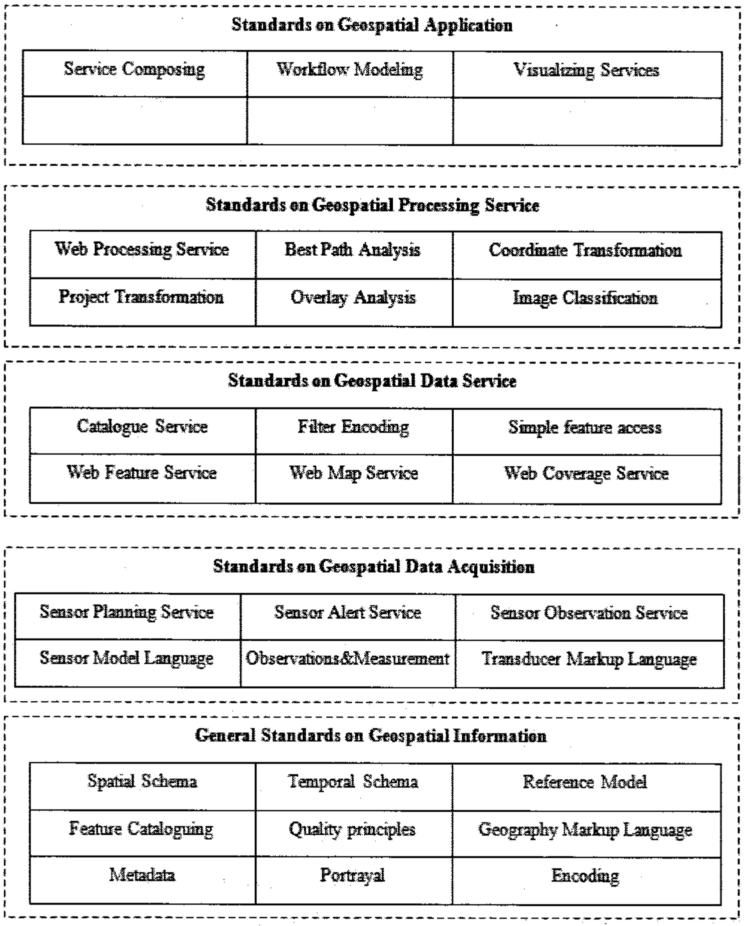

Figure 4. Geospatial service standards

4. A Prototype of the Geospatial Service Web

4.1 Overview

The framework of this GSW prototype system is designed to enable the sharing and processing of geospatial information over the Web. As such, the more generally defined Web Services can support many capabilities of GSW. The implementation of GSW can use existing Web Service technologies directly. Geospatial standards, in particular OGC standards, will ensure the interoperability of GSW implementation, since OGC is the only international organization dedicating to develop geospatial implementation standards and its specifications are widely used by geospatial communities for sharing data and resources. For standards that are not available at geospatial domain, the implementation will adopt W3C Web Services standards which are widely used in general information domain. The standard-based interoperable architecture allows the "plug-in-and-play" of community-developed, standard-compliant Web service. The development of both consensus-based standards and the standard-compliant, interoperable, distributed service components will ensure the openness, growth and evolution of GSW.

The implementation will also leverage the new and ongoing development in the Semantic Web, Artificial Intelligence (AI), Grid technology and Sensor Web etc. Semantic Web technologies, which give machine-processible meanings to the documents, allow the semantics of data and services machine-understandable and thus can be used by machines (reasoning) for more effective discovery, automation, integration and reuse of geospatial data and services. The Semantic Web community works closely with AI community and there has been work in the Semantic Web community to apply ontology ideas developed in the AI community to various aspects of Web Services and Web information search and manipulation. Thus, these technologies show considerable promise, and would allow representation and sharing of geospatial knowledge in a Web-based distributed environment.

Grid technology, a rapid developing technology focusing on distributed resources sharing and coordinated problem solving among dynamic virtual organizations, provide scalable secured sharing of distributed computational resources. The distributed environment supported by the Grid technology, i.e. Grid environment, carries with it various functional components including security, scheduling, data transfer and monitoring. Therefore, it provides a promising prospect to the effective sharing of distributed geospatial resources (e.g. geospatial data, geospatial analysis functions) and support the integrated analysis of geospatial data.

4.2 Sensor Web Service Platform

Sensor Web refers to Web accessible sensor networks and archived sensor data that can be discovered and accessed using standard protocols and application program interfaces (APIs) (Botts, et al., 2007). The goal of the Sensor Web is to provide mechanisms to integrate space-airborne-in situ sensors and enable the Web-based sharing, discovery, exchange and processing of sensor observations, as well as the tasking of sensor systems. From this point of view, the implementation of GSW should incorporate the achievement of the Sensor Web. The approach to the Sensor Web is to establish the standards foundation for plug-in-sensor-and-play Web-based sensor networks through harmonizing existing standards for geospatial data sharing and processing. OGC has developed several encoding and service interface specifications for the enablement of Sensor Web. Fig. 5 shows a demo of sensor plan and monitoring service.

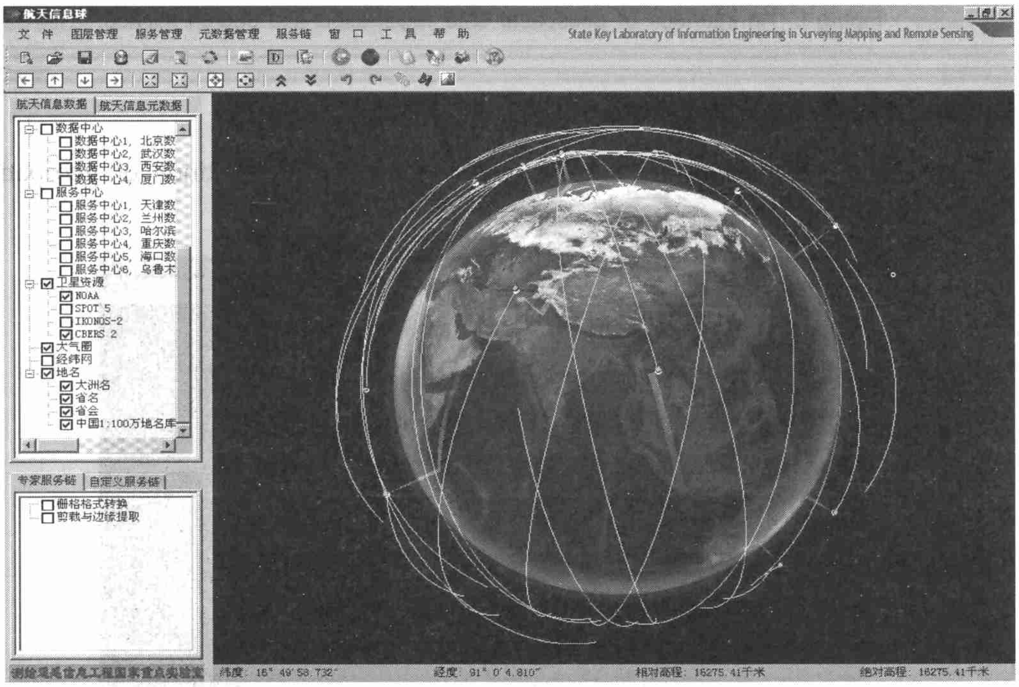

Figure 5. A demostration of sensor plan and monitoring service.

4.3 Geospatial Service Center

Fig. 6 shows an interface of geospatial data registration and search service.

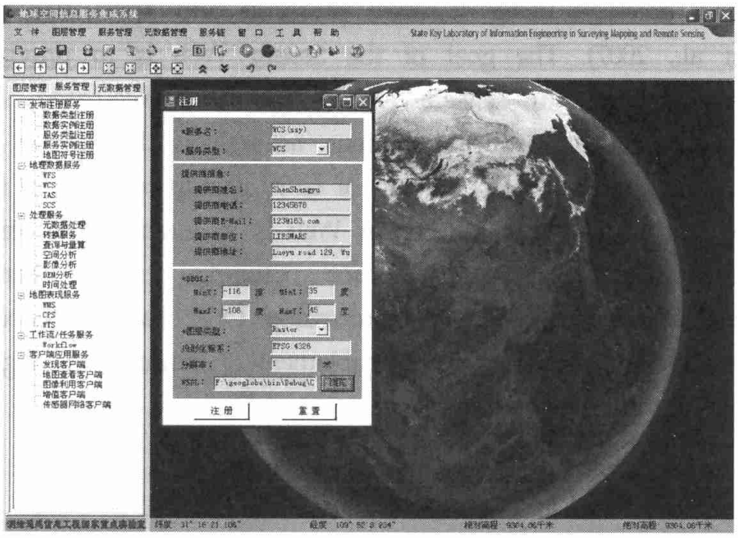

Figure 6. An interface of geospatial data registration and search service

4.4 Services Integration Environment

Fig. 7 has shown an integrated service environment for multi kinds of geospatial data based OGC Web Data Services Specifications.

Figure 7. Web service interface of integrated multi kinds of geospatial data

4.5 Geospatial Application Toolkits

Fig. 8 has shown an abstract service chain modeling based on a Web-based distributed environment for flood analysis.

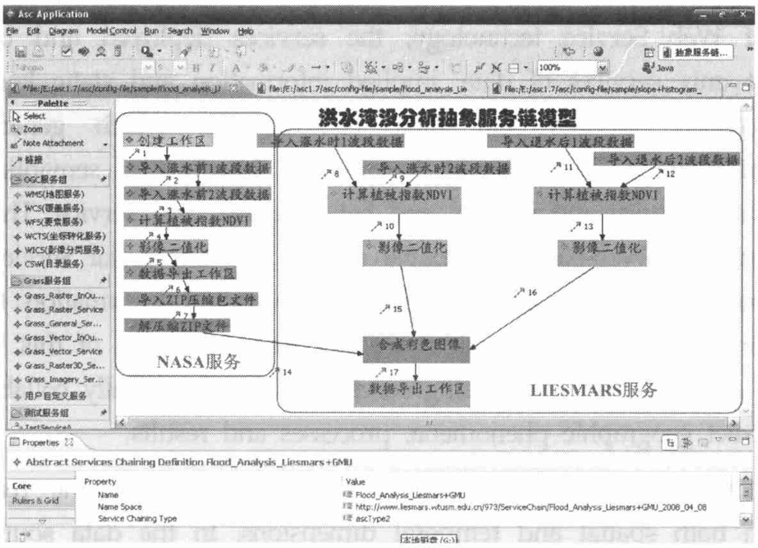

Figure 8. A service chain modeling based on distributed environment for flood analysis.

4.6 Knowledge Service Platform

Figure 9. An interface for searching geospatial knowledge.

5 Conclusion

The Web service technology and service-oriented architecture are developed to publish, discover and retrieve various geospatial data, information and knowledge. With the advancement of Web Service technology, the services deployed and distributed in the Internet are not only services of data, implied information and static knowledge, but also geospatial processing services and their combinations, which generate user-induced information and dynamically growing knowledge. Meanwhile, semantic tools help the interaction between service and service, and between user and service. This paper proposes a broad framework of Web-based geospatial service, i.e. Geospatial Service Web (GSW), to umbrella the basic framework of the future of geospatial information technology. While data, information and knowledge services are still essential bricks of this Web, the focus of GWS is atomic and composite processing services that automatically collaborate to simulate, deduce and predict geographic phenomena, processes and results.

As a new concept and future direction, GSW also expands the reach of geospatial connection from both spatial and temporal dimensions. In the data source rim, this Web extends its antenna from static database to all data collecting sensors ranging from satellite-based, airborne to ground and mobile. In the application end, this Web supports applications from visualization to real-time automatic decision support. Furthermore, this Web has a native mechanism of rule-based growing. All new combinations of geospatial processing services can be deployed, registered and included in the geographic models repository. Some examples show the key technologies for the implementation of this Web and the potential capacities for regional and global applications.

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Web-based geospatial information sharing platform and its application in China

Jianya Gong
Wuhan University, 11 October, 2012

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2. Web Based Geospatial Data Service
3. Web Based GeoCoputation Service
4. Web Based Sensor Service
5. Conclusion and Future Work

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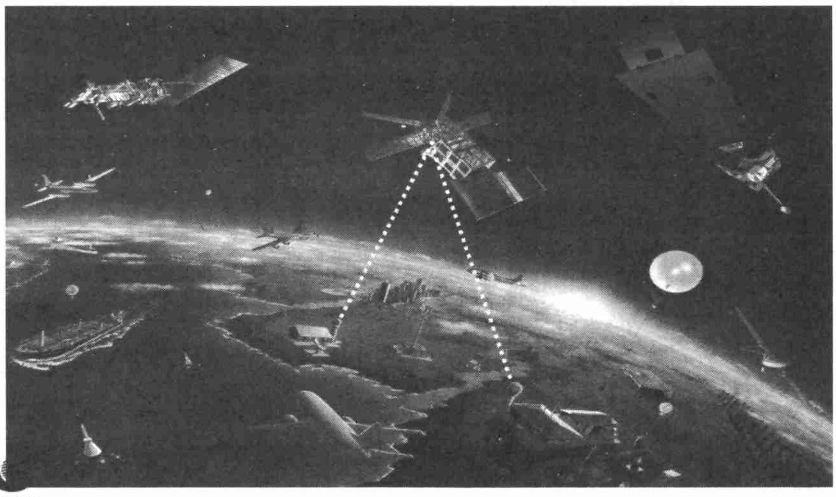
Background

Earth Observation Systems



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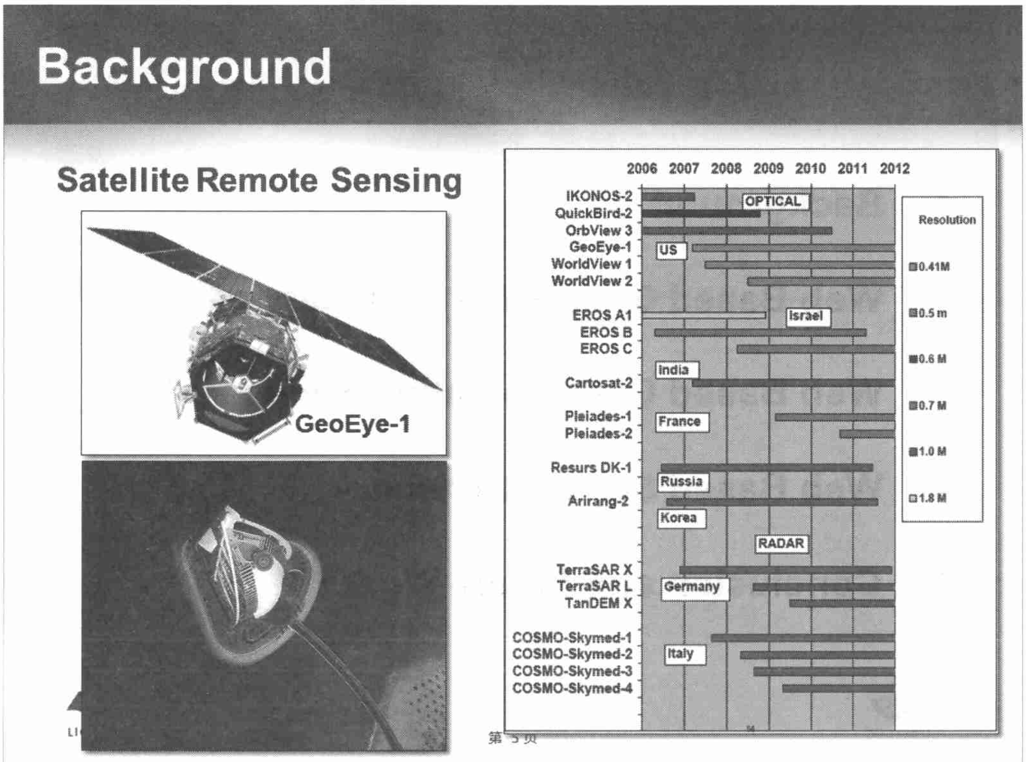
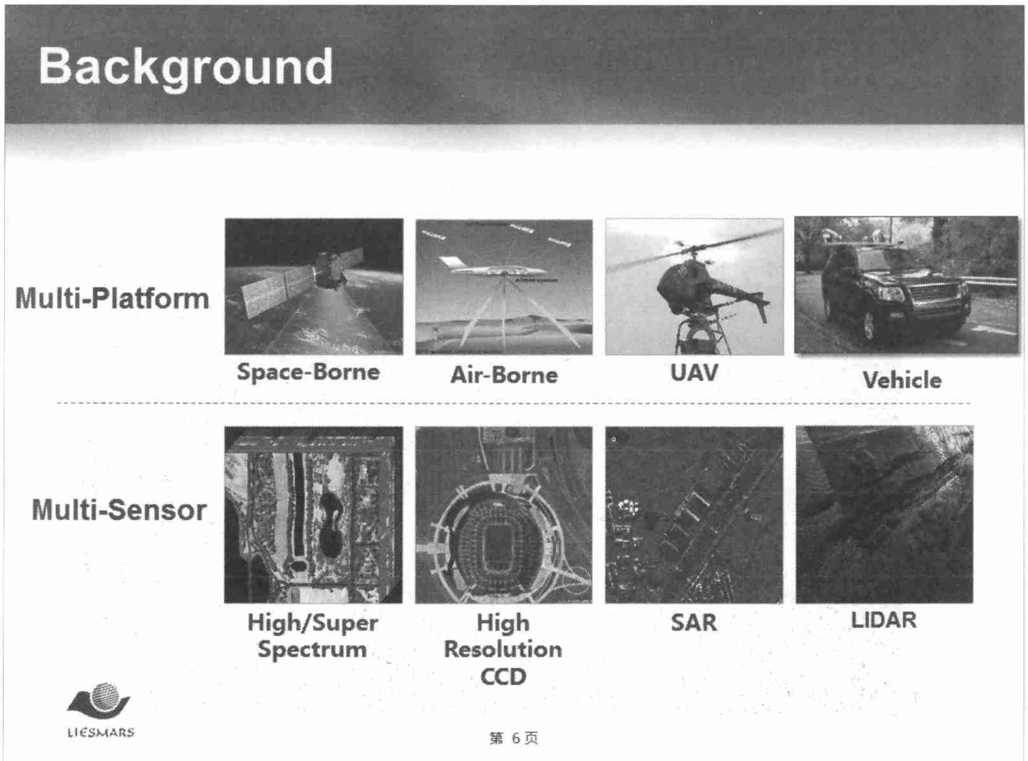

Background
Satellite Remote Sensing
GeoEye-1
2006 2007 2008 2009 2010 2011 2012
IKONOS-2
QuickBird-2
OrbView 3
GeoEye-1
WorldView 1
WorldView 2
EROS A1
EROS B
EROS C
Cartosat-2
Pleiades-1
Pleiades-2
Resurs DK-1
Arirang-2
TerraSAR X
TerraSAR L
TanDEM X
COSMO-Skymed-1
COSMO-Skymed-2
COSMO-Skymed-3
COSMO-Skymed-4
OPTICAL
US
Israel
India
France
Russia
Korea
RADAR
Germany
Italy
Resolution
0.41M
0.5 m
0.6 M
0.7 M
1.0 M
1.8 M


Background
Multi-Platform
Space-Borne
Air-Borne
UAV
Vehicle
Multi-Sensor
High/Super Spectrum
High Resolution CCD
SAR
LIDAR
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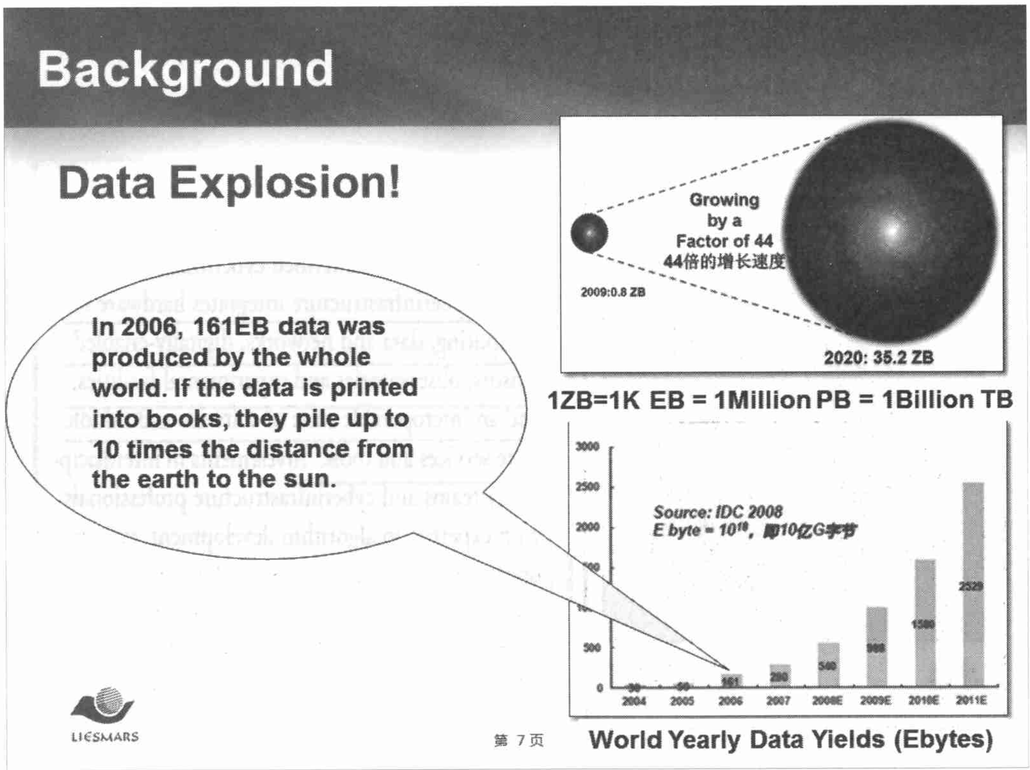
Background
Data Explosion!
In 2006, 161EB data was produced by the whole world. If the data is printed into books, they pile up to 10 times the distance from the earth to the sun.
Growing by a Factor of 44
44倍的增长速度
2009:0.8 ZB
2020: 35.2 ZB
1ZB=1K EB = 1Million PB = 1Billion TB
Source: IDC 2008
3000
2500
2000
500
0
161
280
540
2529
2004
2005
2006
2007
2008E
2009E
2010E
2011E
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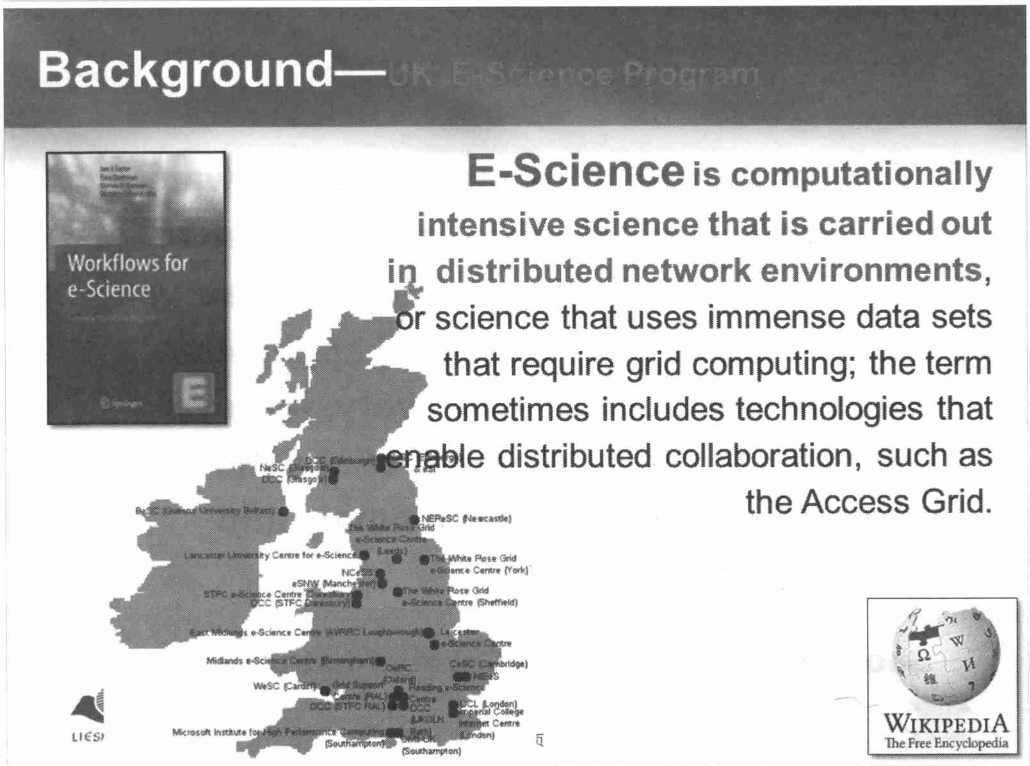
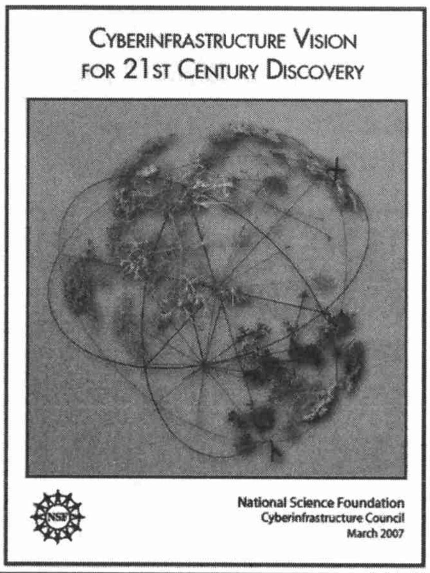
World Yearly Data Yields (Ebytes)


Background—UK E-Science Program
Workflows for e-Science
E-Science is computationally intensive science that is carried out in distributed network environments, or science that uses immense data sets that require grid computing; the term sometimes includes technologies that enable distributed collaboration, such as the Access Grid.
NeSC
NEReSC (Newcastle)
WeSC (Cardiff)
WIKIPEDIA
The Free Encyclopedia

Background— US CyberInfrastracture Program



The comprehensive infrastructure needed to capitalize on dramatic advances in information technology has been termed cyberinfrastructure (CI). Cyberinfrastructure integrates hardware for computing, data and networks, digitally-enabled sensors, observatories and experimental facilities, and an interoperable suite of software and middleware services and tools. Investments in interdisciplinary teams and cyberinfrastructure professionals with expertise in algorithm development, system operations, and applications development are also essential to exploit the full power of cyberinfrastructure to create, disseminate, and preserve scientific data, information and knowledge.

Geospatial Service Web : Concept

Various of resources including hardware, software and middleware, network, sensor , data, information, knowledge can be served in the internet for sharing and application, the user can publish, discovery, retrieval, process and integrate geospatial data, information and knowledge timely and conveniently.

Geospatial Service Web -- CyberInfrastructure

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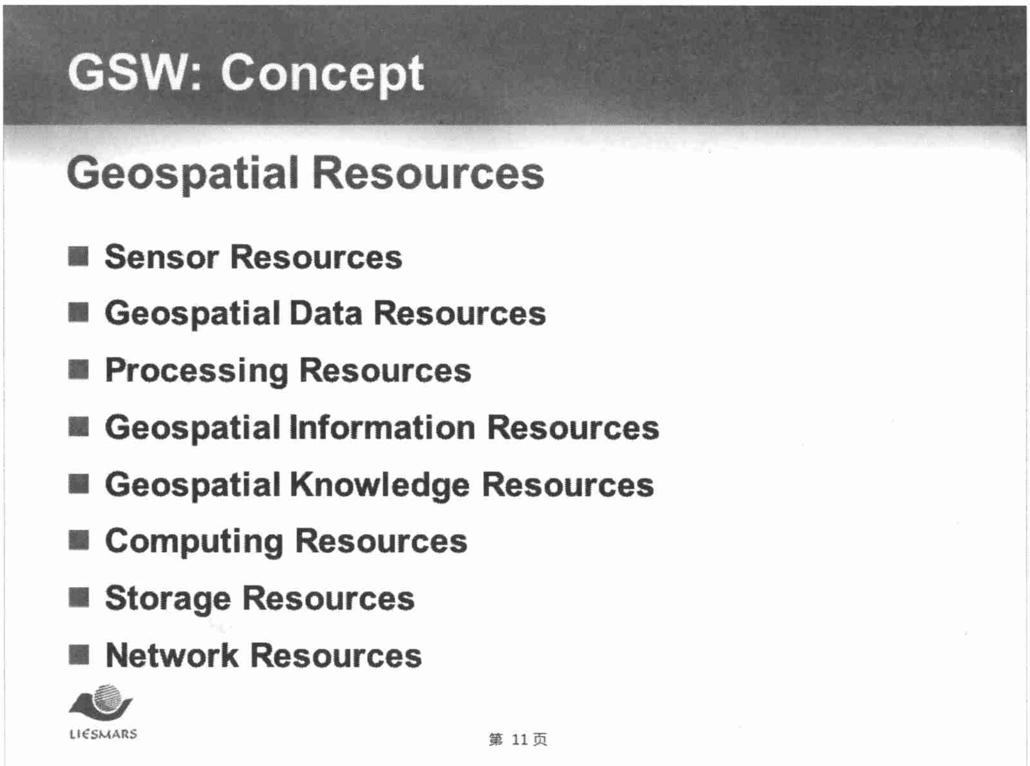
GSW: Concept
Geospatial Resources
Sensor Resources
Geospatial Data Resources
Processing Resources
Geospatial Information Resources
Geospatial Knowledge Resources
Computing Resources
Storage Resources
Network Resources
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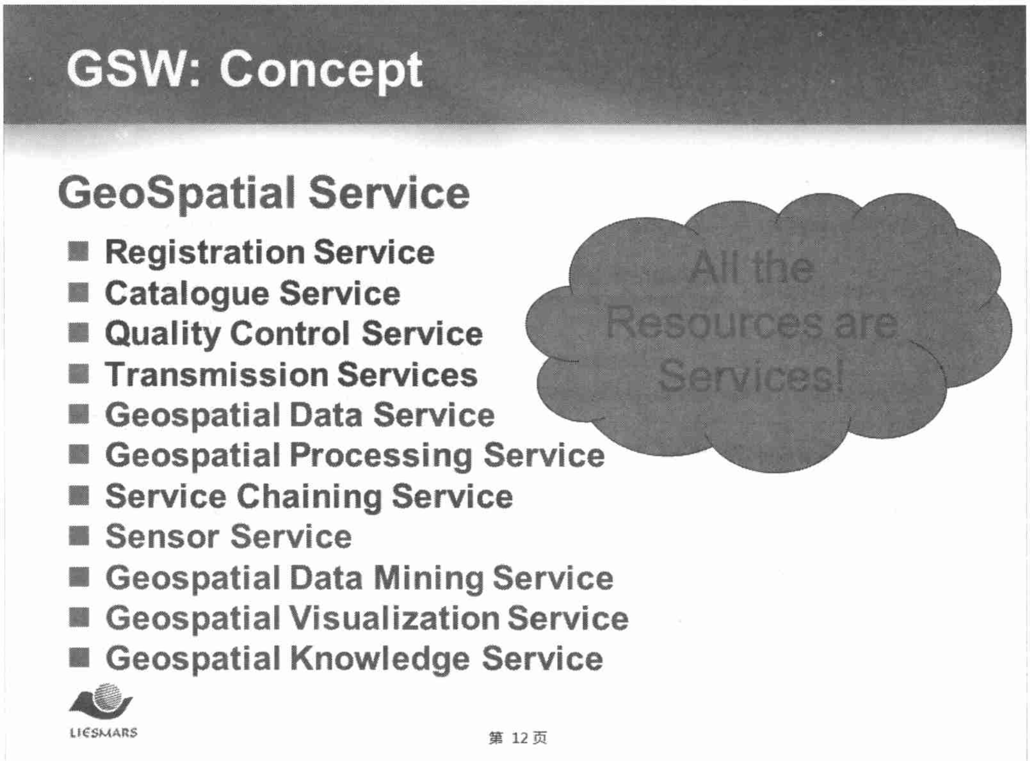
GSW: Concept
GeoSpatial Service
Registration Service
Catalogue Service
Quality Control Service
Transmission Services
Geospatial Data Service
Geospatial Processing Service
Service Chaining Service
Sensor Service
Geospatial Data Mining Service
Geospatial Visualization Service
Geospatial Knowledge Service
All the Resources are Services!
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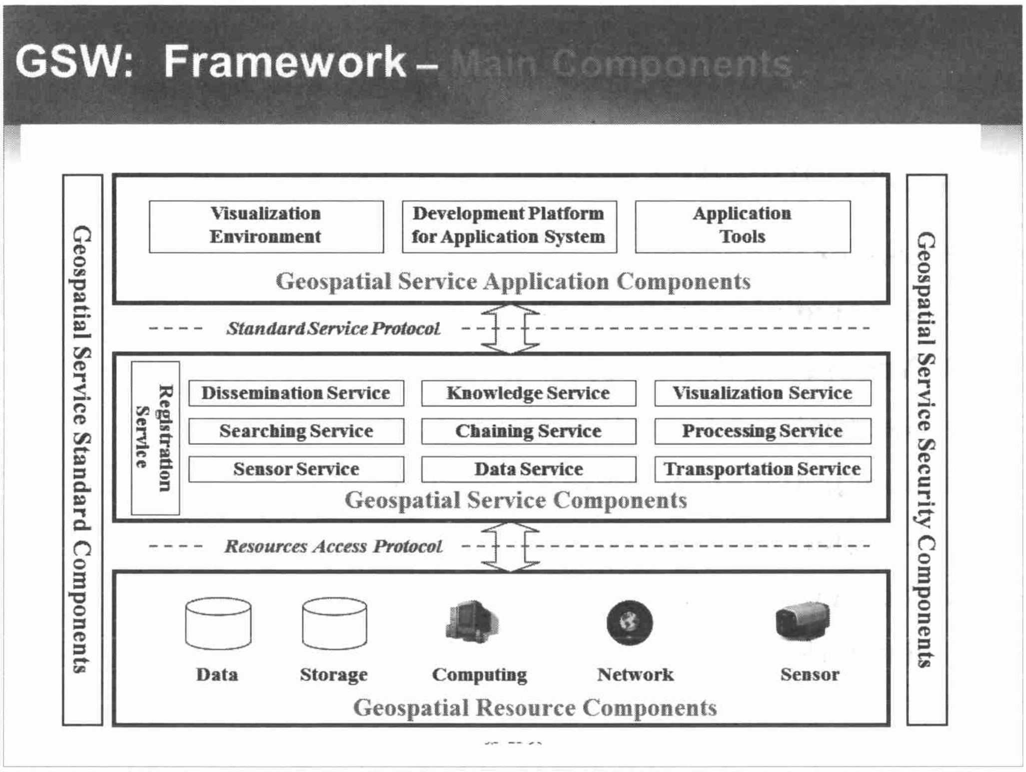
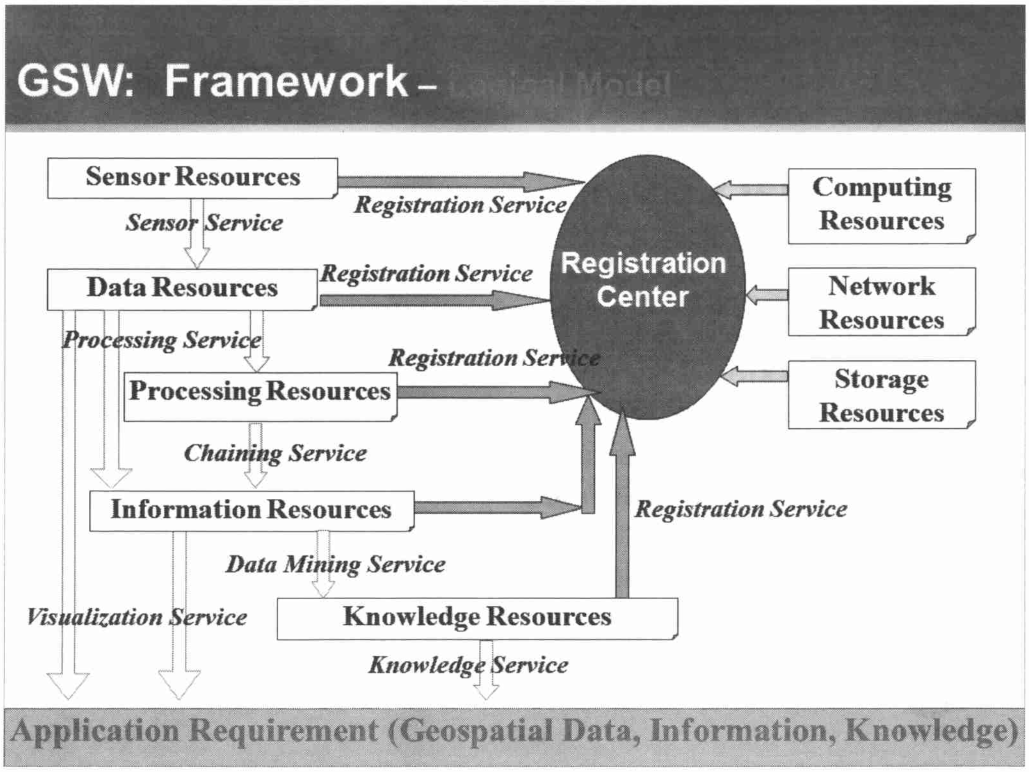
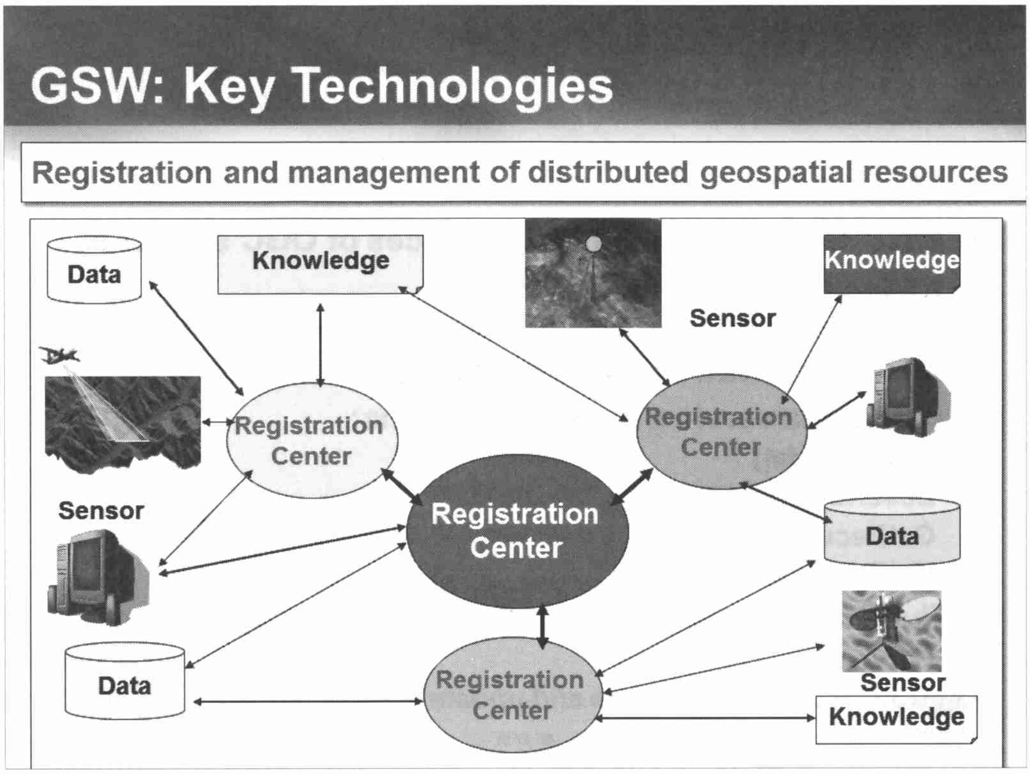
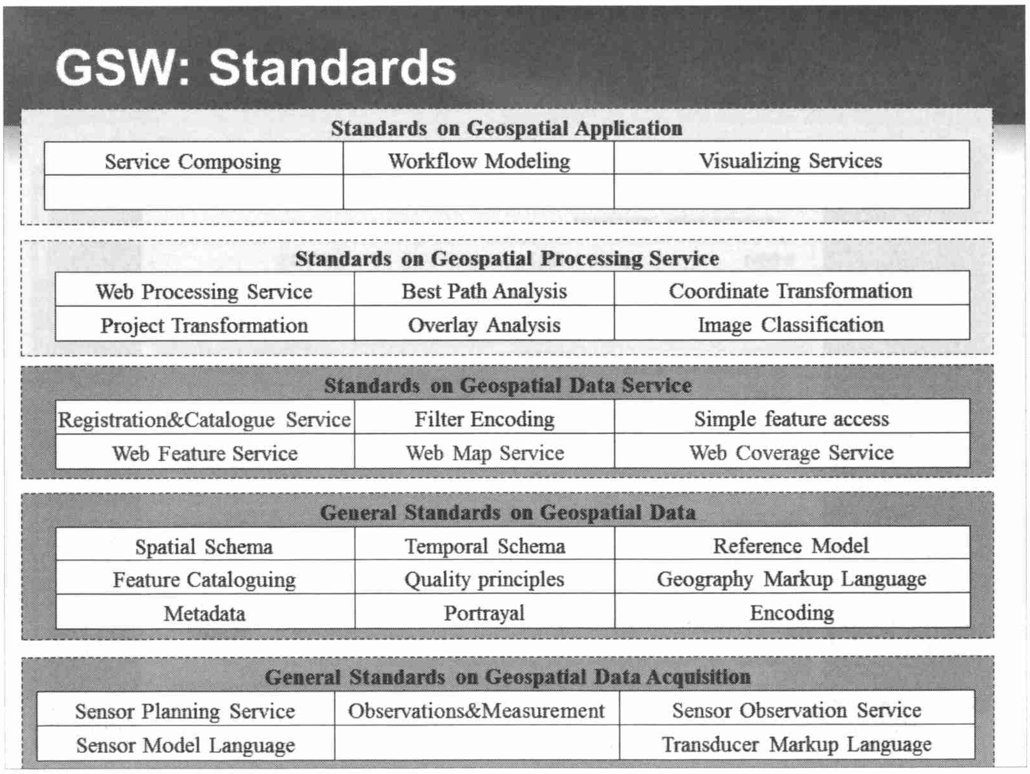

GSW: Framework – Main Components
Visualization Environment
Development Platform for Application System
Application Tools
Geospatial Service Application Components
Standard Service Protocol
Registration Service
Dissemination Service
Knowledge Service
Visualization Service
Searching Service
Chaining Service
Processing Service
Sensor Service
Data Service
Transportation Service
Geospatial Service Components
Resources Access Protocol
Data
Storage
Computing
Network
Sensor
Geospatial Resource Components
Geospatial Service Standard Components
Geospatial Service Security Components


GSW: Framework – Logical Model
Sensor Resources
Sensor Service
Registration Service
Computing Resources
Data Resources
Registration Service
Registration Center
Network Resources
Processing Service
Registration Service
Processing Resources
Storage Resources
Chaining Service
Information Resources
Registration Service
Data Mining Service
Visualization Service
Knowledge Resources
Knowledge Service
Application Requirement (Geospatial Data, Information, Knowledge)




GSW: Standards

Standards on Geospatial Application

Service Composing	Workflow Modeling	Visualizing Services

Standards on Geospatial Processing Service

Web Processing Service	Best Path Analysis	Coordinate Transformation
Project Transformation	Overlay Analysis	Image Classification

Standards on Geospatial Data Service

Registration&Catalogue Service	Filter Encoding	Simple feature access
Web Feature Service	Web Map Service	Web Coverage Service

General Standards on Geospatial Data

Spatial Schema	Temporal Schema	Reference Model
Feature Cataloguing	Quality principles	Geography Markup Language
Metadata	Portrayal	Encoding

General Standards on Geospatial Data Acquisition

Sensor Planning Service	Observations&Measurement	Sensor Observation Service
Sensor Model Language		Transducer Markup Language

Registration and Catalogue

■ Registration and Catalogue Service for Web

- ■ **OWS-Common: common interfaces of OGC services, its operation:**
  - GetCapablities(): specification of a service and metadata
- ■ **WRS-Retrieval: search, discover records from a catalogue service, major operations:**
  - GetRecords()
  - DescribeRecord()
  - GetRecordbyId()
  - GetDomain()
- ■ **Publication: manage registrations, major operations:**
  - Harvest
  - Transaction: insert, erase and update

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Registration and Catalogue Service

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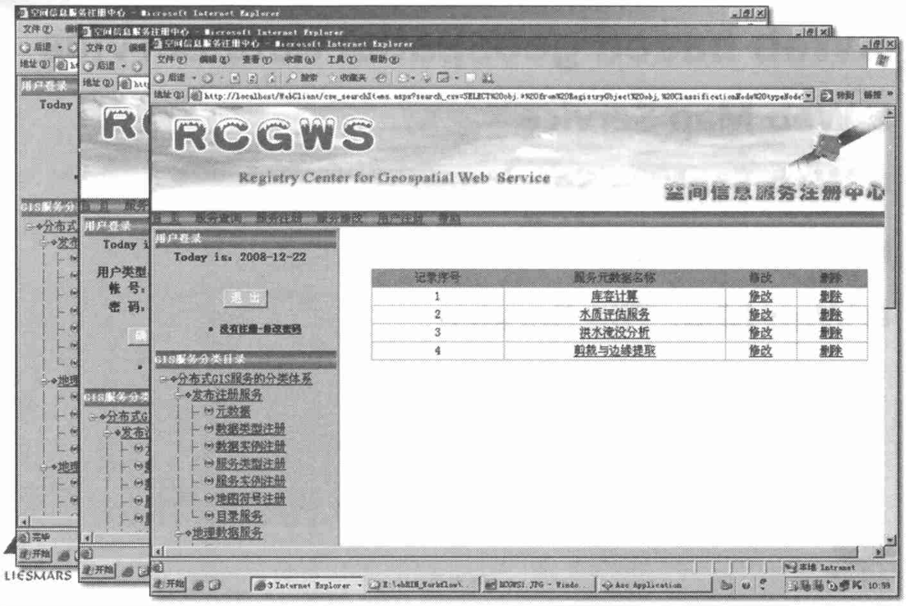
Registry Center fro Spatial Data and Processing Services



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Contents

1. Background
2. Web Based Geospatial Data Service
3. Web Based GeoCoputation Service
4. Web Based Sensor Service
5. Conclusion and Future Work

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Standards for geospatial data service

- **Web based geospatial data service**
  - **Web Map Service**
  - **Web Feature Service**
  - **Web Coverage Service**
  - **Web Map Tile Service**

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Online Data Service (2)

- **Web Map Service (WMS)**

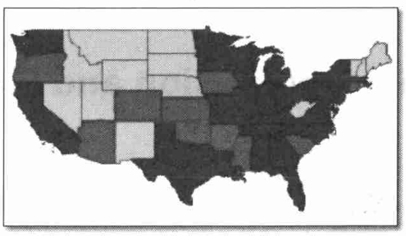
（1）GetCapabilities（必选）

http://localhost:8080/geoserver/wms?service=WMS&request=GetCapabilities

(2)GetMap(必选)

http://localhost:8080/geoserver/wms?bbox=-130,24,-66,50&styles=population&Format=image/png&request=GetMap&layers=topp:states&width=550&height=250&srs=EPSG:4326

（3）GetFeatureInfo（可选）



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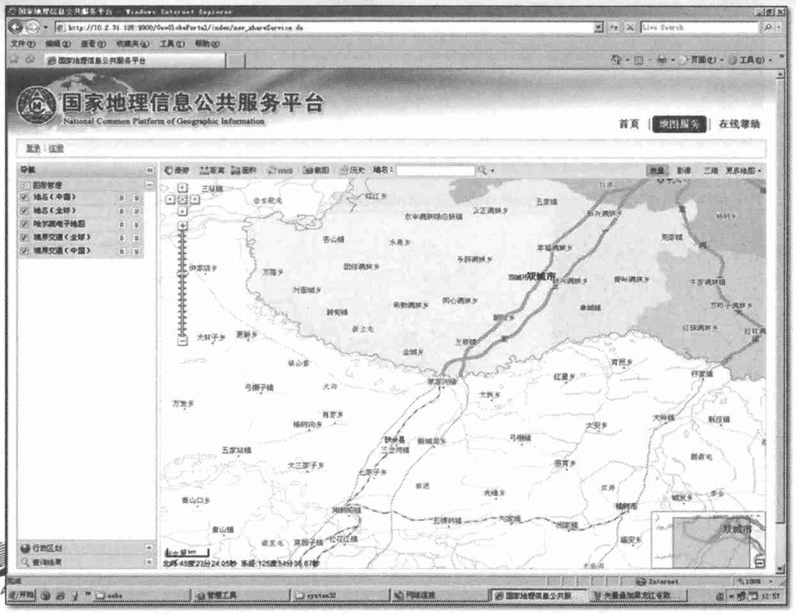
Web Map Service (WMS)



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Online Data Service (3)

■Web Feature Service (WFS)

- GetCapabilites(): get capability document
- DescribeFeatureType():
- GetFeature(): get feature objects
- Transaction():
- LockFeature(): lock feature objects for update transaction

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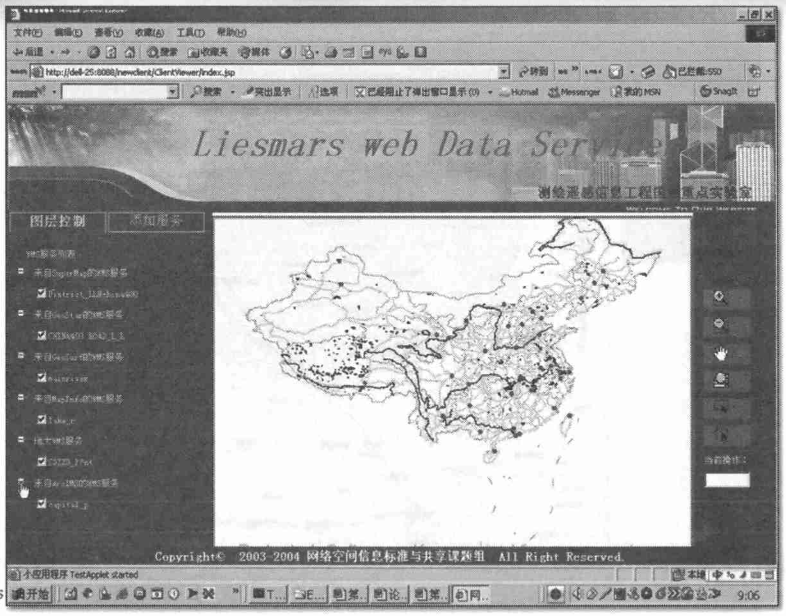
Vector Data Service via WFS



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Online Data Service (3)

- **Web Coverage Service (WCS)**
  - GetCapabilites():
  - GetCoverage()
  - DescribeCoverageType()

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Image and DEM Service via WCS

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Online Data Service (4)

■Web Map Tile Service (WMTS)

- **WMTS, OpenGIS Web Map Tile Service, v1.0.0。**
- **GetCapabilites()**
- **GetTile()**
- **GetFeatureInfo()**

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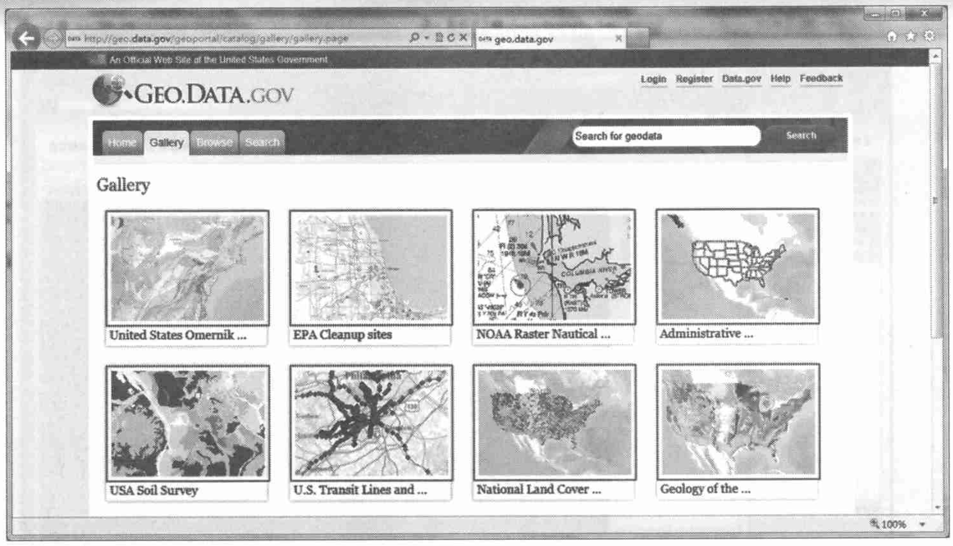
Geospatial Data Service platform



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US Geospatial One-Stop Data Service System

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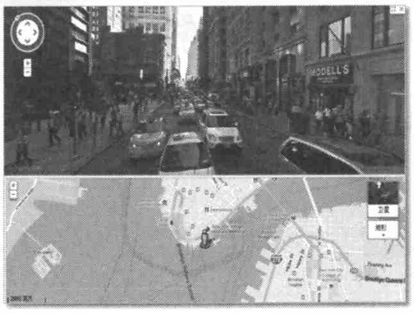
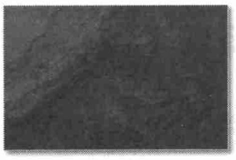
Geospatial Data Service platform

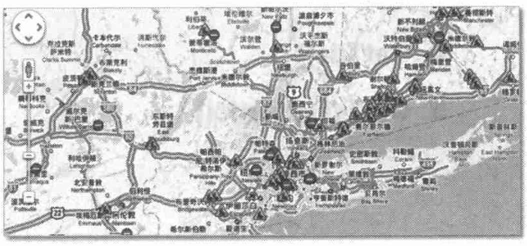


Street Map



Ocean

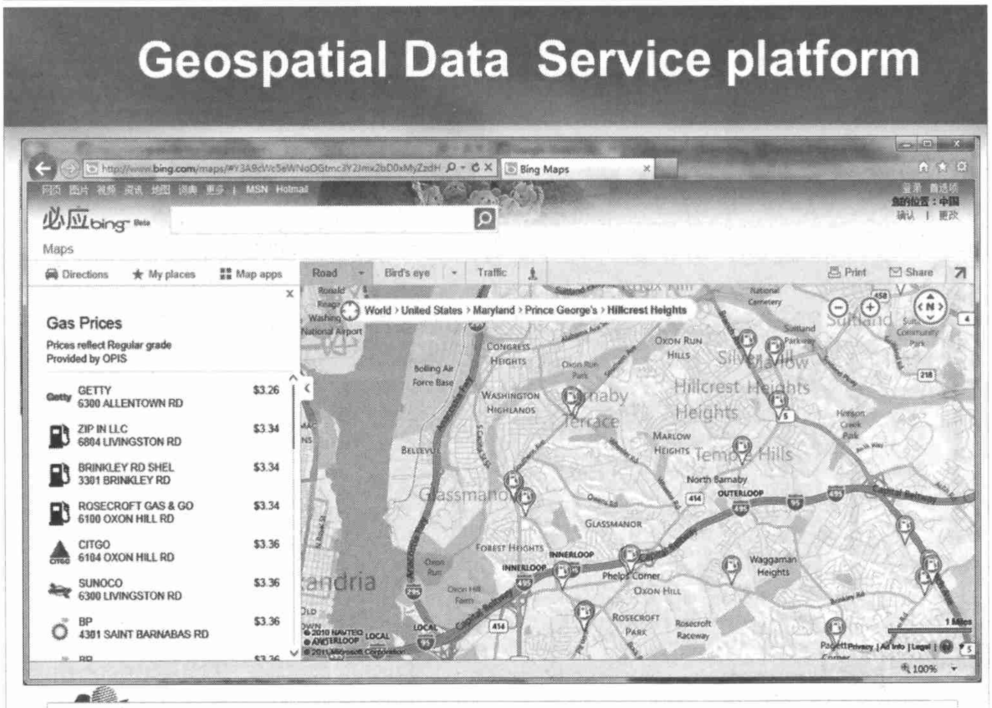
Photo



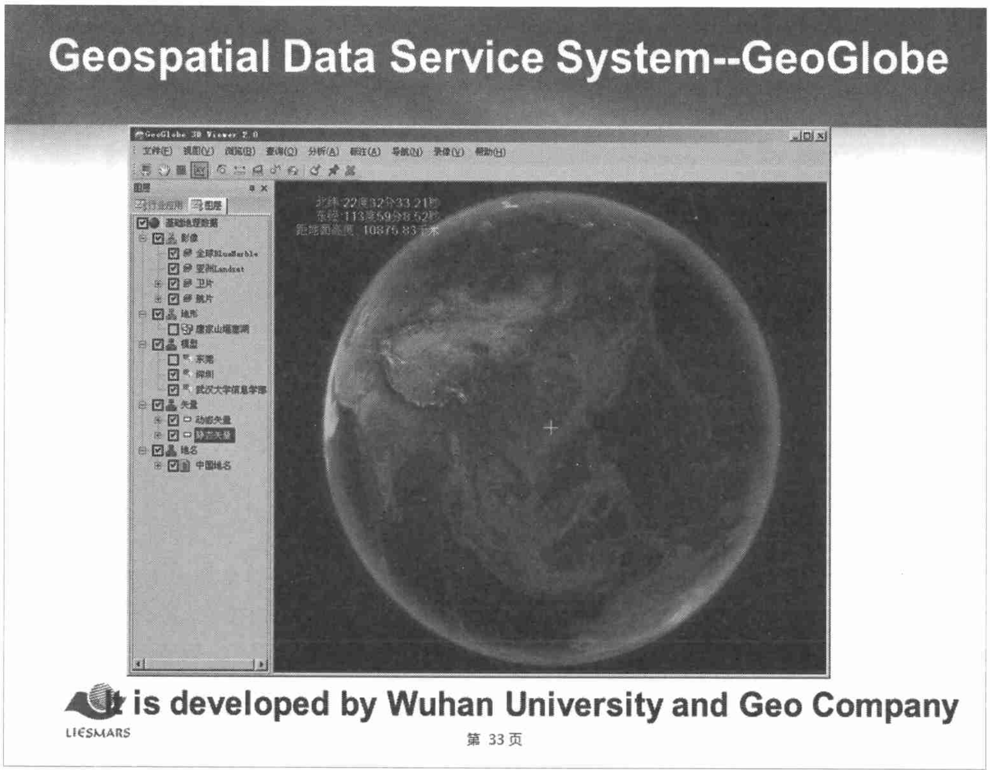
Real-time Traffic

Google Earth has grown up as one of the most influential platform of sharing geospatial information.

Google Earth for information sharing.



Microsoft Bing Maps


Geospatial Data Service System--GeoGlobe
It is developed by Wuhan University and Geo Company
LIESMARS
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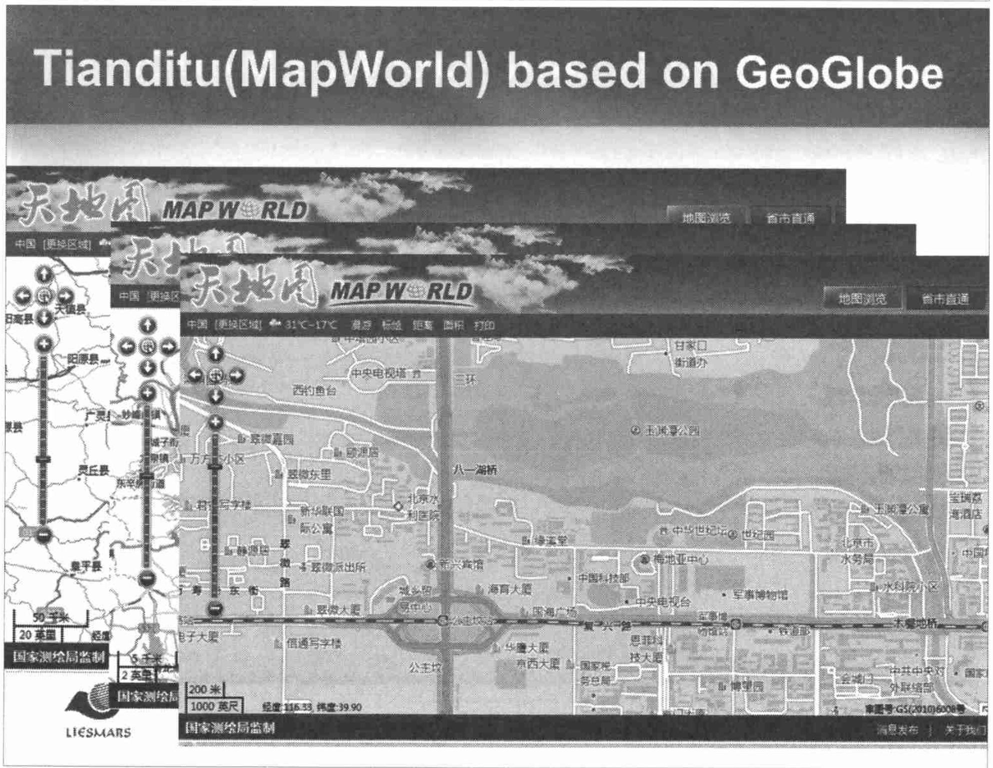
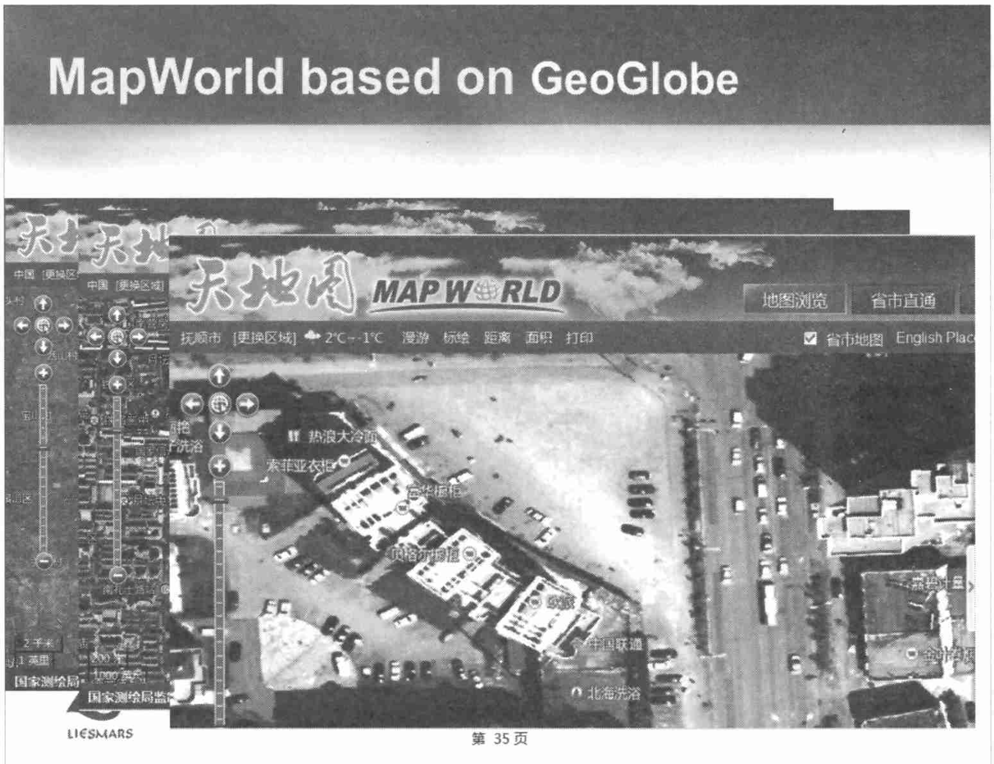

Tianditu(MapWorld) based on GeoGlobe
天地图 MAP WORLD
LIESMARS


MapWorld based on GeoGlobe
MAP W RLD
地图浏览
省市直通
抚顺市 [更换区域] 2°C~-1°C 漫游 标绘 距离 面积 打印
省市地图 English Plac
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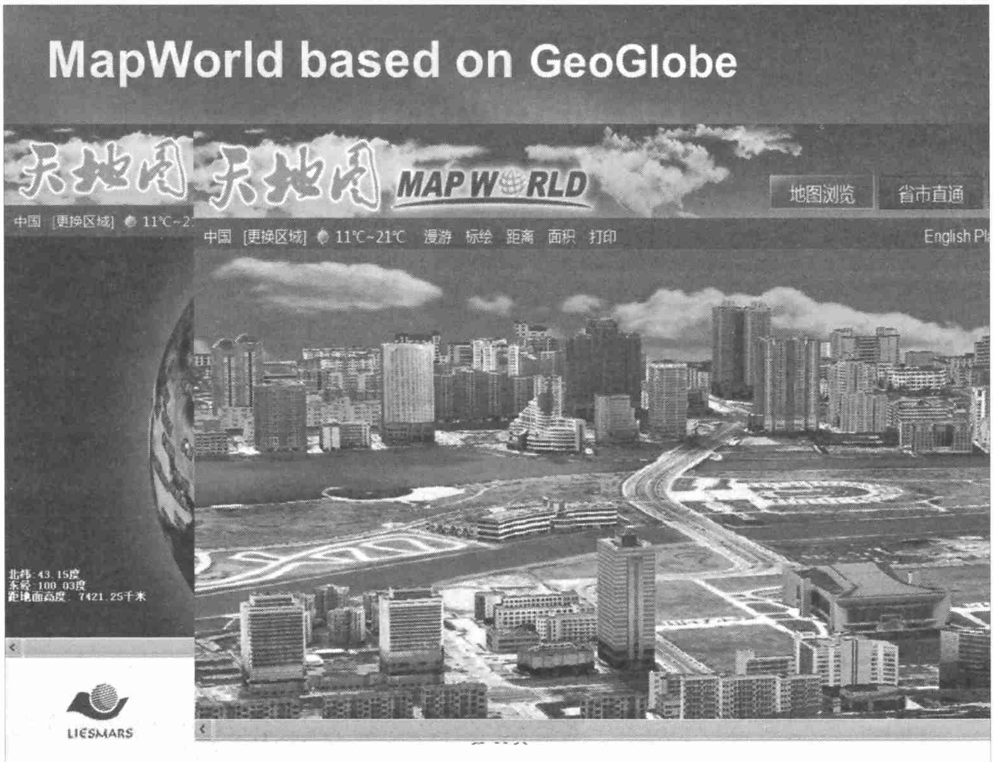
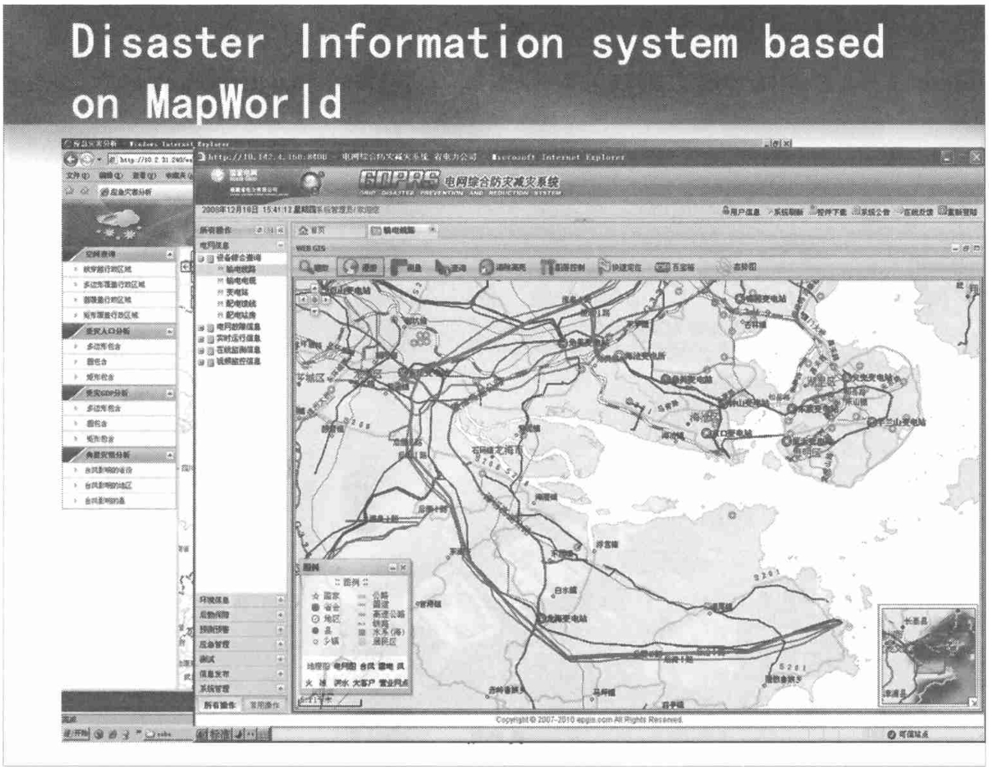
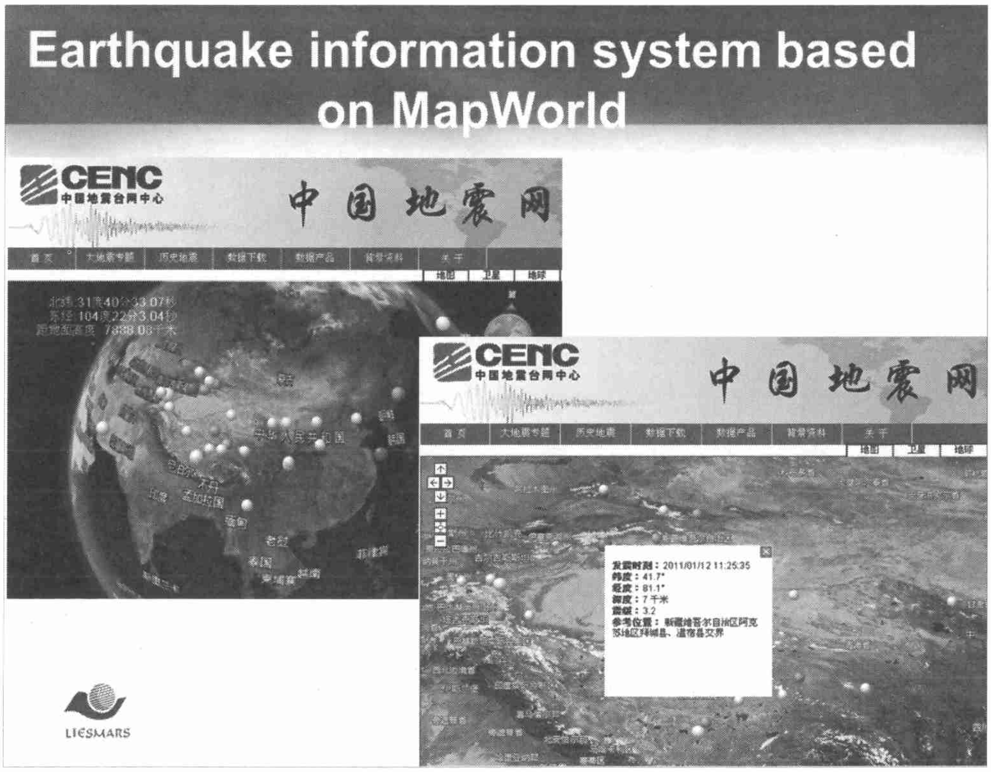

MapWorld based on GeoGlobe
MAP W RLD
地图浏览
省市直通
中国 [更换区域] 11°C~21°C 漫游 标绘 距离 面积 打印
English Pl
LIESMARS


Disaster Information system based on MapWorld


Earthquake information system based on MapWorld
CENC
中国地震台网中心
中国地震网
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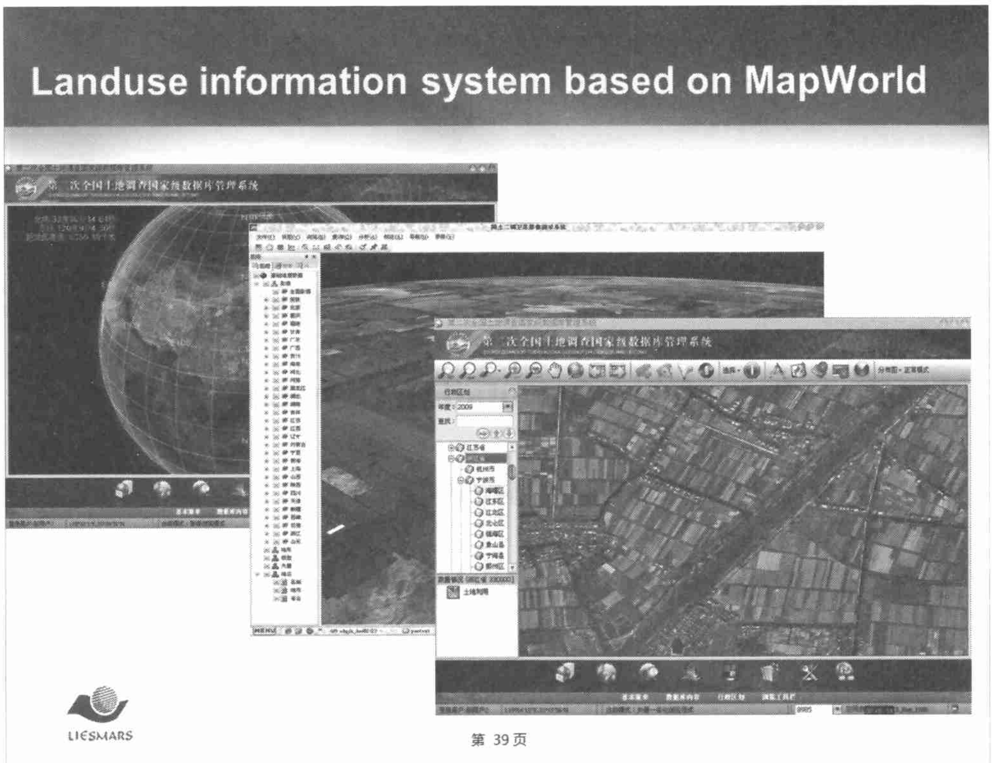
Landuse information system based on MapWorld
LIESMARS
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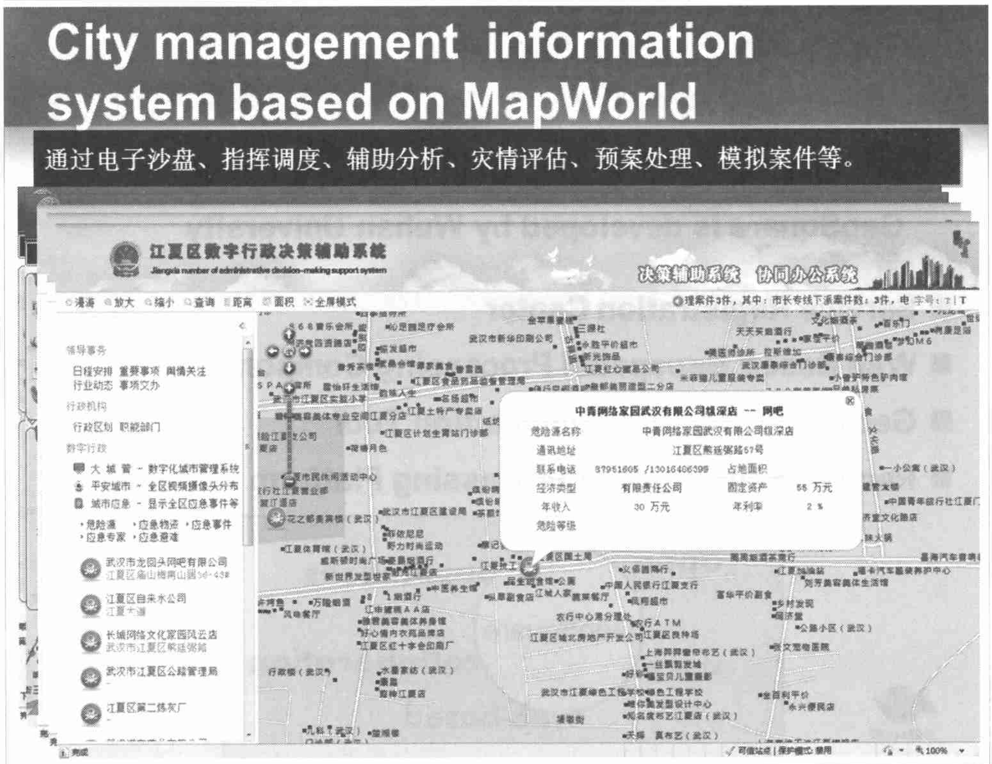
City management information system based on MapWorld
通过电子沙盘、指挥调度、辅助分析、灾情评估、预案处理、模拟案件等。
江夏区数字行政决策辅助系统
决策辅助系统
协同办公系统

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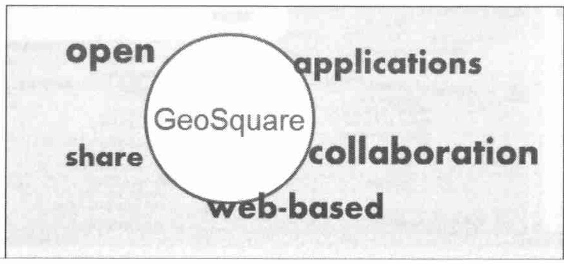
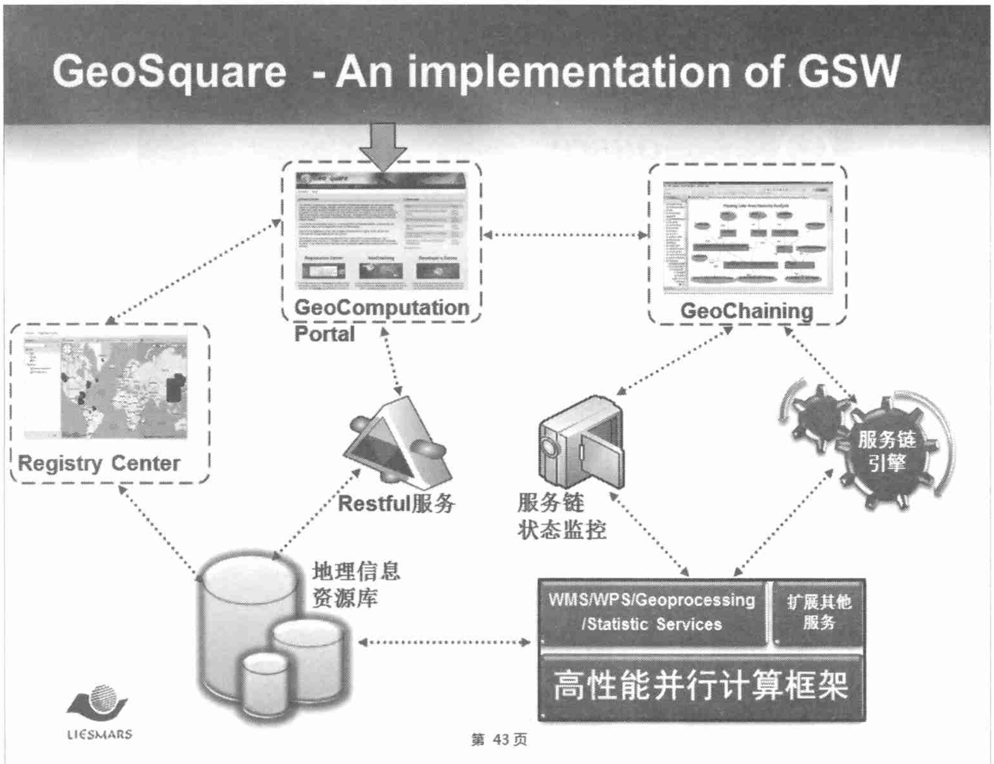
Prototype System

A Web Based GeoCoputation Prototype System-- GeoSquare is developed by Wuhan University

- Service Registration Center
- Web Based Geospatial Processing Components
- Geospatial Service Composition Tool
- Remote Sensing Data Processing Platform - OpenRS



LIESMARS


GeoSquare - An implementation of GSW
GeoComputation Portal
GeoChaining
Registry Center
Restful服务
服务链
状态监控
服务链
引擎
地理信息
资源库
WMS/WPS/Geoprocessing
/Statistic Services
扩展其他
服务
高性能并行计算框架
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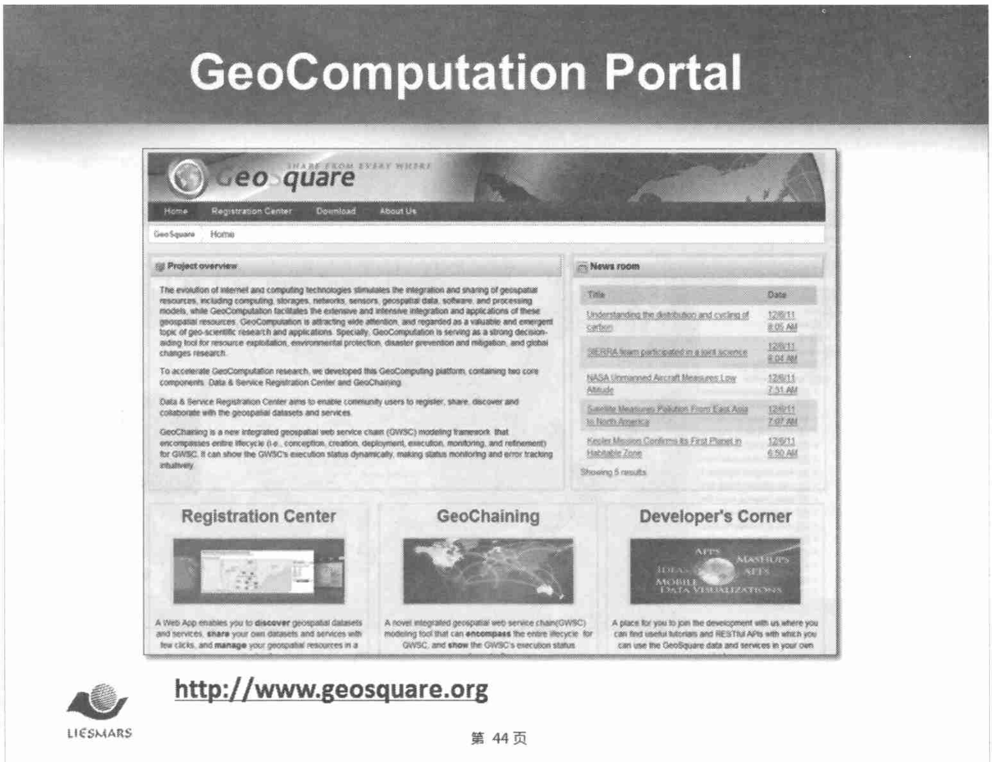
GeoComputation Portal
Home
Registration Center
Download
About Us
Project overview
News room
Registration Center
GeoChaining
Developer's Corner
http://www.geosquare.org
LIESMARS
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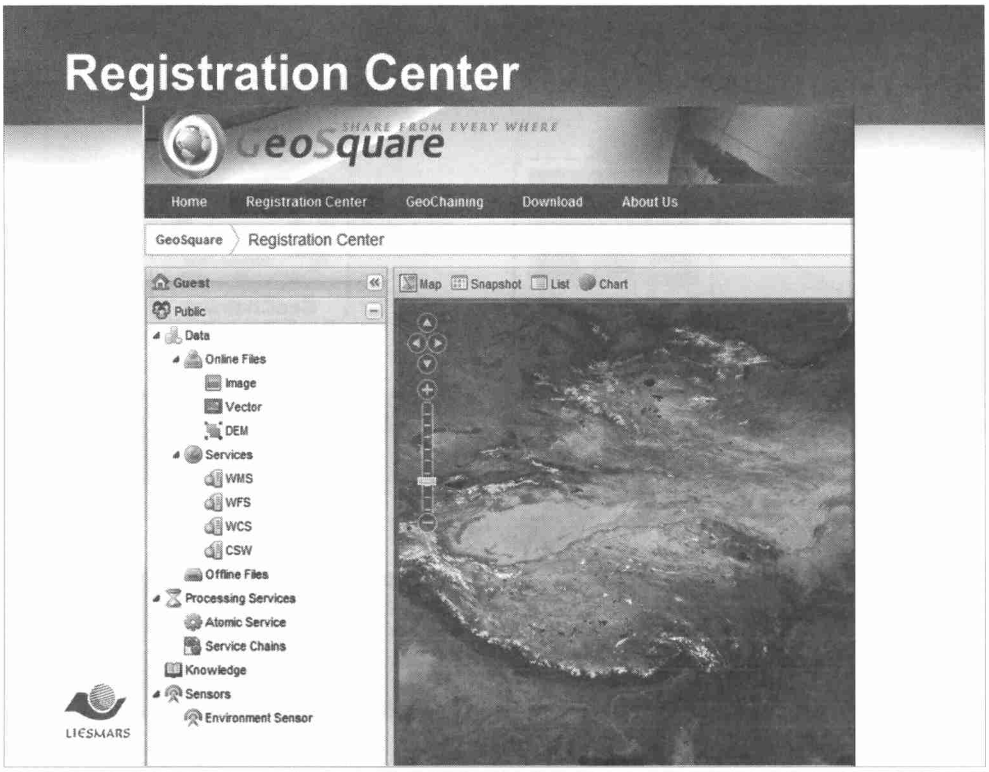
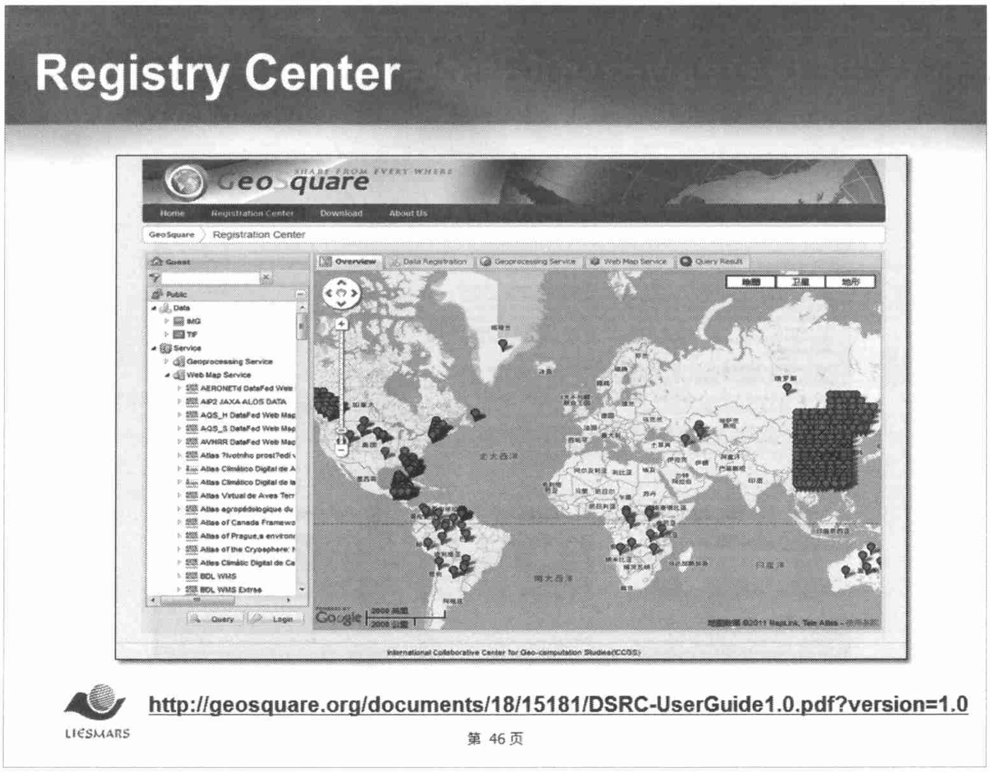

Registration Center
GeoSquare
SHARE FROM EVERY WHERE
Home
Registration Center
GeoChaining
Download
About Us
GeoSquare
Registration Center
Guest
Public
Data
Online Files
Image
Vector
DEM
Services
WMS
WFS
WCS
CSW
Offline Files
Processing Services
Atomic Service
Service Chains
Knowledge
Sensors
Environment Sensor
Map
Snapshot
List
Chart
LIESMARS


Registry Center
GeoSquare
Home
Registration Center
Download
About Us
GeoSquare
Registration Center
Guest
Public
Data
Service
Geoprocessing Service
Web Map Service
Overview
Data Registration
Geoprocessing Service
Web Map Service
Query Result
Query
Login
Google
International Collaborative Center for Geo-computation Studies(ICCGS)
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http://geosquare.org/documents/18/15181/DSRC-UserGuide1.0.pdf?version=1.0
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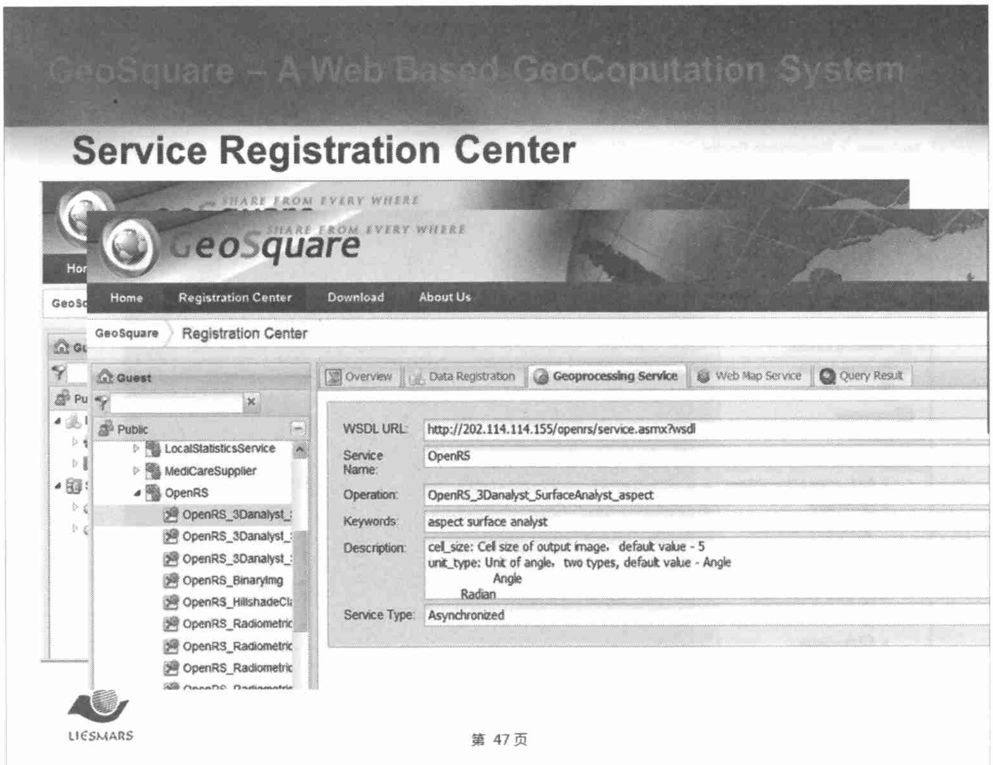
GeoSquare – A Web Based GeoCoputation System
Service Registration Center
SHARE FROM EVERY WHERE
GeoSquare
Home
Registration Center
Download
About Us
GeoSquare
Registration Center
Guest
Public
LocalStatisticsService
MediCareSupplier
OpenRS
OpenRS_BinaryImg
Overview
Data Registration
Geoprocessing Service
Web Map Service
Query Result
WSDL URL:
http://202.114.114.155/openrs/service.asmx?wsdl
Service Name:
OpenRS
Operation:
OpenRS_3Danalyst_SurfaceAnalyst_aspect
Keywords:
aspect surface analyst
Description:
cell_size: Cell size of output image, default value - 5
unit_type: Unit of angle, two types, default value - Angle
Angle
Radian
Service Type:
Asynchronized
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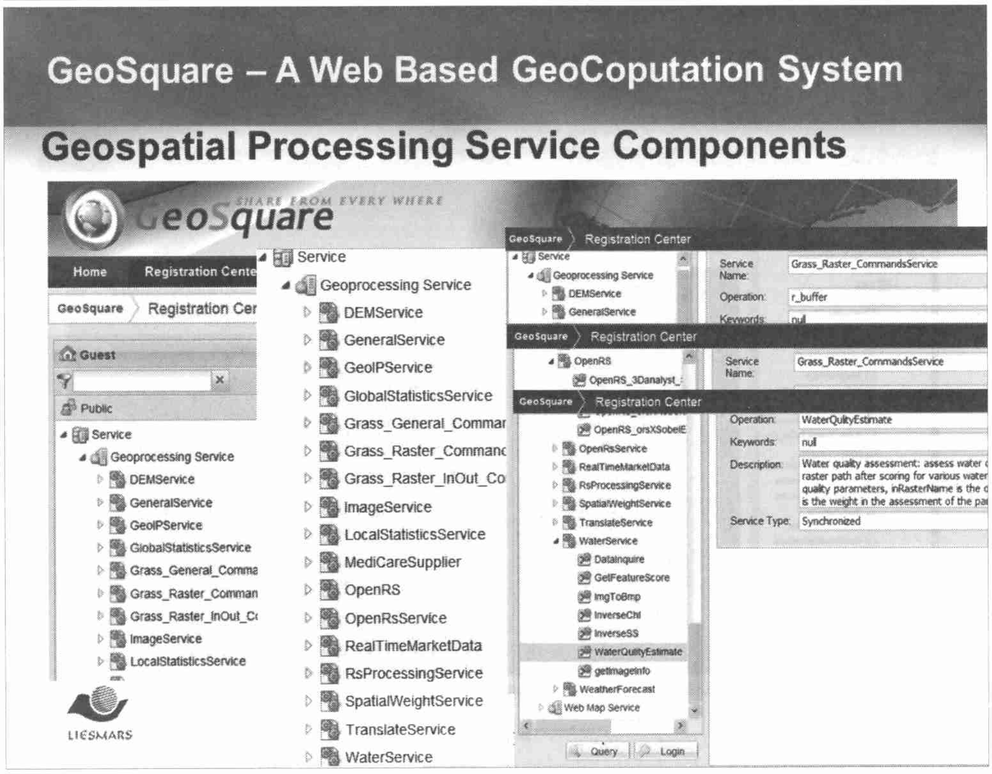
GeoSquare – A Web Based GeoCoputation System
Geospatial Processing Service Components
SHARE FROM EVERY WHERE
GeoSquare
Home
Guest
Public
Service
Geoprocessing Service
DEMService
GeneralService
GeoIPService
GlobalStatisticsService
ImageService
LocalStatisticsService
MediCareSupplier
OpenRS
OpenRsService
RealTimeMarketData
RsProcessingService
SpatialWeightService
TranslateService
WaterService
Registration Center
Service Name:
Grass_Raster_CommandsService
Operation:
r_buffer
WaterQulityEstimate
Service Type:
Synchronized
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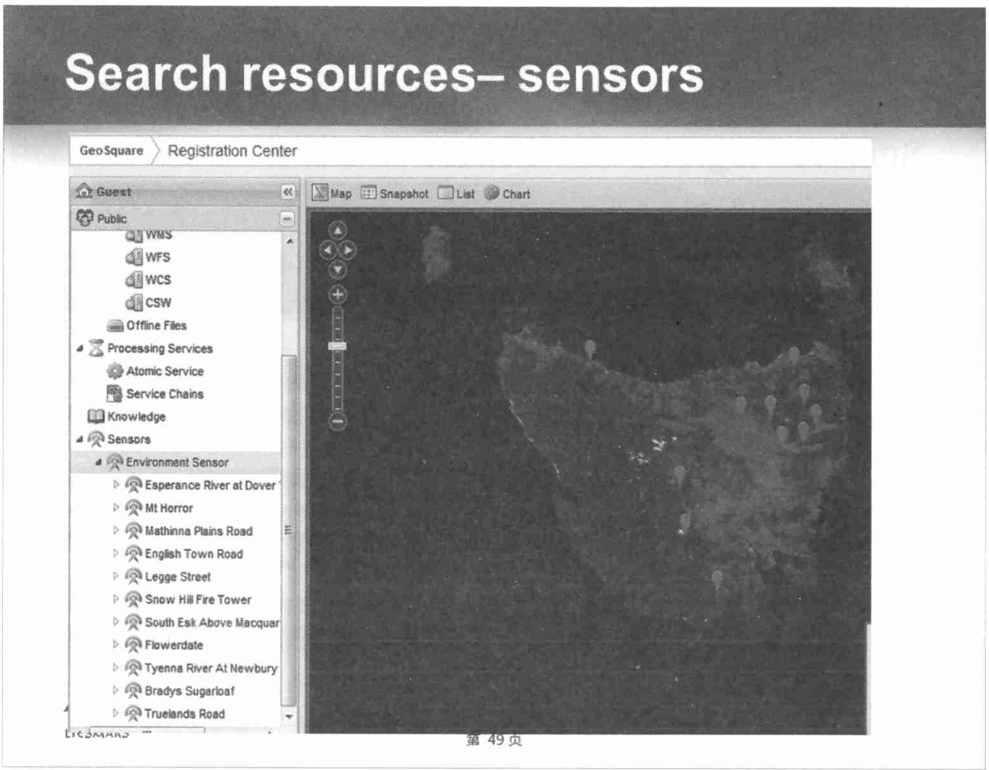
Search resources– sensors
GeoSquare
Registration Center
Guest
Public
WMS
WFS
WCS
CSW
Offline Files
Processing Services
Atomic Service
Service Chains
Knowledge
Sensors
Environment Sensor
Esperance River at Dover
Mt Horror
Mathinna Plains Road
English Town Road
Legge Street
Snow Hill Fire Tower
South Esk Above Macquar
Flowerdale
Tyenna River At Newbury
Bradys Sugarloaf
Truelands Road
Map
Snapshot
List
Chart
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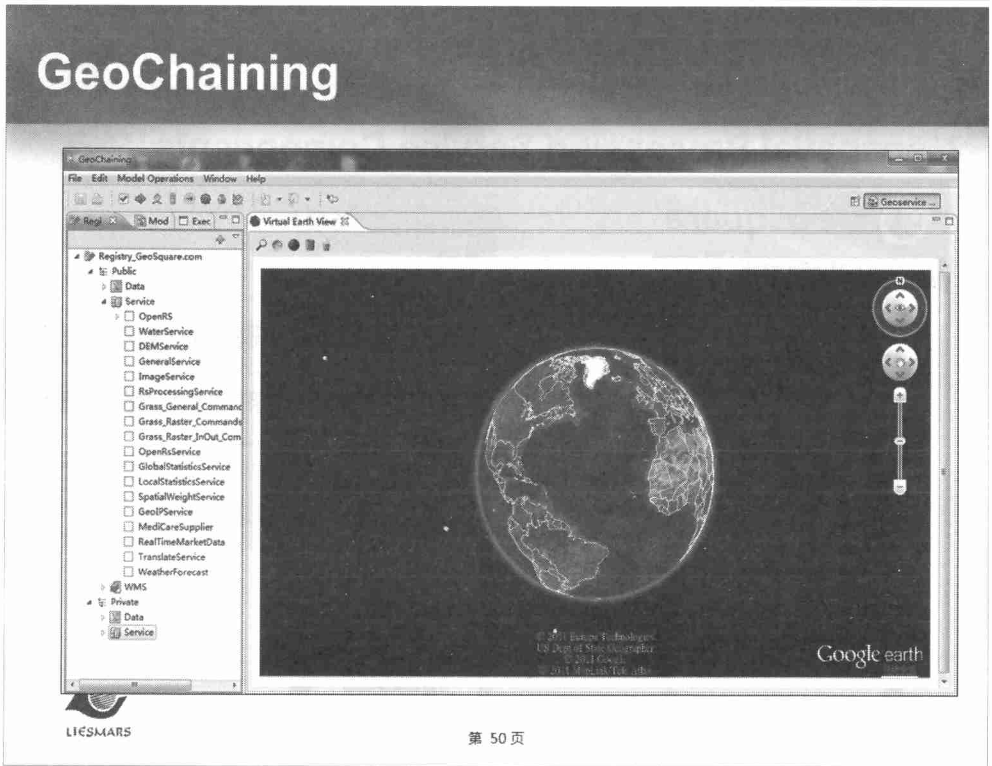
GeoChaining
File Edit Model Operations Window Help
Virtual Earth View
Registry_GeoSquare.com
Public
Data
Service
OpenRS
WaterService
DEMService
GeneralService
ImageService
RsProcessingService
Grass_General_Command
Grass_Raster_Commands
Grass_Raster_InOut_Com
OpenRsService
GlobalStatisticsService
LocalStatisticsService
SpatialWeightService
GeoIPService
MediCareSupplier
RealTimeMarketData
TranslateService
WeatherForecast
WMS
Private
Data
Service
Google earth
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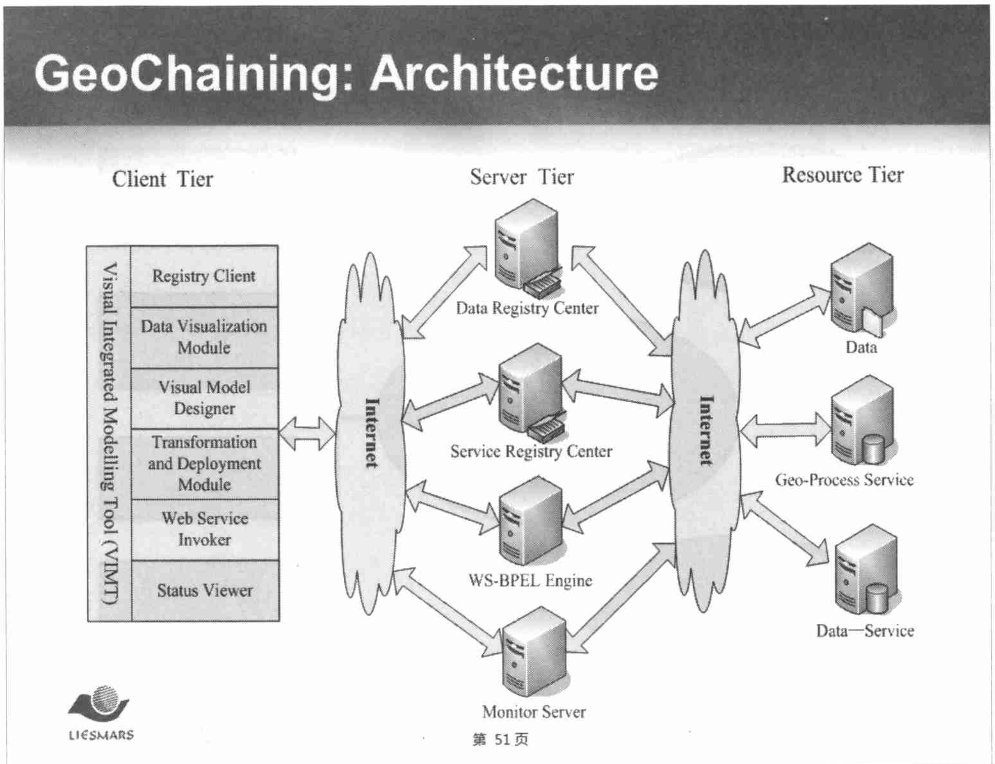
GeoChaining: Architecture
Client Tier
Server Tier
Resource Tier
Visual Integrated Modelling Tool (VIMT)
Registry Client
Data Visualization Module
Visual Model Designer
Transformation and Deployment Module
Web Service Invoker
Status Viewer
Internet
Data Registry Center
Service Registry Center
WS-BPEL Engine
Monitor Server
Internet
Data
Geo-Process Service
Data—Service
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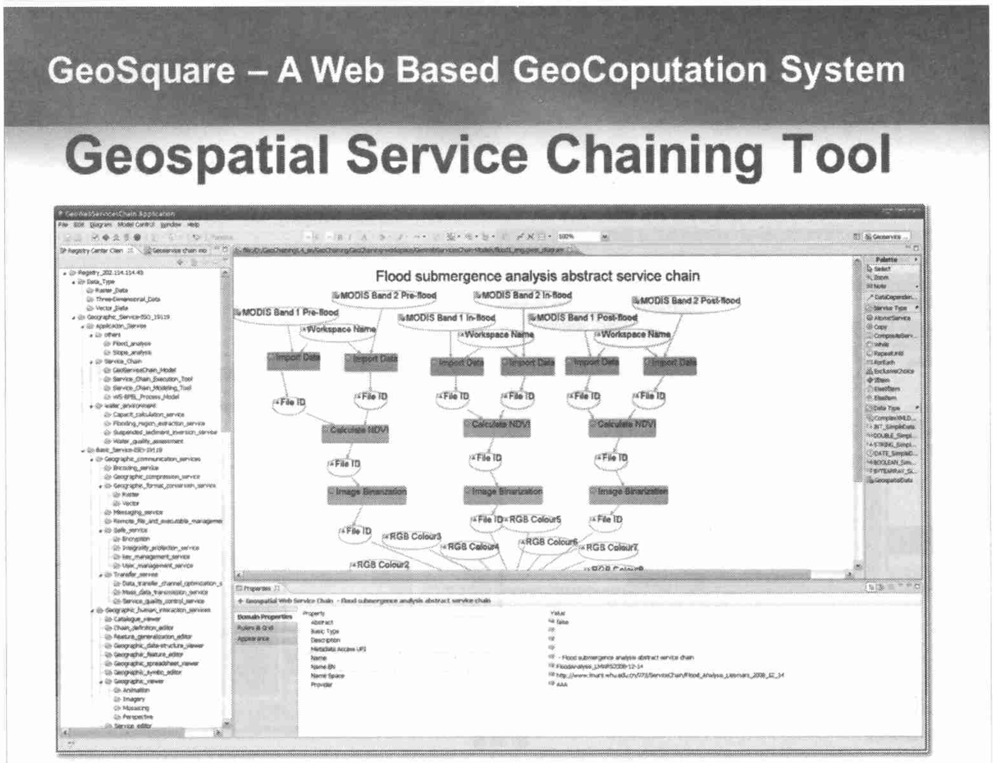
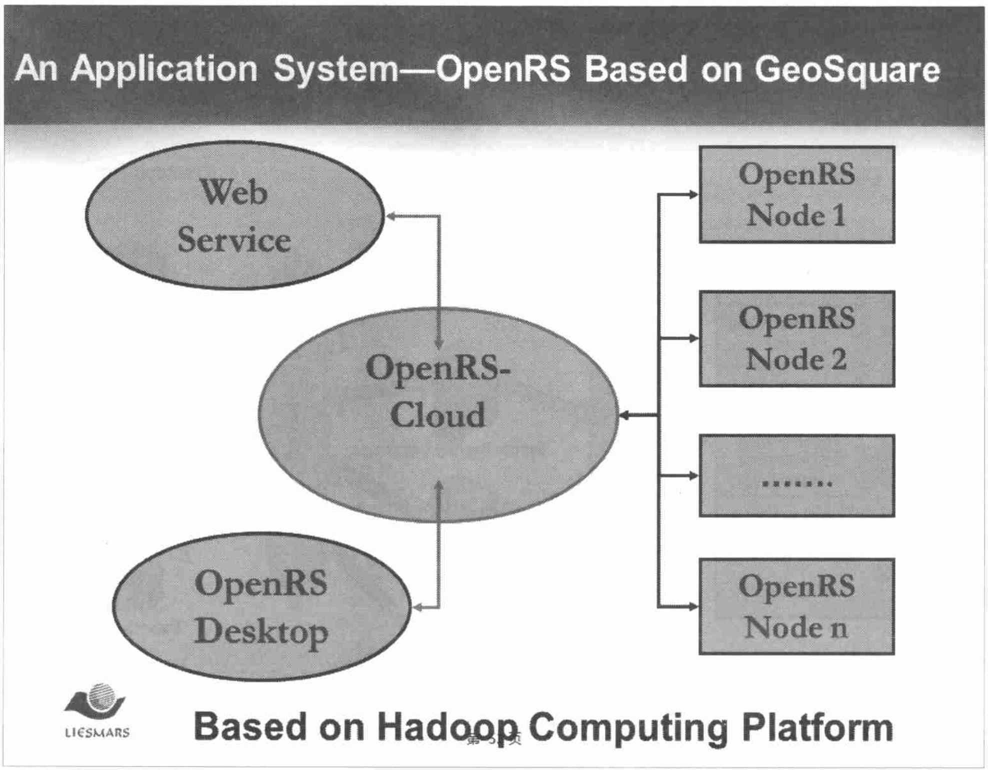
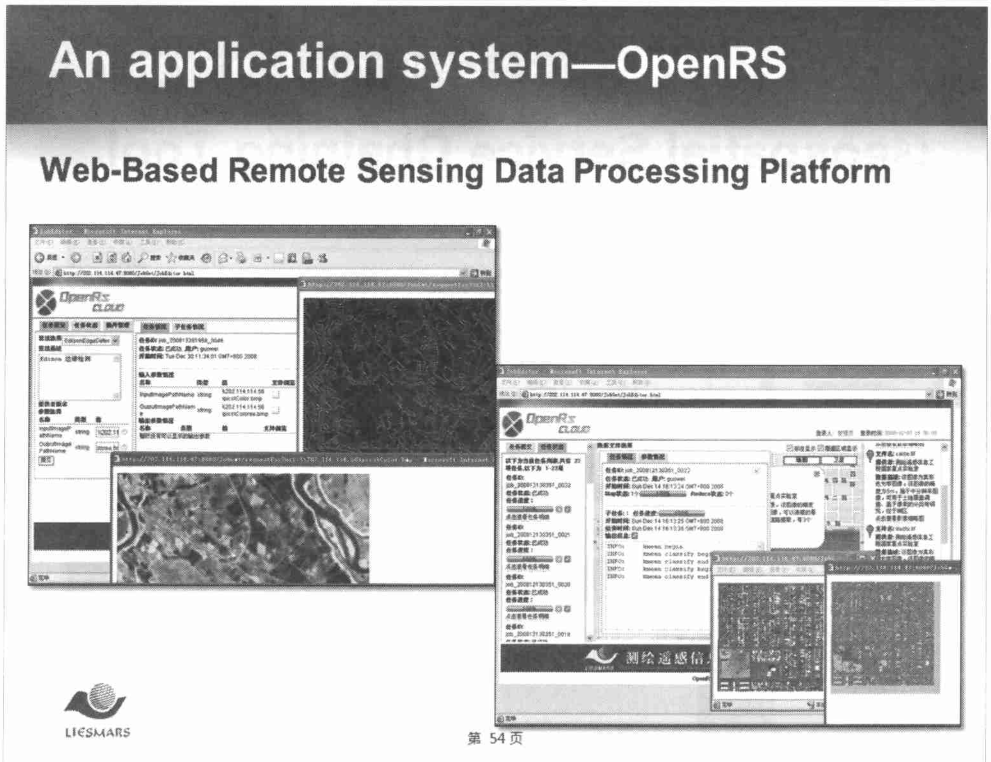

GeoSquare – A Web Based GeoCoputation System
Geospatial Service Chaining Tool
Flood submergence analysis abstract service chain
MODIS Band 2 Pre-flood
MODIS Band 2 In-flood
MODIS Band 2 Post-flood
MODIS Band 1 Pre-flood
MODIS Band 1 In-flood
MODIS Band 1 Post-flood
Workspace Name
Import Data
File ID
Calculate NDVI
Image Binarization
RGB Colour


An Application System—OpenRS Based on GeoSquare
Web Service
OpenRS-Cloud
OpenRS Desktop
OpenRS Node 1
OpenRS Node 2
....
OpenRS Node n
LIESMARS
Based on Hadoop Computing Platform


An application system—OpenRS
Web-Based Remote Sensing Data Processing Platform
OpenRS CLOUD
LIESMARS
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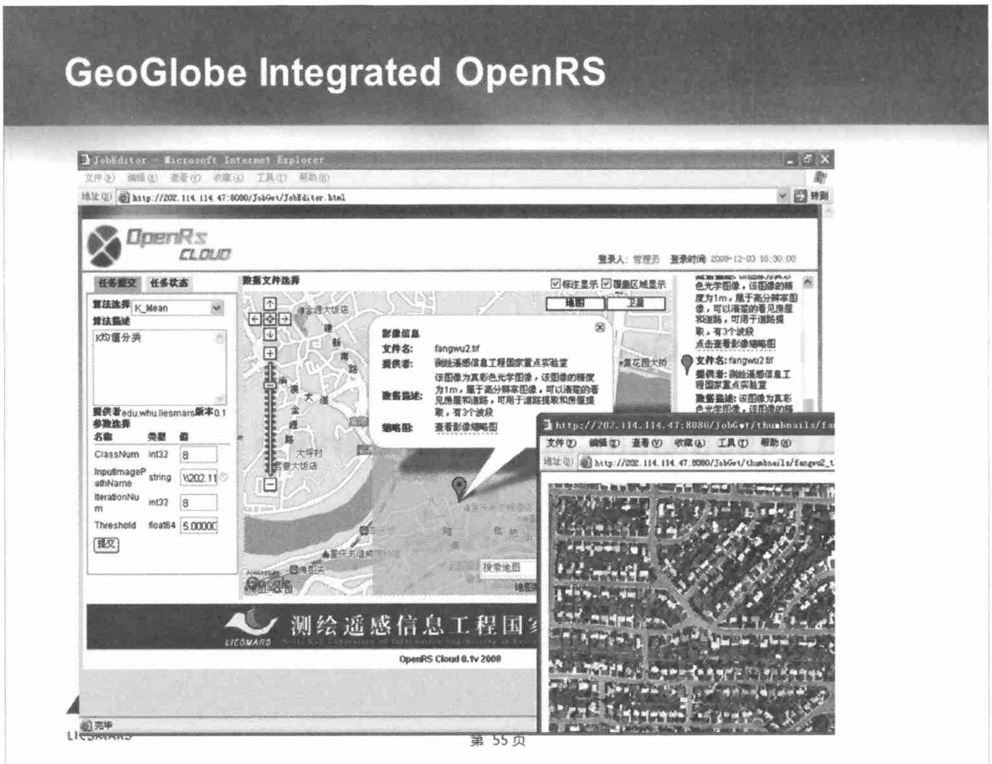
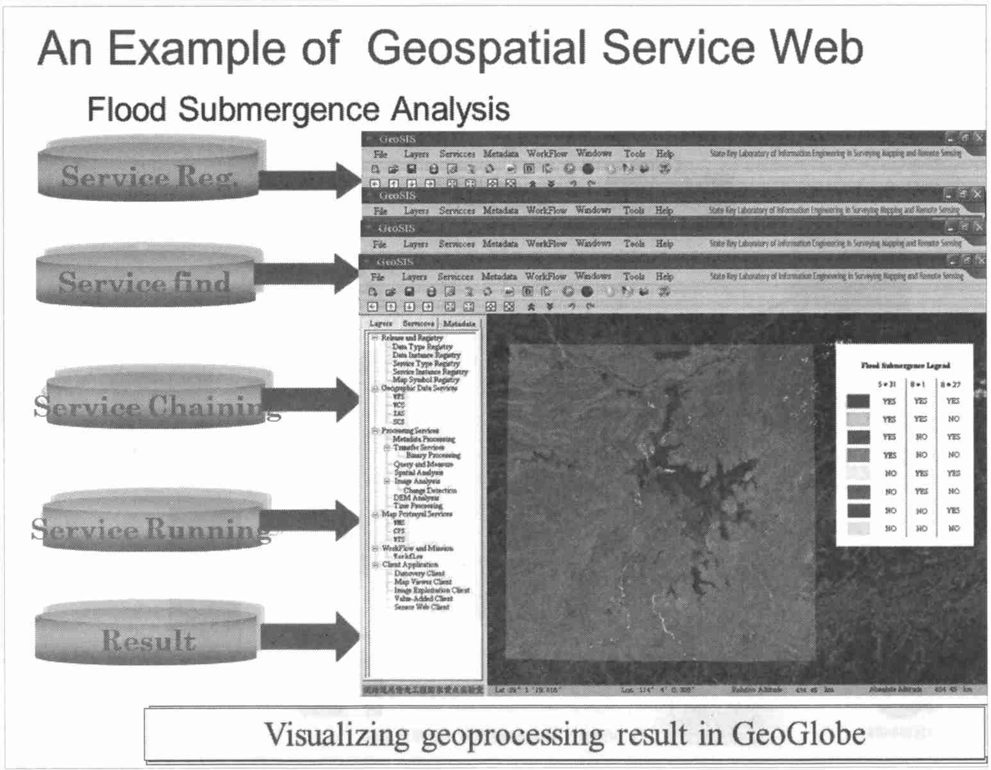
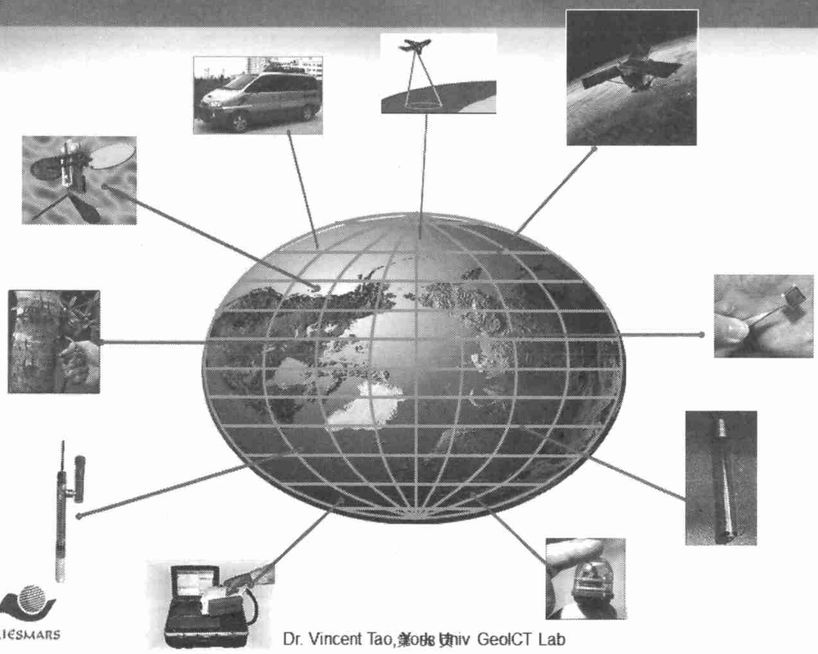

GeoGlobe Integrated OpenRS
OpenRS CLOUD
测绘遥感信息工程国家
第 55 页


An Example of Geospatial Service Web
Flood Submergence Analysis
Service Reg.
Service find
Service Chaining
Service Running
Result
Visualizing geoprocessing result in GeoGlobe

Contents

1. Concept of Geospatial Service Web
2. Web Based Geospatial Data Service
3. Web Based GeoCoputation Service
4. Web Based Sensor Service
5. Conclusion and Future Work

Sensor Web concept



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Dr. Vincent Tao, York Univ GeoICT Lab

Prototype System

A Web Based Sensor Service Prototype System is developed by Wuhan University

- **Sensor modeling (Tool)**
- **GeoSensor (platform)**
  - **Sensor Planning Service**
  - **Sensor Observation Service**

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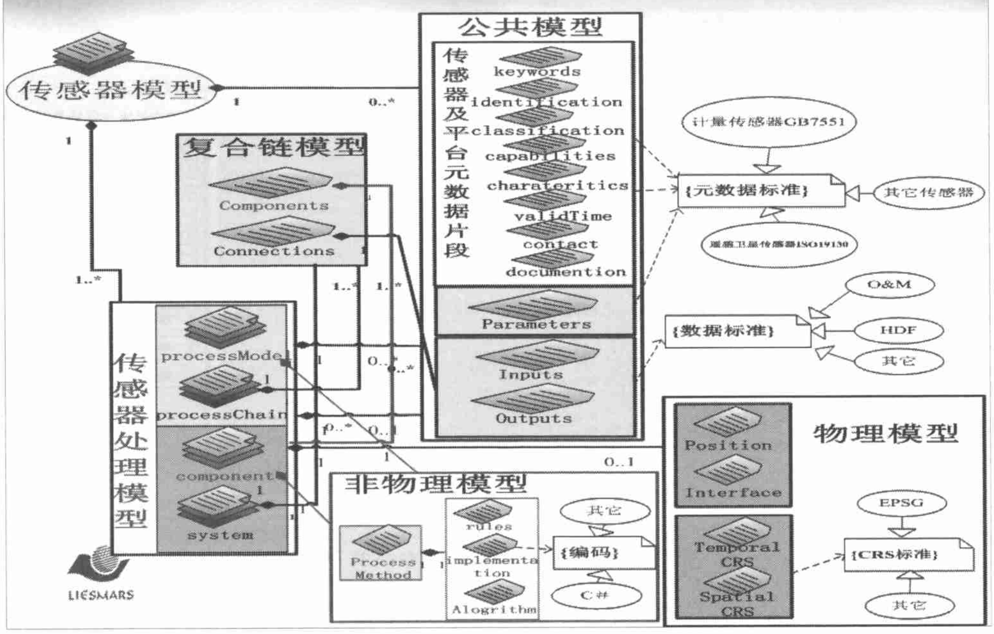
SensorModeling



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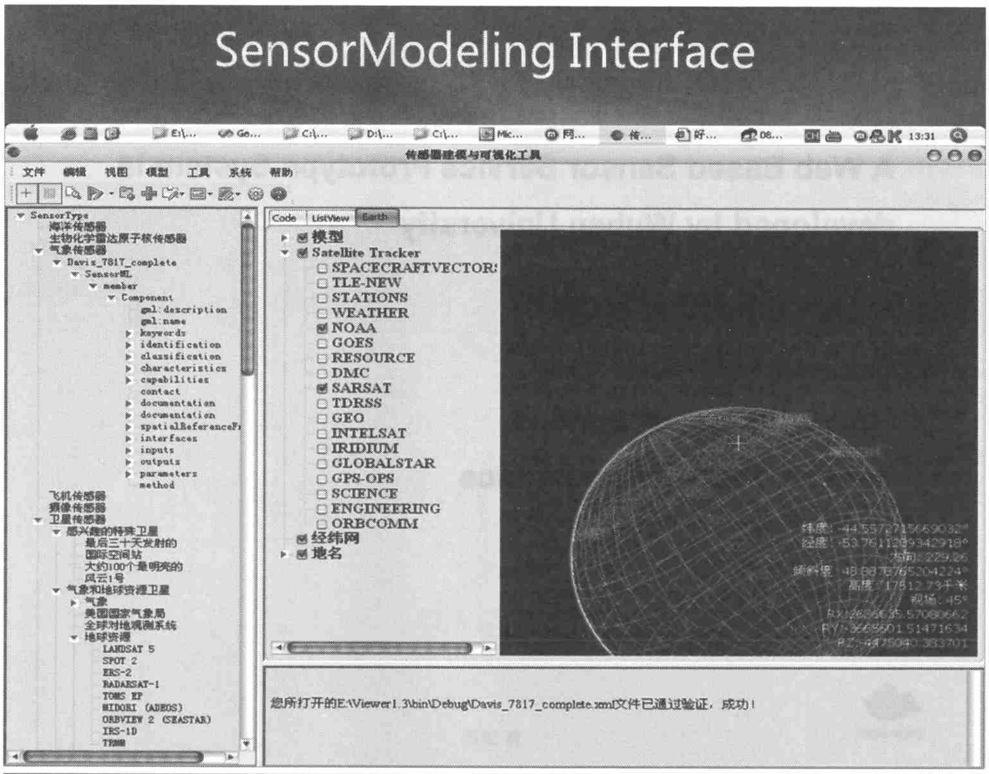
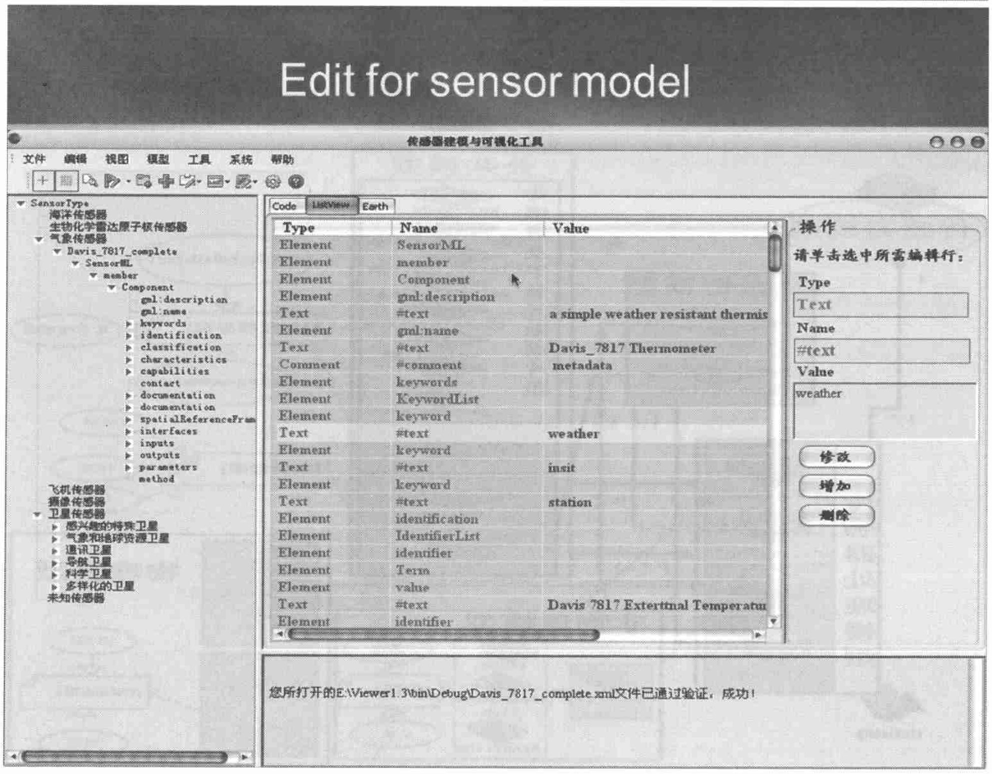

SensorModeling Interface
传感器建模与可视化工具
文件 编辑 视图 模型 工具 系统 帮助
SensorType
海洋传感器
生物化学雷达原子核传感器
气象传感器
Davis_7817_complete
Code
ListView
Earth
模型
Satellite Tracker
SPACECRAFTVECTOR:
TLE-NEW
STATIONS
WEATHER
NOAA
GOES
RESOURCE
DMC
SARSAT
TDRSS
GEO
INTELSAT
IRIDIUM
GLOBALSTAR
GPS-OPS
SCIENCE
ENGINEERING
ORBCOMM
经纬网
地名
飞机传感器
摄像传感器
卫星传感器
您所打开的E:\Viewer1.3\bin\Debug\Davis_7817_complete.xml文件已通过验证，成功！


Edit for sensor model
传感器建模与可视化工具
文件 编辑 视图 模型 工具 系统 帮助
Code
ListView
Earth
Type
Name
Value
Element
SensorML
member
Component
gml:description
Text
#text
a simple weather resistant thermis
gml:name
Davis_7817 Thermometer
Comment
#comment
metadata
keywords
KeywordList
keyword
weather
insit
station
identification
IdentifierList
identifier
Term
value
Davis 7817 Extertnal Temperatur
操作
请单击选中所需编辑行：
修改
增加
删除
飞机传感器
摄像传感器
卫星传感器
未知传感器
您所打开的E:\Viewer1.3\bin\Debug\Davis_7817_complete.xml文件已通过验证，成功！

GeoSensor

GeoSensor : GeoSensor-Server and GeoSensor-Client

服务名称	发布地址
SPS	http://swe.whu.edu.cn:9000/SPSV101
SOS	http://swe.whu.edu.cn:9000/SOS/sos
WCS	http://swe.whu.edu.cn:9000/geoserver/wcs
WMS	http://swe.whu.edu.cn:9000/geoserver/wms
WFS	http://swe.whu.edu.cn:9000/geoserver/wfs
WPS	http://swe.whu.edu.cn:9000/WPS
WNS	http://swe.whu.edu.cn:9000/WNS

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GeoSensor-Server_list

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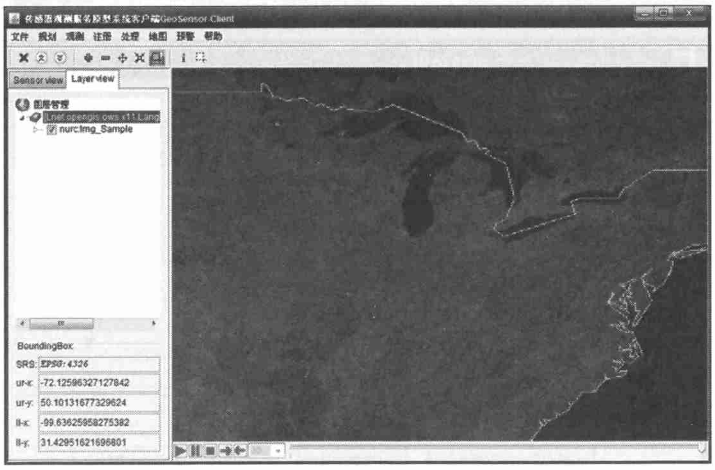
Geosensor Client



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Sensor Alert and Planning Service
State Key Laboratory of Information Engineering in Surveying Mapping and Remote Sensing


Sensor Planning service
GetFeasibility-Submit对话框
Notification Parameters
Notification ID:
1
Notification URL:
http://swe.whu.edu.cn:9000/WNS
SPS 必选参数
startTime:
2010-04-12T:12:00:00
endTime:
2010-04-14T:12:00:00
space:
X
Y
Upper Corner:
116
33
Lower Corner:
108
29
GetFeasibility
Submit
DescribeResultAcess
SPS GetFeasibility/Submit
SPS DescribeTasking
SPS GetCapabilities
LIESMARS
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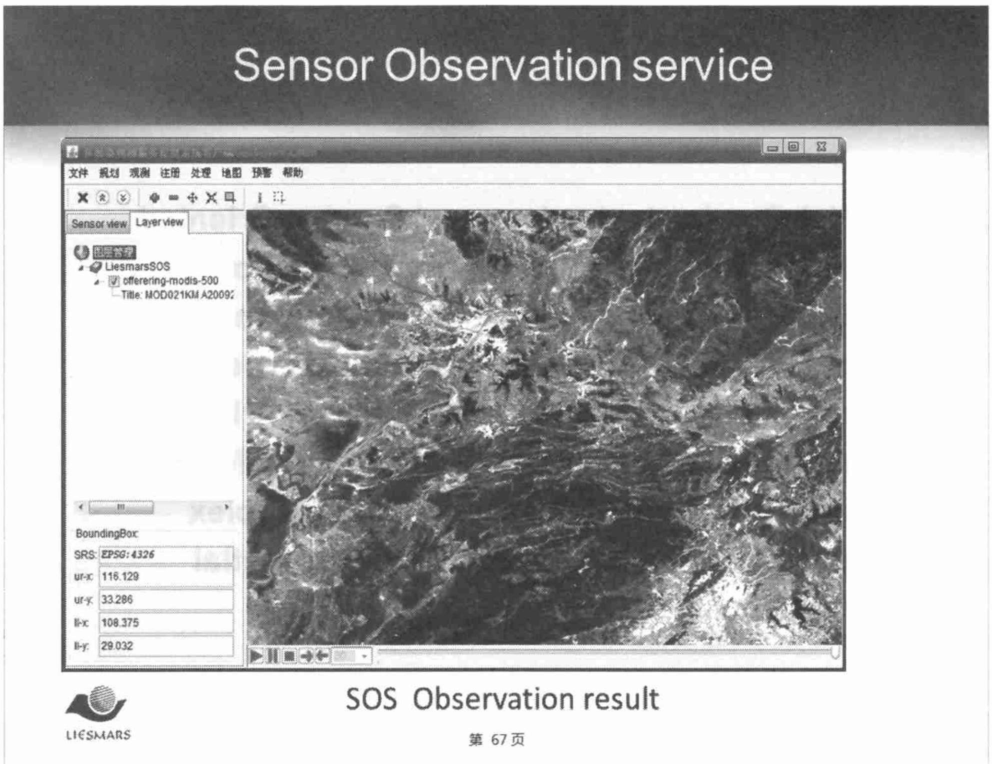
Sensor Observation service
文件 规划 观测 注册 处理 地图 预警 帮助
Sensor view
Layer view
图层管理
LiesmarsSOS
offerering-modis-500
BoundingBox
SRS: EPSG:4326
ur-x: 116.129
ur-y: 33.286
ll-x: 108.375
ll-y: 29.032
SOS Observation result
LIESMARS
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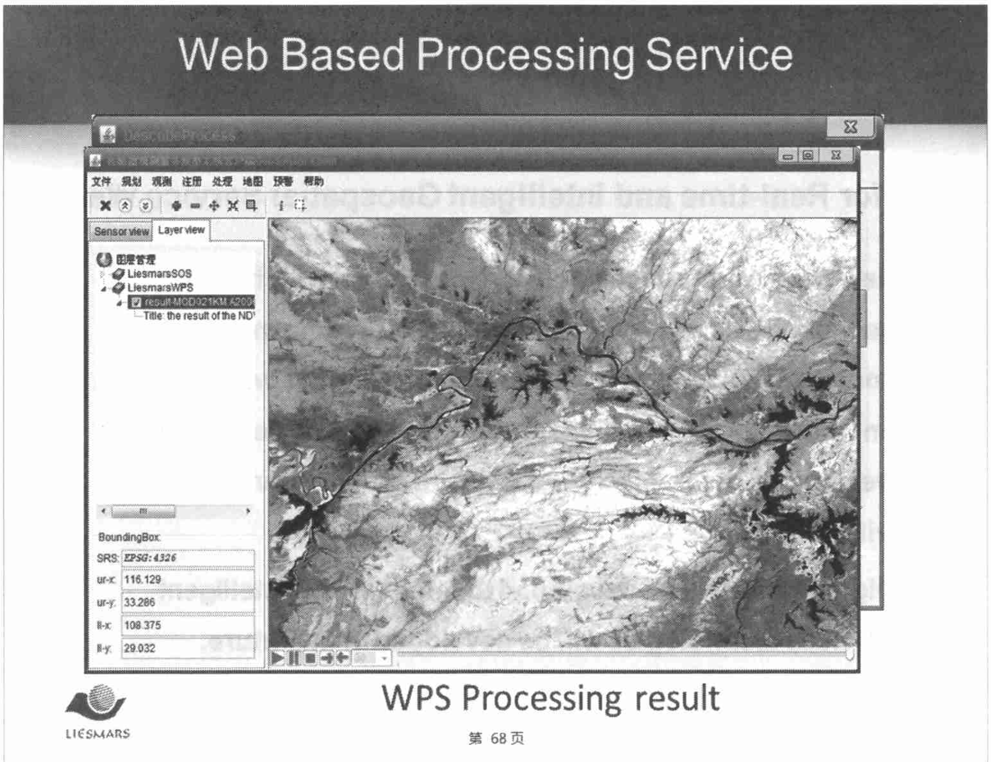
Web Based Processing Service
文件 规划 观测 注册 处理 地图 预警 帮助
Sensor view
Layer view
图层管理
LiesmarsSOS
LiesmarsWPS
BoundingBox
SRS: EPSG:4326
ur-x: 116.129
ur-y: 33.286
ll-x: 108.375
ll-y: 29.032
WPS Processing result
LIESMARS
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5. Conclusion and Future Work

The Web Service technology and Service-Oriented Architecture are developed to publish, discover and retrieve various geospatial data, information and knowledge. With the advancement of Web Service technology, the services deployed and distributed in the Internet are not only services of data, information and knowledge, but also sensor, more complex geospatial processing services such as spatial analysis and modeling.

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5. Conclusion and Future Work

Call for Real-time and Intelligent Geospatial Service Web

- New geospatial information service system which integrates geo-spatial data acquiring, information processing, knowledge discovering and intelligent services will be based on information grid(cloud) platform and supported by Sensor web and grid(cloud) technology. GeoSpatial Service Cloud will be developed
- Digital Earth will be developed to Smart Earth. Intelligent services technologies will be developed in the future.

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Thanks for
your attention!

[Session 1]

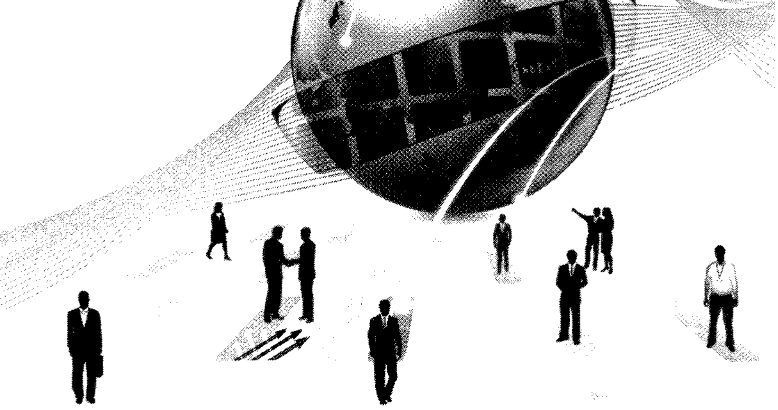
Geo Innovations and Supporting Policies in East Asian Countries

5

National GIS Strategic Development toward Geospatial Interoperability Application in Taiwan

Prof. Tien-Yin Chou

(Feng Chia University, Taiwan)



ICG-TEK 2012

International Conference on sharing Geospatial Technology, Experience and Knowledge

National GIS Strategic Development toward Geospatial Interoperability Application in Taiwan

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Abstract

The technique application systems of GIS development have been transformed from single computer or client/server structure into web-based services, Services Oriented Architecture (SOA), and cloud computing for the past several decades which also rapidly expanded into different aspects of fields. In Taiwan, the National Development Council (NDC) initiated the suggestion to develop National Geographic Information Systems (NGIS) in 1986. The strategic Master plan of NGIS and first stage of ten-year development project were introduced and announced in 1988. Taiwan authority has funded billions of New Taiwan dollars to promote GIS related development over the past 20 years. Started from database establishment and data warehouse implementation, then, gradually initiated information sharing between and within governmental agencies as well as public citizens. Taiwan authority recognized that Geospatial Interoperability should be one of the most fundamental parts for future widely application of GIS technology. Now a day, not only governmental agencies, but also private companies are enforced and adopting geospatial techniques to improve efficiency and flexibility in emergency and daily issues following nationwide geospatial standard.

Keywords: Geospatial, Interoperability, Service Oriented Architecture

1. Introduction and Background

1.1 The background of national geographic information system

The fundamental of geospatial technique development is based on NGIS in Taiwan. A strategic Master plan of NGIS and ten-year development project of NGIS marked the blue print and endorsed the white paper of geospatial information development in Taiwan.

In 1990, the National Geographic Information System Steering Committee (NGISSC) assisted in grouping, integration, communication and negotiation among various departments of government and set up the strategies and working guidelines of NGIS. NGISSC helped the growth of GIS industry and market competitiveness. The Steering Committee of National Geographic Information was actively involved in the promotion of geographic information system development and researches to the improvement of relating geographic information technology. In the construction of spatial database, it has set up Natural Environment Database, Natural Resources and Ecological Database, Environment Quality Database, Social Economic Database, Transportation Network Database, Land information Database, Land-use Planning Database, Public Pipeline Database and Topographic Database. These nine major database groups have been enforced to accumulate geographic information concerning their respective responsibilities. There are also six application promotion groups which are National develop planning group, standard and platform group, human resource and technique development group, industrial GIS application group, disaster prevention and application promotion group, and travel traffic application promotion group have been set up from 2008 by NGISSC.

1.2 Core and Basic Geospatial Database Establishment

In NGIS, the core and basic geographic database has been defined to include topographic maps, digital terrain model (DTM), orthophoto, common version electronic maps (CVEM), cadastral maps, address geocoding, and land use investigation maps etc.

National Land Surveying and Mapping Center (NLSC), a branch of MOI, was assigned to implement Common Version Electronic Maps (CVEM) and land use investigation maps that can satisfy the most needs of public sectors. Those map data offer the latest orthophoto image and vector layer attribute information. Thus, the requirements can be satisfied as base map for national planning and environmental conservation, disaster prevention and recovery etc. The following are examples of Common Version Electronic Maps (CVEM) and land use investigation maps.

Figure 1. Common Version Electronic Maps (CVEM) in Taiwan
(http://emap.nlsc.gov.tw/gis/)

Figure 2. Land use investigation maps in Taiwan
(http://lui.nlsc.gov.tw/LUWeb/Eng/Content_e.aspx)

1.3 Geospatial standard

According to ISO/IEC Guide 2, Standard is 'A document established by consensus and approved by a recognized body that provides for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context'.(ISO/IEC Guide 2:1996, definition 3.2)

Standard is a key to integrate heterogeneous hardware and software. Standard can allow geospatial content and services to be seamlessly integrated. Not only to shorten the gap among various software and hardware, but also to improve the data sharing efficiency.

There are many committees or consortiums in the world, such as ISO, OGC, and W3C etc., to provide free and openly available standards to benefit the geospatial information. In Taiwan, a team of 'Comprehensive Planning, Standard System and Data Warehouse Group' was established by the Information Center of the Ministry of the Interior, which was aimed to build up the standardized criteria and data warehousing.

Government agencies and private companies have to adopt geospatial standards to share geospatial information. Under this framework, geospatial information can be easily value-added and near real-time updated. The most popular standards are WMS, WFS, SWE (SOS, SPS, WSN, and SAS etc.), WCS, and WPS in Taiwan. Not only implement international standards, but also establish the domain standards for data sharing. So far, there are 21 of domain standards have been announced and published in Taiwan, which include metadata (TaiWan Spatial Metadata Profile; TWSMP), administrative boundary map, address map, transportation network, cadastral map etc. Domain standards were designed accordance with international standards, for example, TWSMP is accordance with ISO 19115 and ISO 19139 which is draw up by International Organization for Standard (ISO).

Fig. 3 shows a typical example that Soil and Water Conservation Bureau (SWCB) adopts SWE, WMS and WFS standards to integrate various sensors data and display map layers in a platform driven by various governmental agencies in Taiwan.

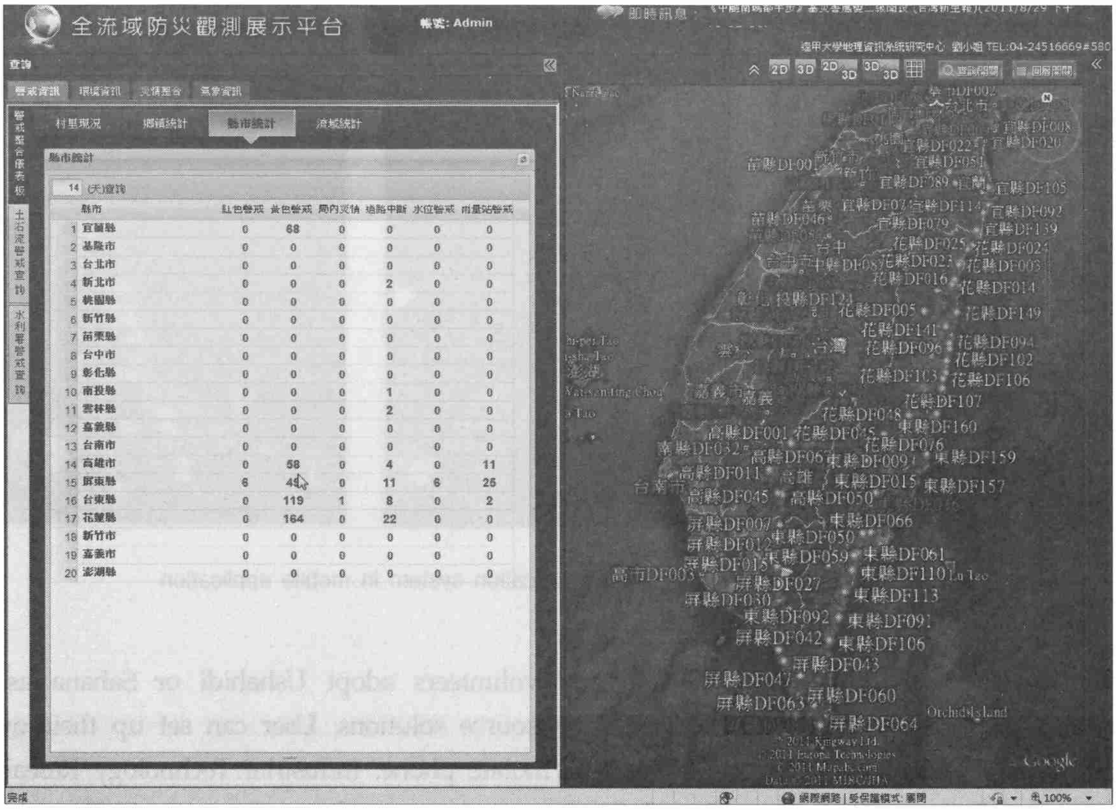

Figure 3. Watershed- based disaster preparation and observation platform

2. Geospatial development in Taiwan

2.1 Volunteered geographic information (VGI)

Due to internet and mobile facilities, spatial information application are one of the booming market in recent years, Volunteered Geographic Information has become more and more popular in Taiwan. One can find easily in many public participation applications for map mapping and disaster response and recovery through VGI. National Science and Technology Center for Disaster Reduction (NCDR) develops IOS and Android Apps to share near real-time weather forecast information, precipitation and debris flow alert and disaster event. Fig. 4 shows graphical user interface in disaster information communication system apps.

Figure 4. Disaster information communication system in mobile application

Non-governmental organization (NGO) and volunteers adopt Ushahidi or Sahana as a platform for disaster response which are open source solutions. User can set up their own platform to gather disaster reports by web or mobile phone. Industrial Technology Research Institute of Taiwan (ITRI) has shipped five smart phones with an Open GeoSMS enabled Ushahidi app installed to Samoa for the Cyclone Simulation activity. Fig. 5 shows the concept of disaster report by OpenGeoSMS and deliver post image which is based on cloud platform.

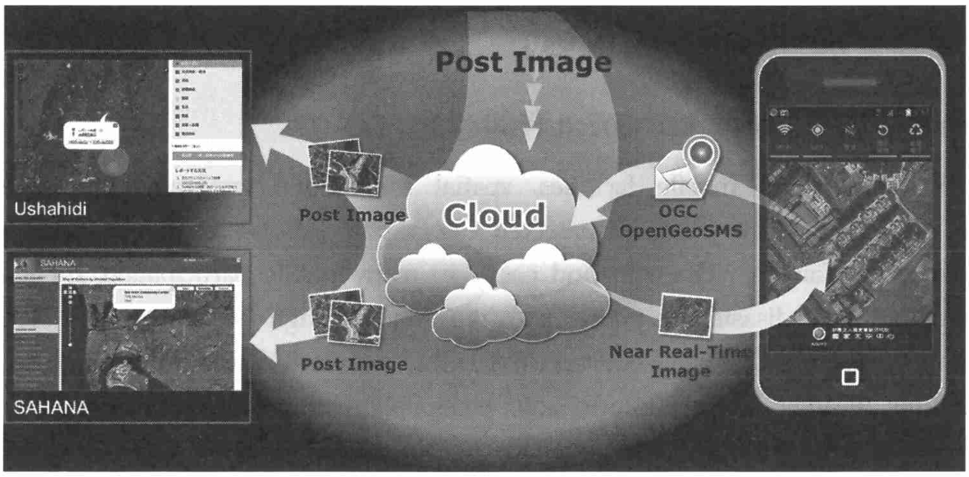

Figure 5. Disaster report by OpenGeoSMS and open data platform

2.2 International cooperation

Earth Observation is an interdisciplinary science which needs various disciplines and technologies to be integrated and interoperate among those heterogeneous individuals to fulfill the goal of several societal beneficial areas (such as climates, disaster, food, health, etc.).

The Group on Earth Observations (GEO) is coordinating efforts to build a Global Earth Observation System of Systems (GEOSS). GEO was launched in response to calls for action by the 2002 World Summit on Sustainable Development and by the G8 (Group of Eight) leading industrialized countries. These high-level meetings recognized that international collaboration is essential for exploiting the growing potential of Earth observations to support decision making in an increasingly complex and environmentally stressed world.

The architecture of GEOSS was developed by OGC (Open Geospatial Consortium); the purpose of GEOSS is to integrate the heterogeneous monitoring systems which are de facto existed in the world into a huge global monitoring network by using the open standards. The Open Geospatial Consortium (OGC) is an international industry consortium of over 400 companies, government agencies and universities participating in a consensus process to develop publicly available interface standards. OpenGIS® Standards support interoperable solutions that "geo-enable" the Web, wireless and location-based services, and mainstream IT. The standards empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications.

Taiwan is aiming at the de facto participation in GEO and OGC, as the principal member of OGC, Feng Chia university has been involving in OGC's research and initiatives since 2008, and successfully participate in GEO Architecture Implementation Pilot (AIP) serious initiatives by means of the member of OGC, furthermore, one researcher in this project has been nominated by OGC as the member of GEOSS post 2015 working group and has been approved by GEO. In AIP-3 project, Feng Chia University cooperated with SPOT Image Company and University of Heidelberg to involve in disaster management working group (DMWG). DMWG proposed the concept of near real-time vehicle dispatching and implemented. Fig. 6 shows the snapshot of emergency vehicle dispatching system. With those previous successful tasks, the goal of this project are will support the research faculties in the project will increase the depth and breadth of participation in GEO and OGC.

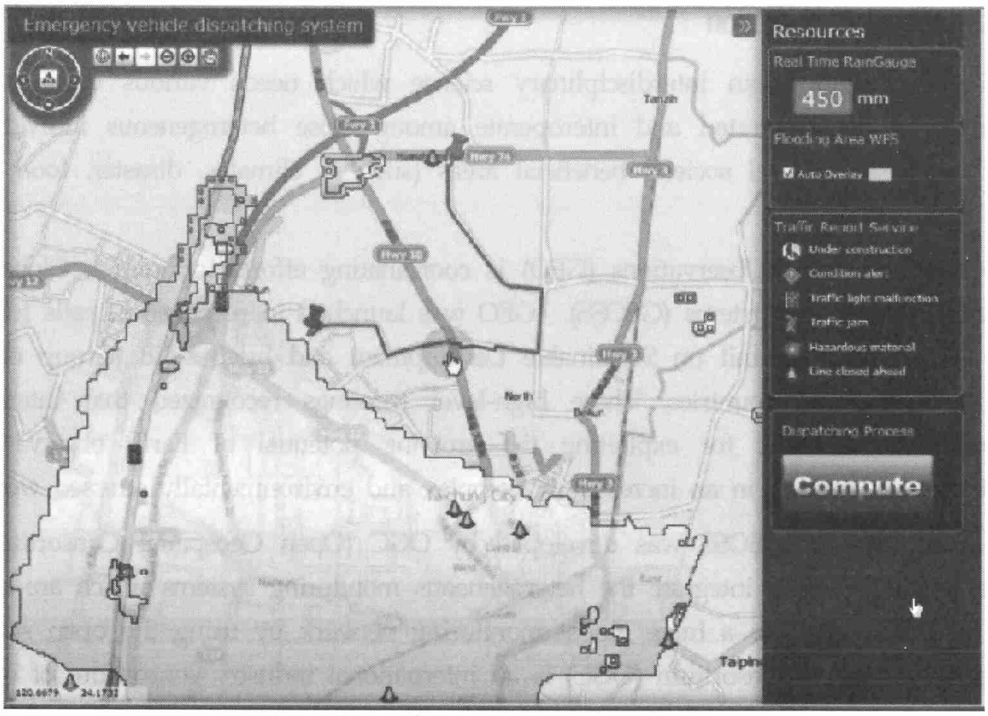

Figure 6. near real- time vehicle dispatching system in GEOSS AIP-3

2.3 Satellite Images Support

National space Organization (NSPO), one of independent non-profit institute under National Applied Research Laboratories (NARL), was established in 2003 to promote the development of space technique and take charge of manipulating the FORMOSAT series of Earth observation satellites in Taiwan.

Taiwan successfully launched the FORMOSAT-1, FORMOSAT-2, and FORMOSAT-3 satellites in 1999, 2004, and 2006, respectively. FORMOSAT-1 is a scientific satellite that completed three scientific missions: ocean-color imaging, ionosphere plasma and electrodynamics measurement, and Ka-band (20-30GHz) communication experiments. Although this satellite ended its mission in June 2004, FORMOSAT-1 has successfully gathered more than 5.5 years of data for oceanography and ionosphere studies. For instance, ocean-color imaging data is very useful for analyzing pigment distributions in the ocean and aerosol density in the atmosphere at the middle latitudes. All this information is available on the National Space Organization's (NSPO) website and can be easily accessed by the public.

FORMOSAT-2 is a high-resolution electric-optical (EO) type remote sensing satellite with a secondary scientific payload to observe the natural upward lighting discharge phenomenon. FORMOSAT-2 was successfully launched on May 21, 2004. With high resolution of 2 meter panchromatic data and 8 meter multispectral satellite image data., images taken by FORMOSAT-2 not only fulfilling Taiwan civilian needs on land utilization, agricultural and forest planning, disaster assessments, and environmental monitoring but are also being distributed to international users for specific applications. FORMOSAT-2 operates in a sun-synchronous orbit with revisit time equal to one day. The unique feature of this daily revisit capability is significantly useful for post disaster assessment and environmental monitoring.

Figure 7a. FS22m panchromatic - July 2004

Figure 7b. FS2 8m multispectral - May 2005

(http://www.satimagingcorp.com/gallery-formosat-2.html)

Taiwan has been providing FORMOSAT-2 images to free of charge for humanity relief usage through international organizations including International Charter (58 contributions since 2006), Planet Action (16 contributions since 2008), Sentinel Asia (2 contribution since June 2010), and various academic communities, some significant events, including the Southern Asian tsunami (December 2004), Hurricane Katrina (August, 2005), northern Pakistan earthquake (October 2005), landslide in the Philippines (March 2006), Indonesia earthquake (May 2006), California wildfire (October 2007), Antarctic Wilkins Ice Shelf disintegration (March 2008), Sichuan earthquake (May 2008), Haiti earthquake (January 2010), Chile earthquake, (February 2010), and Japan 311 earthquake and tsunami (March 2011). With the unique daily revisit capability, FORMOSAT-2 has quick access to disaster areas and can provide continue monitoring information useful for rescue planning. As an example, FORMOSAT-2 images of the Southern Asian tsunami have been posted on the NSPO's website since December 30, 2004. As of January 4, 2005, more than 900 users from

70 countries have downloaded FOMOSAT-2 images for disaster relief and other uses.

The other example is Japan 311 earthquake and tsunami. The Sendai earthquake and tsunami was a 9.0 Richter magnitude scale earthquake that occurred at 05:46 UTC (14:46 local time) on March 11, 2011. The earthquake triggered tsunami waves of up to 10 meters that struck Japan's northern-east Pacific coast and caused extensive damage in Japan. With the daily revisit feature of FORMOSAT-2, NSPO immediately trigged the FORMOSAT-2 emergent image tasking and successfully took the satellite images on March 12, 2011. These 2-m resolution images have been distributed to associated domestic and foreign research institutes for further image processing and analysis. In addition, NSPO has also forwarded the FORMOSAT-2 images to Sentinel Asia in support of disaster management activity in the Asia-Pacific region, as shown in Fig. 8.

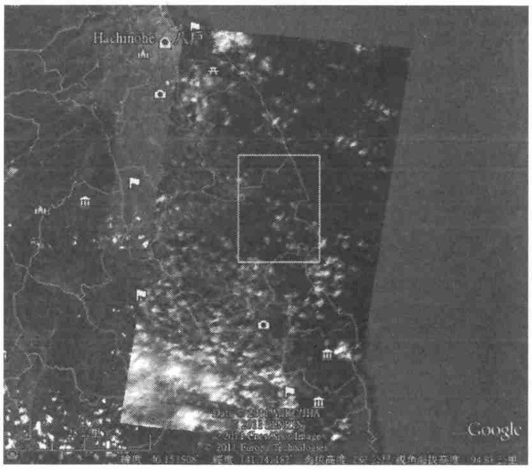

Figure 8a. Quick look images of FS2 in Iwate

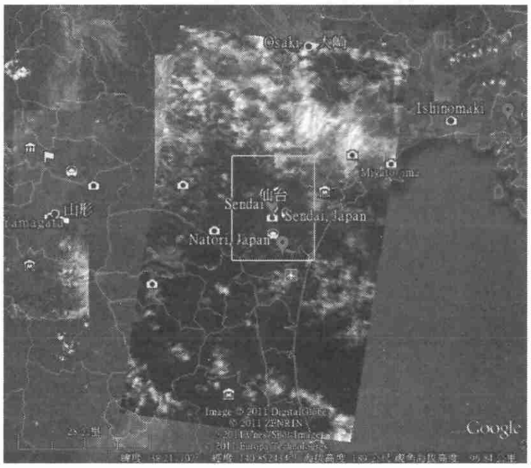

Figure 8b. Quick look images of FS2 in Sendai area

(http://www.nspo.org.tw/Japan_Earthquake/en/Japan_Earthquake-0312.htm)

NASA was also adopted and posted FORMOSAT-2 images for the post-disaster assessment, such as California wildfire, Hurricane Katrina, and Sichuan earthquake, etc., in NASA's Earth Observatory website. These demonstrate Taiwan's positive contribution and its willingness to share resources with the international community wherever and whenever needed. Based on the FOMOSAT-2 image data, Taiwan is implementing a globally unique 3D High-resolution GEO lab dedicating for decision support to natural disaster prevention and environmental monitoring. The lab is on international basis and will be open to international community for cyber education and research collaboration. Moreover, Taiwan has joined the other international environmental observation organizations, such as GLEON

(Global Lake Environmental Observation Network) and CREON (Coral Reef Environmental Observation Network) to contribute on the development of cyber technologies and knowledge base for international sharing and collaboration.

3. Geospatial Interoperability and Cloud Development

3.1 Service-oriented architecture (SOA) in Taiwan

Service-oriented architecture (SOA) is a set of principles and methodologies for designing and developing software in the form of interoperable services. (Wiki definition) SOA is the mechanism about machine to machine based on opaque chaining.

The service-oriented architecture has been seen with several typical applications during its development on NGIS in recent years. The SOA examples in Taiwan are MOI (Taiwan Geospatial One Stop; TGOS), W.R.A. (Water Resources Information Service Platform; WRISP), the Institute of Transport, MOTC, etc. TGOS stands for a NGIS Data warehouse and web service one-stop portal which provide metadata query, geospatial data overlay, free geospatial data download and web services query\apply. Fig. 9 shows the map display platform of TGOS.

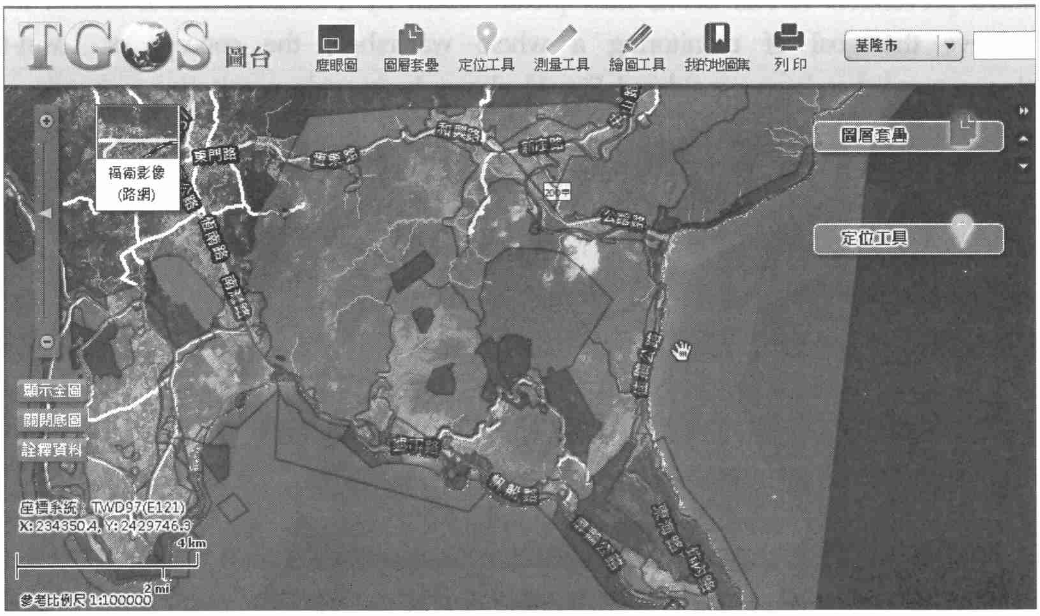

Figure 9. Taiwan Geospatial One Stop platform

The GIS contents have come to include the sensors since the 911 incident in U.S. in 2001. In the wake of Taiwan's 88 Flood, particularly, the integration of sensor information became part of government's major executive contents. Also included in this issue are the latest results and applications of the debris flow observation on OGC SWE architecture, which makes the Soil and Water Conservation Bureau, Council of Agriculture internationally proud. Further included is the world's latest development on the technology of service-oriented architecture, e.g., event-driven service-oriented architecture and cloud algorithm.

Nowadays, the administration and execution of disaster monitoring in Taiwan are able to achieve the goal of overall monitoring with the assistance of various tools and technology distributed in different organizations under Service-oriented architecture. The Soil and Water Conservation Bureau (SWCB) has developed and established on-site and mobile stations to observe debris flows in Taiwan. There are 17 on-site monitoring stations installed along a debris-flow-prone stream and 3 mobile stations in this network. The instruments used for monitoring include rain gauges, wire sensors, geophones, soil moisture sensors, water level meters, and CCD cameras. The monitoring stations works for 24/7 to collect data from the site, providing useful information for debris flow researches and hazard response tasks. The monitoring system has been proved to be useful for emergency response regarding debris flow hazards. The current monitoring system has well operated as expected and had helped SWCB and Executive Yuan on recent typhoon events regarding the debris flow hazard prevention. A real debris flow picture taken by a CCD camera is shown in Fig. 10.To achieve the goal of monitoring a whole watershed, the concept of basin-wide monitoring network has been considered Fig. 11 shows basin-wide monitoring network.

Figure 10. Snapshot of the debris flow in Ai-Yu-Zi River at Shen-Mu Village, Nantou County, Taiwan, on August 8, 2009, during Typhoon Morakot (Lee etc., 2010)

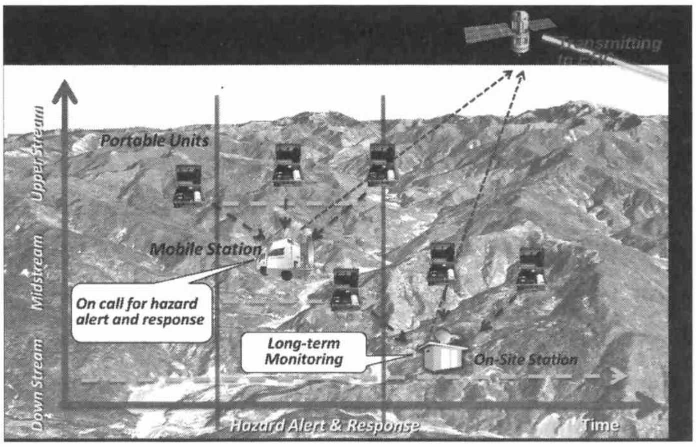

Figure 11. Basin-wide monitoring network (Wang etc., 2011)

All debris flow stations have at least 400 sensors. One of the important issues of debris flow monitoring system is sensor data integration. To achieve the goal of data sharing and information integration, the Sensor Web Enablement (SWE) framework was implemented in the debris flow monitoring system. Fig.12 shows the overview of the monitoring scenario.

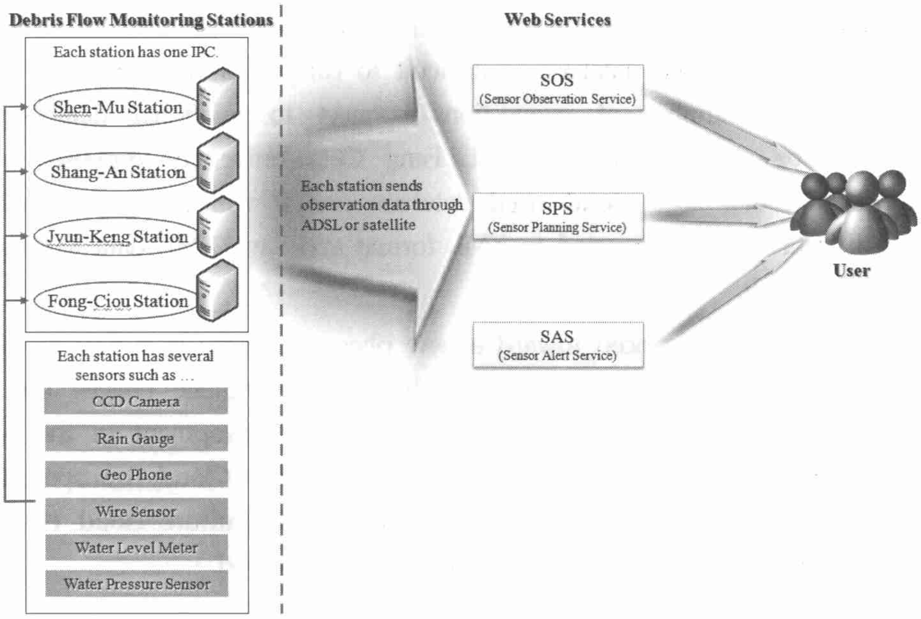

Figure 12. Overview of Monitoring Scenario

3.2 Cloud Computing

Cloud computing is the use of computing resources (hardware and software) that are delivered as a service over a network (typically the Internet). The name comes from the use of a cloud-shaped symbol as an abstraction for the complex infrastructure it contains in system diagrams. Cloud computing entrusts remote services with a user's data, software and computation. (Wiki definition) The cloud computing is considered to solve the large-scale of data analysis and storage problem. One of the characteristics of the cloud computing is high extendibility, flexibility and high fault tolerance. The cloud computing is used in distributed architecture which the data stored in distributed nodes in cloud and it can effectively improve the problem of overloading on a single server.

In Taiwan, due to cloud computing is booming in recent years, government agencies and private companies involve adopting this technique to solve data storage, computing capability and applications. Delta Electronics, Quanta computer, Trend Micro Incorporated are the examples involving the development of cloud computing in Taiwan. Feng Chia University adopts Hadoop to deal with 4.5 EXA byte lunar sensor data from KAGUYA satellite cooperate with AIST, NIES and AIT.

Another example of cloud computing is the cloud-based sensor data warehouse. The sensor data has a characteristic of time and daily capacity usage is calculated in GBs of data. The traditional relational database is difficult to carry such large-scale of data access. In addition, a large number of connections connect to relational database that the performance will be significantly decreased. Feng Chia university proposes an idea of manage sensor data that used cloud-based database and it will increase the efficiency of database I/O if data can be converted to XML format and save XML data to single column under experiment result.

NGIS applications have advanced toward a new phase, not only is it possible to integrate various matured information technologies to achieve the synthetic effects, but also it is possible to bring in the techniques and concepts under development in the world (e.g., service-oriented architecture, grid and cloud algorithm).TGOS Cloud, transportation cloud, water resource cloud, police cloud, education cloud and agriculture cloud etc. have been submitted since 2012. Fig. 13 is the whole picture of TGOS cloud.

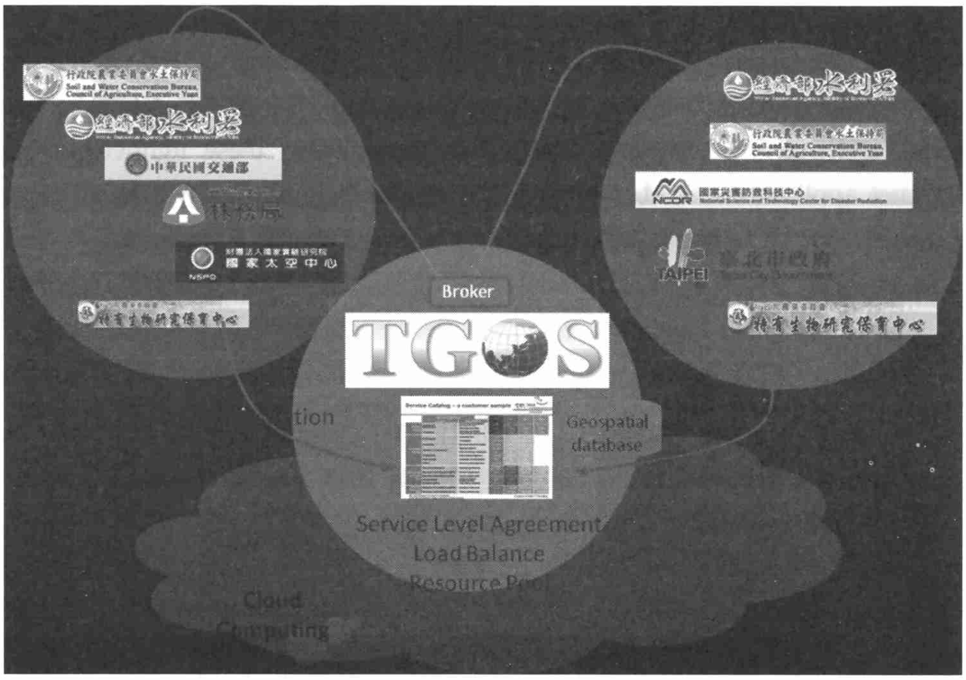

Figure 13. Overview of Monitoring Scenario

4. Conclusion

The application of knowledge created by Geospatial technologies has long been held back by difficulties in sharing information between different agencies, organizations and even between different functions within same institute. NGIS is a broad term for systems that are designed to enable collaboration and wider sharing of spatial data in Taiwan. The development of interoperability standards - notably from the Open Geospatial Consortium (OGC), ISO and W3C - is driving a new generation SDIs that enable data to be discovered and used seamlessly and without being tied to one or other GIS product.

GIS should be regarded more than single software package; it is an enterprise architecture undertaking and also an opportunity to improve the accessibility and utility of existing spatial data holdings. As well as facilitate data sharing between users, data standardized investment can enable simple, agile and sustainable integration of spatial information with other business systems and processes.

GIS services go beyond simple maps and images are coming, there will be lots of services available for both public and private sectors on the open Web. Services will be standards-based, open and interoperable and mash-able. One can easily orchestrate multiple services to support new applications, and this orchestration will include things like integrating ERP databases with maps or embedding maps inside of ERP applications using SOAP and traditional Web services architectures. Multiple kinds of data sets, map layers and database tables will be brought together dynamically in these lightweight applications as rich Internet applications. And, definitely, geospatial technologies will be more compatible with the mainstream IT technologies but still keep its geospatial uniqueness.

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http://lui.nlsc.gov.tw/LUWeb/Eng/Content_e.aspx

http://www.opengeospatial.org/node/1520

http://www.narl.org.tw/en/about_us/

http://www.satimagingcorp.com/gallery-formosat-2.html

http://www.nspo.org.tw/Japan_Earthquake/en/Japan_Earthquake-0312.htm

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http://en.wikipedia.org/wiki/Cloud_computing

http://www.gis.tw/zh-TW/News/Detail/235

http://www.ogcnetwork.net/pub/ogcnetwork/GEOSS/AIP3/pages/Demo.html

International Conference on sharing Geospatial Technology, Experience, Knowledge 2012

National GIS Strategic Development toward Geospatial Interoperability Application in Taiwan

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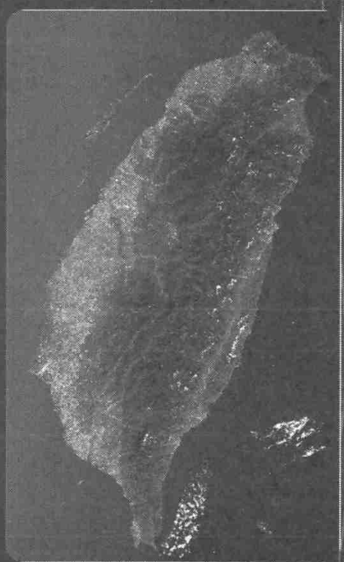
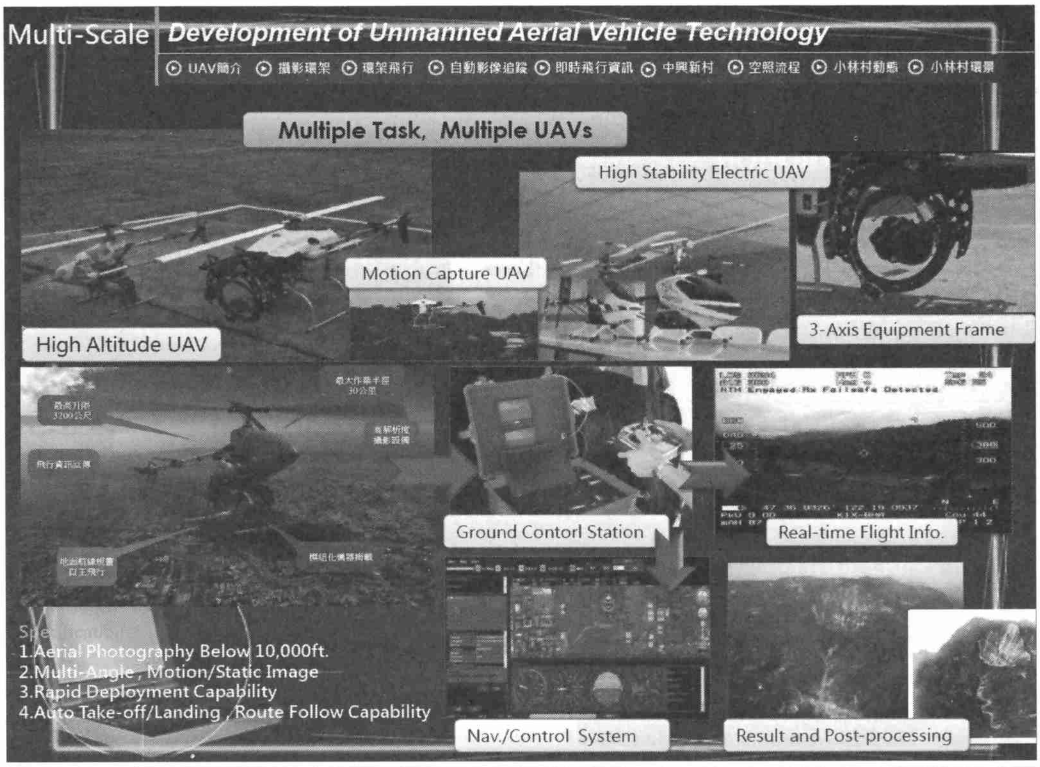
OGC Compliance Testing Center

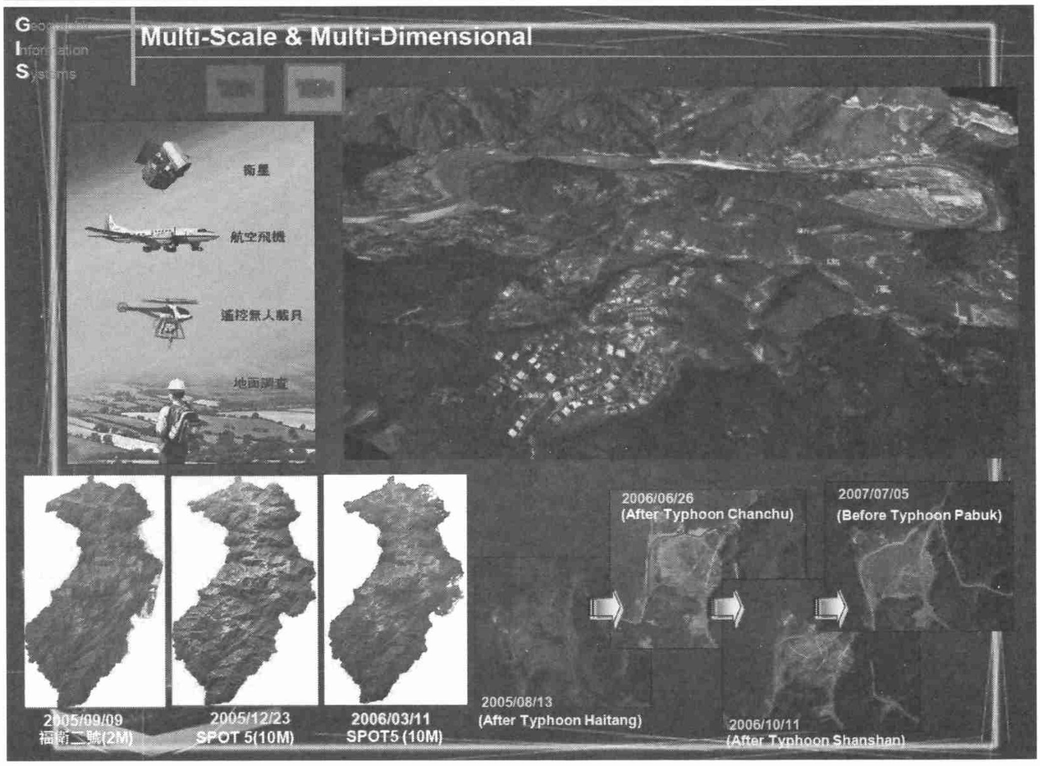
GIS.FCU

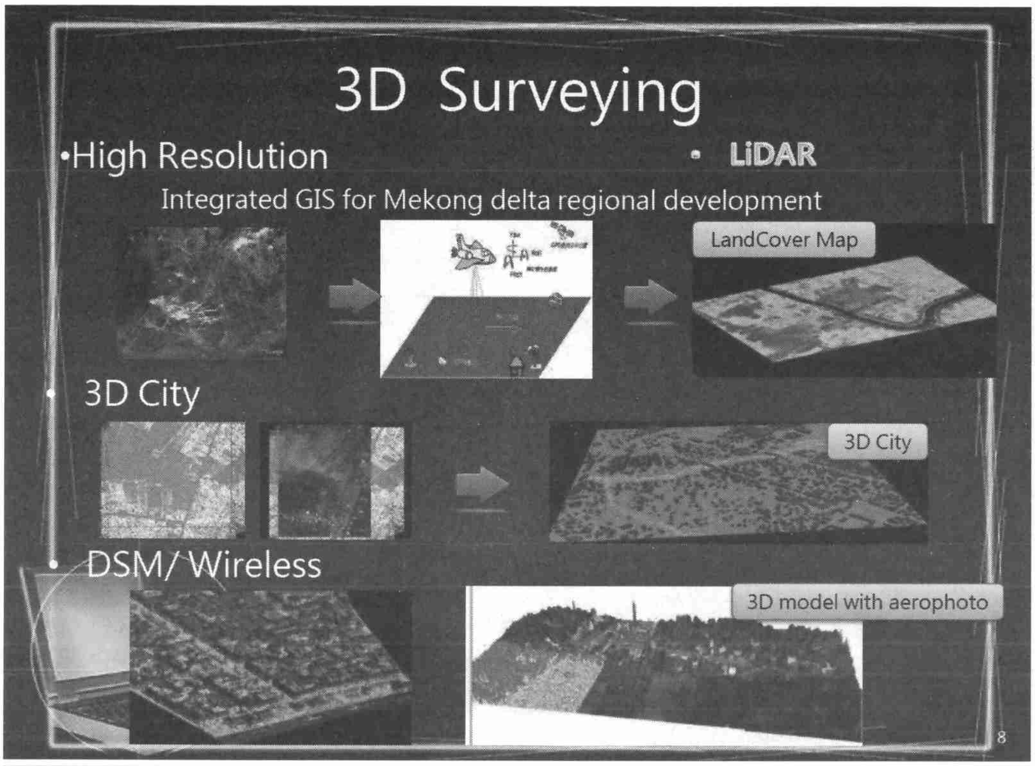
Taiwan

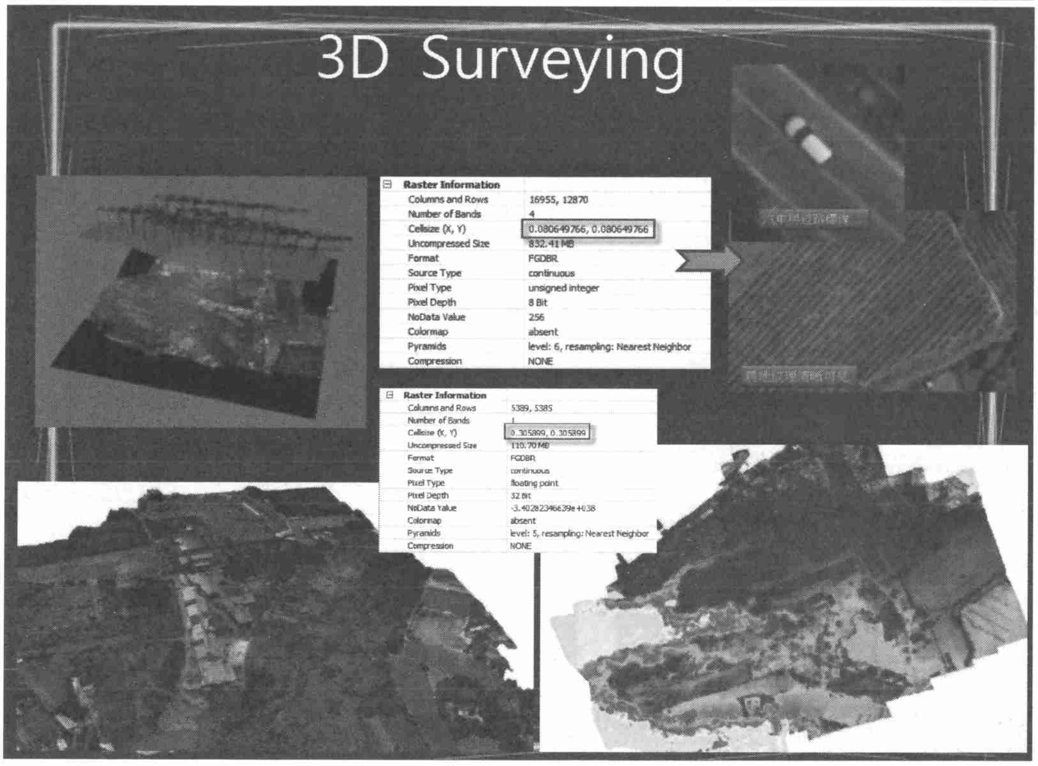
- Terrain :
  - 36,000 Km2 with 26,000 Km2 slope land (73%)
  - peak: 3952 m
- Population ：
  - 23 million
- Land use ：
  - Flat land: 24%
  - permanent crops: 1%
  - forests and woodland: 55%
  - other: 20%
- Natural hazards ：
  - earthquakes and typhoons.

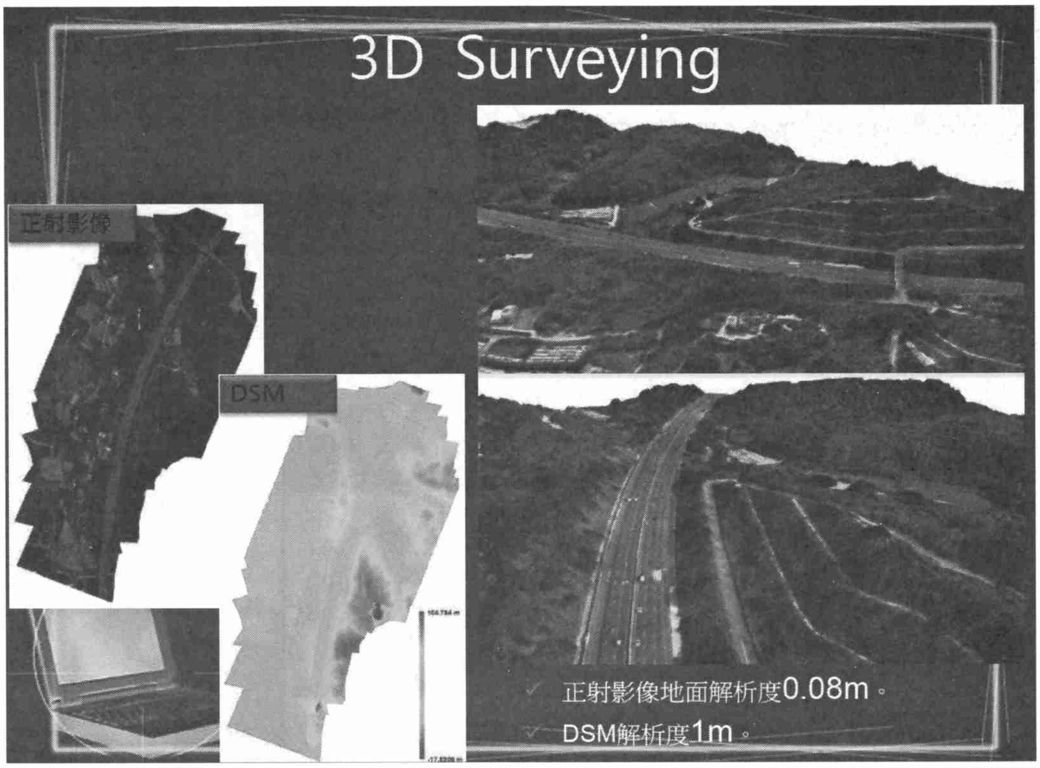


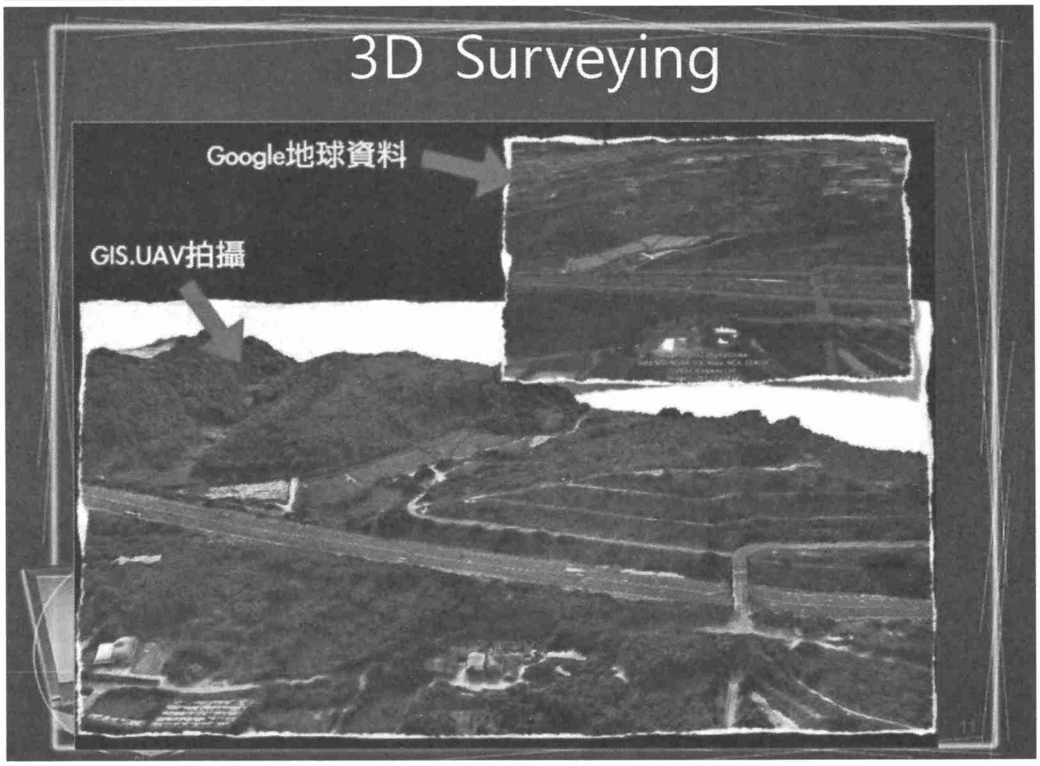

Multi-Scale
Development of Unmanned Aerial Vehicle Technology
UAV簡介
攝影環架
環架飛行
自動影像追蹤
即時飛行資訊
中興新村
空照流程
小林村動態
小林村環景
Multiple Task, Multiple UAVs
High Stability Electric UAV
Motion Capture UAV
High Altitude UAV
3-Axis Equipment Frame
Ground Contorl Station
Real-time Flight Info.
1.Aerial Photography Below 10,000ft.
2.Multi-Angle , Motion/Static Image
3.Rapid Deployment Capability
4.Auto Take-off/Landing , Route Follow Capability
Nav./Control System
Result and Post-processing

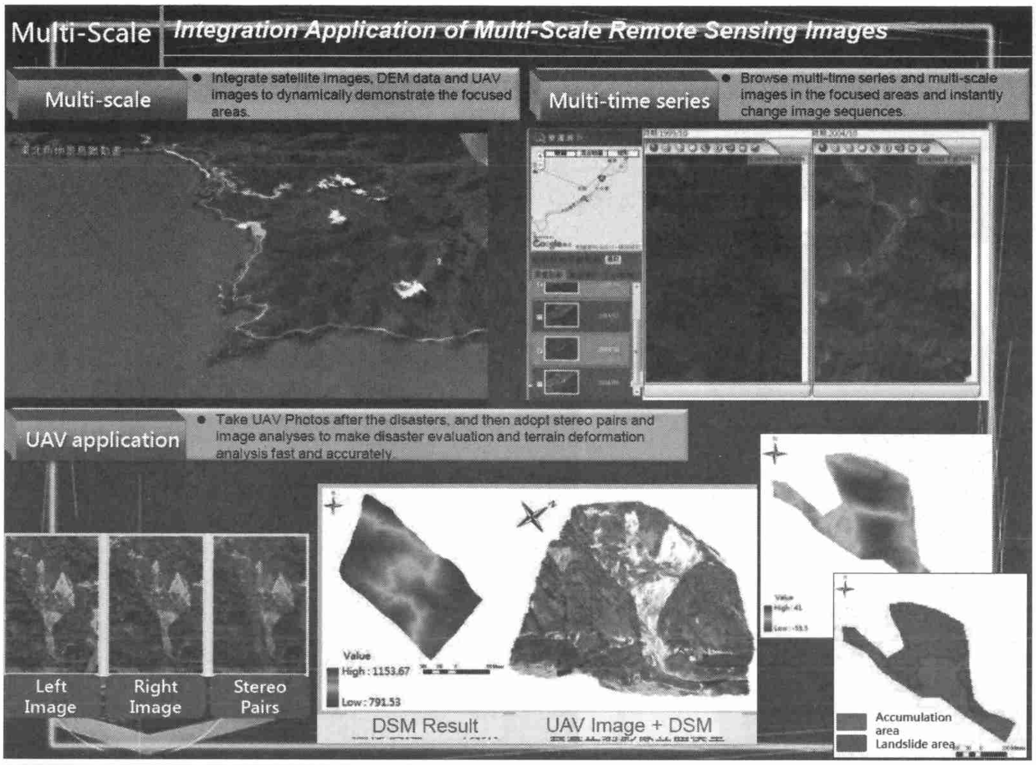

Multi-Scale & Multi-Dimensional
衛星
航空飛機
遙控無人載具
地面調查
2005/09/09
2005/12/23
SPOT 5(10M)
2006/03/11
SPOT5 (10M)
2005/08/13
(After Typhoon Haitang)
2006/06/26
(After Typhoon Chanchu)
2006/10/11
(After Typhoon Shanshan)
2007/07/05
(Before Typhoon Pabuk)

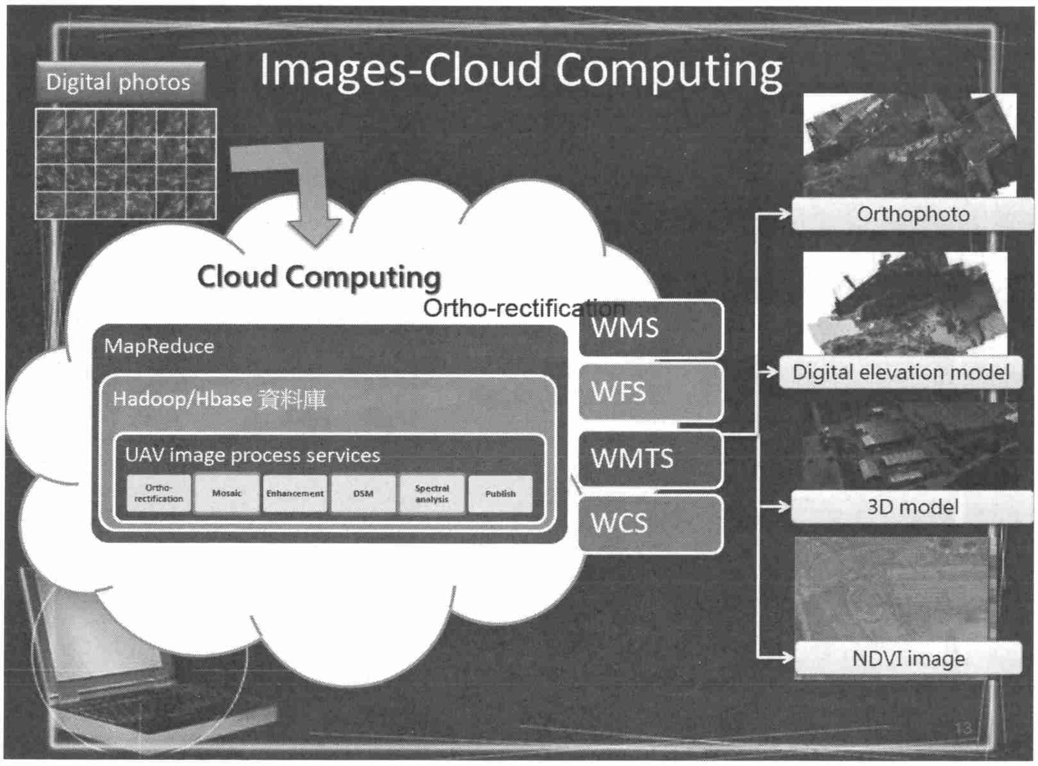

3D Surveying
•High Resolution
• LiDAR
Integrated GIS for Mekong delta regional development
LandCover Map
3D City
3D City
DSM/ Wireless
3D model with aerophoto
8

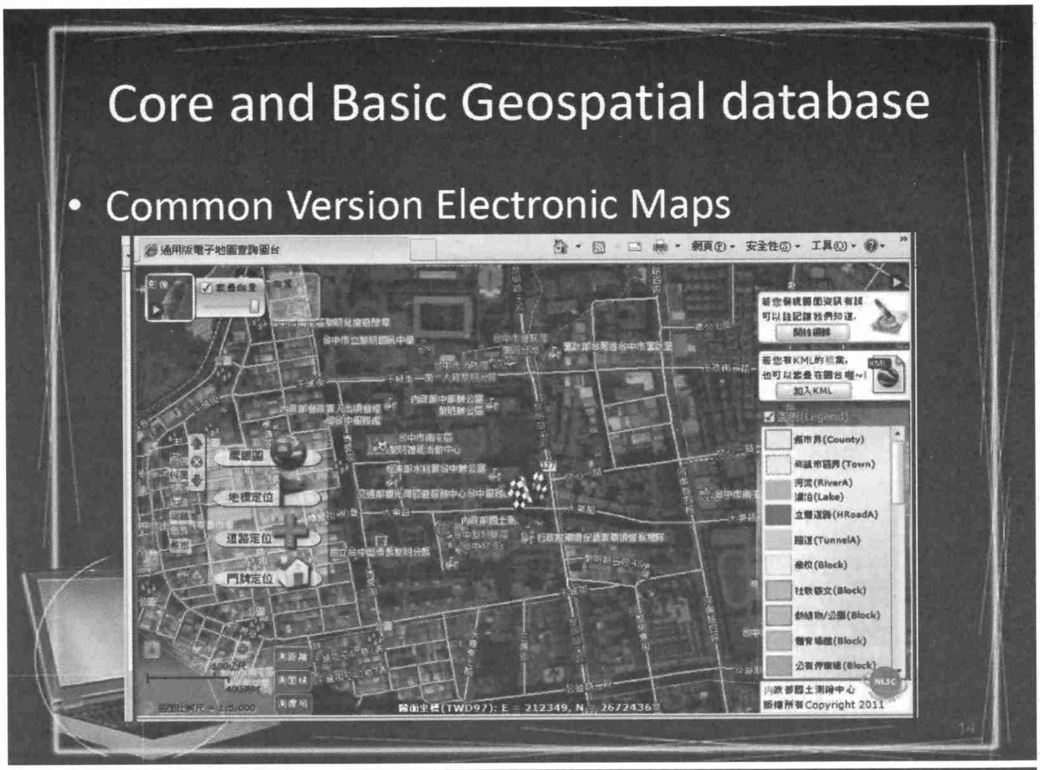

3D Surveying
Raster Information
Columns and Rows 16955, 12870
Number of Bands 4
Cellsize (X, Y) 0.080649766, 0.080649766
Uncompressed Size 832.41 MB
Format FGDBR
Source Type continuous
Pixel Type unsigned integer
Pixel Depth 8 Bit
NoData Value 256
Colormap absent
Pyramids level: 6, resampling: Nearest Neighbor
Compression NONE
Raster Information
Columns and Rows 5389, 5385
Number of Bands 1
Cellsize (X, Y) 0.305899, 0.305899
Uncompressed Size 110.70 MB
Format FGDBR
Source Type continuous
Pixel Type floating point
Pixel Depth 32 Bit
NoData Value -3.40282346639e+038
Colormap absent
Pyramids level: 5, resampling: Nearest Neighbor
Compression NONE

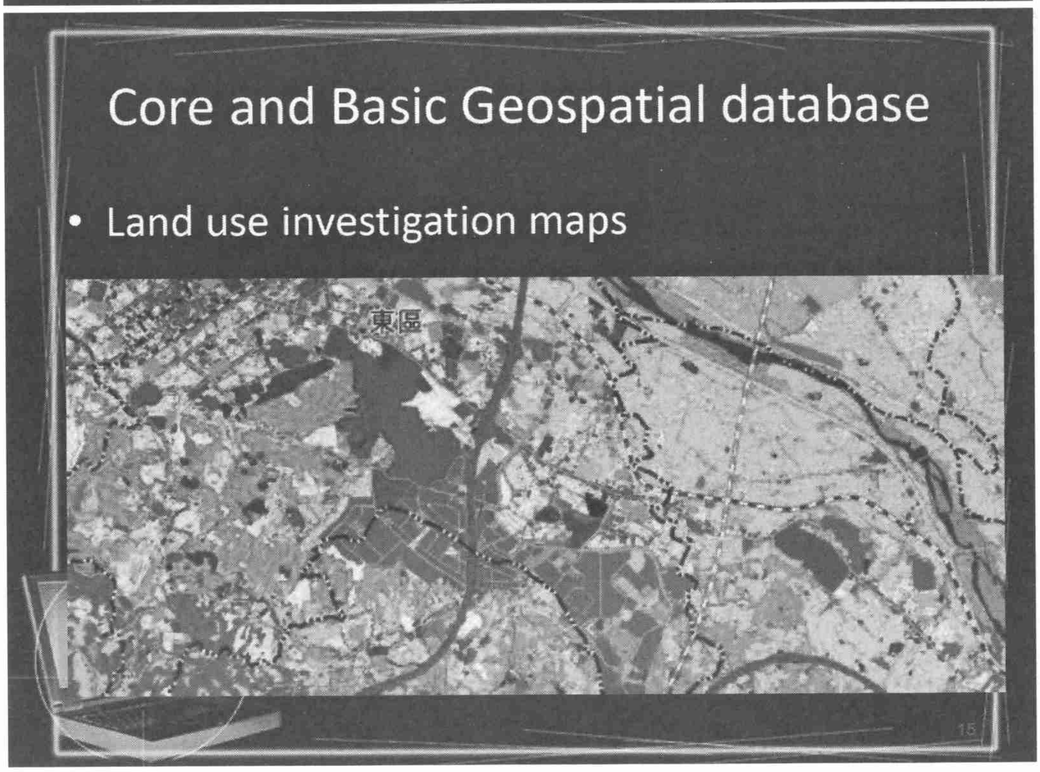

3D Surveying
正射影像
DSM
正射影像地面解析度0.08m。
DSM解析度1m。

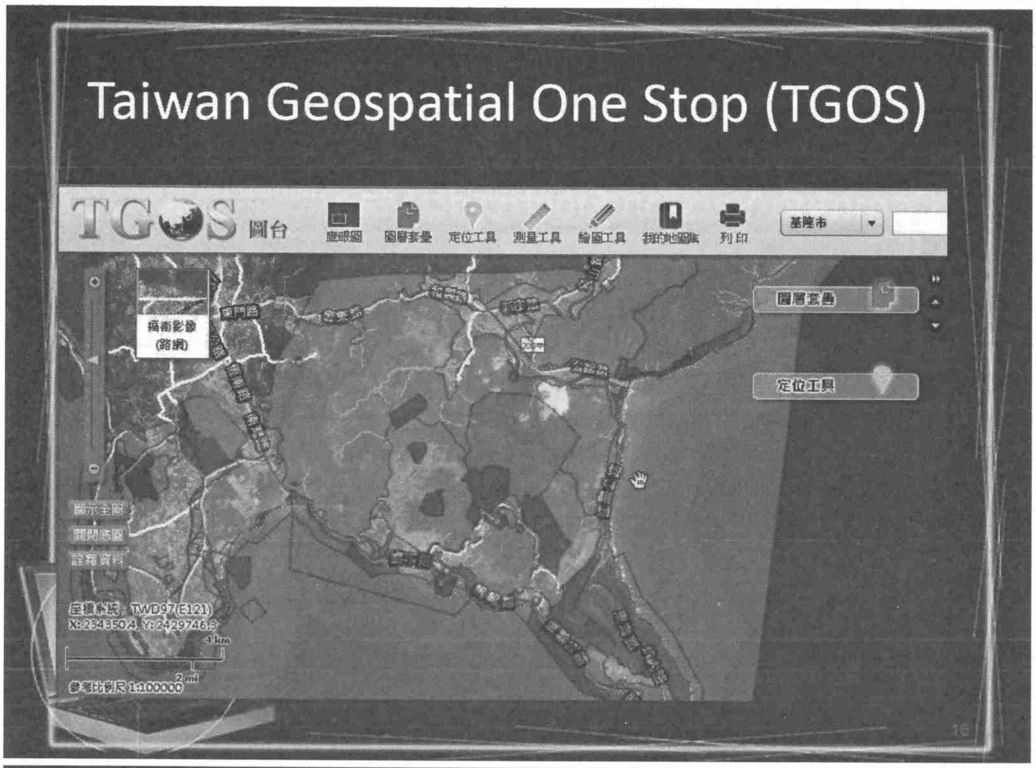

3D Surveying
Google地球資料
GIS.UAV拍攝

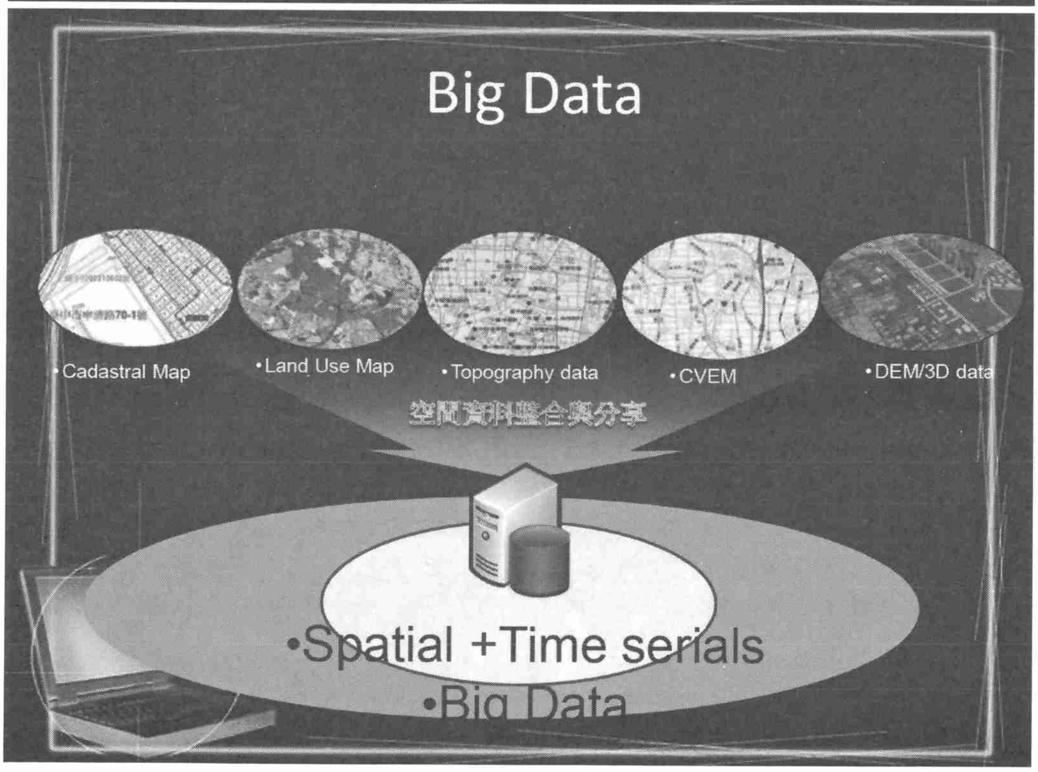

Multi-Scale
Integration Application of Multi-Scale Remote Sensing Images
Multi-scale
Integrate satellite images, DEM data and UAV images to dynamically demonstrate the focused areas.
Multi-time series
Browse multi-time series and multi-scale images in the focused areas and instantly change image sequences.
UAV application
Take UAV Photos after the disasters, and then adopt stereo pairs and image analyses to make disaster evaluation and terrain deformation analysis fast and accurately.
Left Image
Right Image
Stereo Pairs
Value
High : 1153.67
Low : 791.53
DSM Result
UAV Image + DSM
Accumulation area
Landslide area

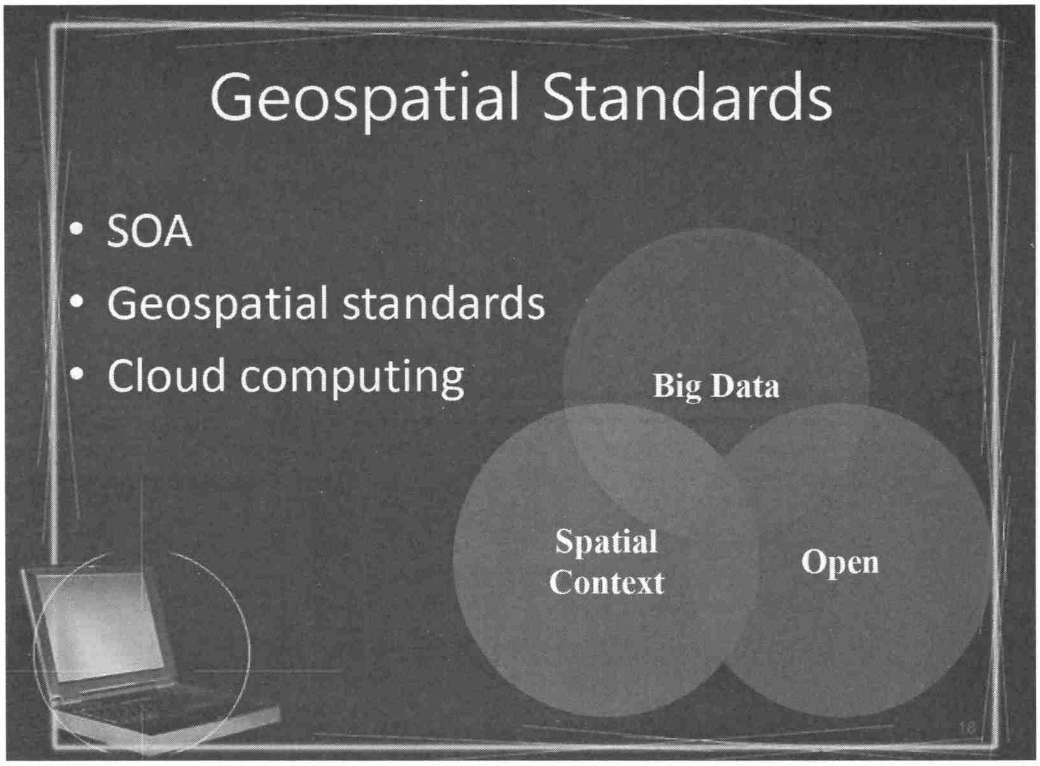

Images-Cloud Computing
Digital photos
Cloud Computing
Ortho-rectification
MapReduce
Hadoop/Hbase 資料庫
UAV image process services
Ortho-rectification
Mosaic
Enhancement
DSM
Spectral analysis
Publish
WMS
WFS
WMTS
WCS
Orthophoto
Digital elevation model
3D model
NDVI image

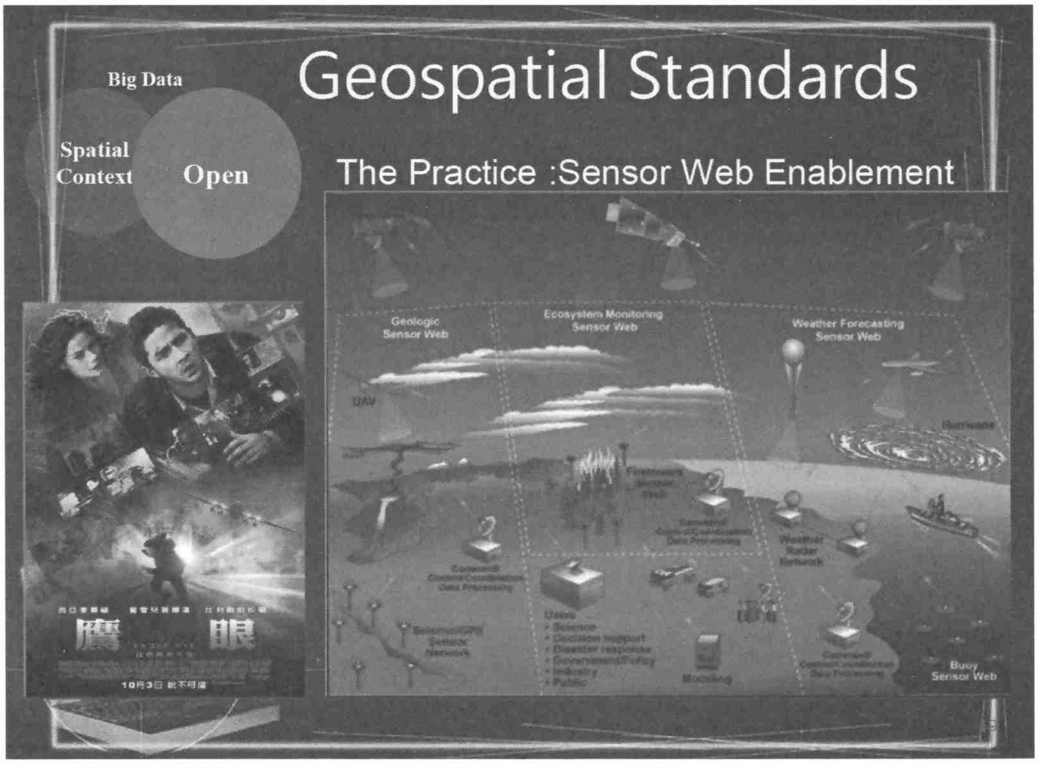

Core and Basic Geospatial database
• Common Version Electronic Maps

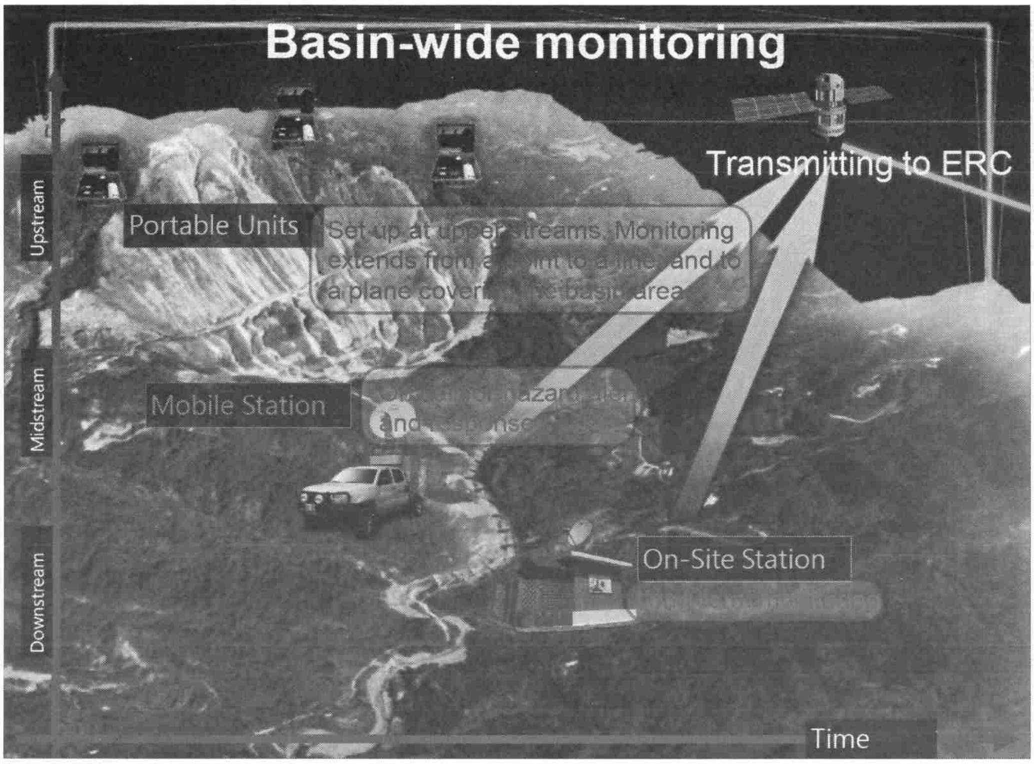

Core and Basic Geospatial database
• Land use investigation maps
東區

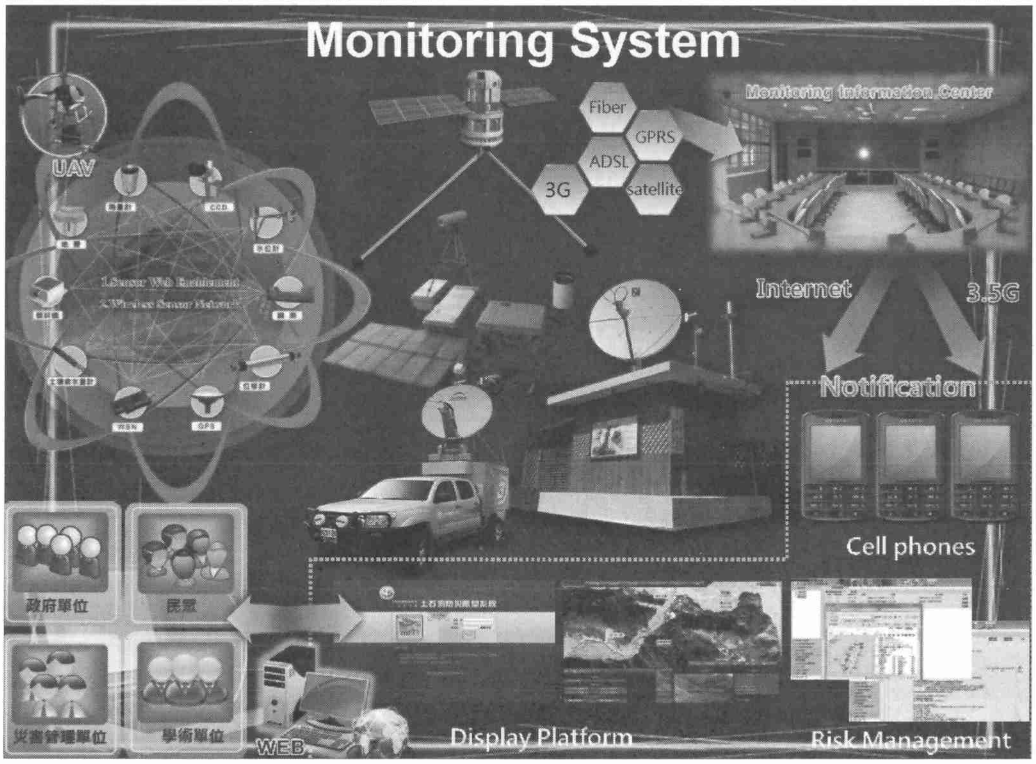

Taiwan Geospatial One Stop (TGOS)
TGOS 圖台
底圖
圖層套疊
定位工具
測量工具
繪圖工具
我的地圖庫
列印
基隆市
圖層套疊
定位工具
參考比例尺 1:100000

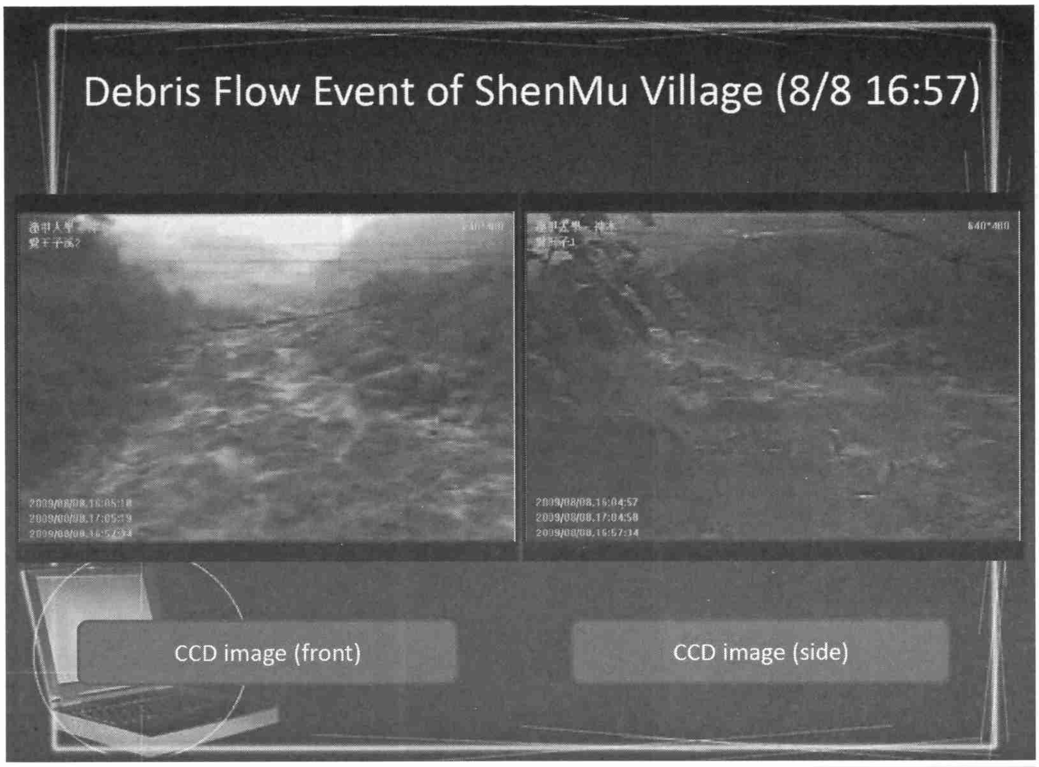

Big Data
•Cadastral Map
•Land Use Map
•Topography data
•CVEM
•DEM/3D data
空間資料整合與分享
•Spatial +Time serials
•Big Data

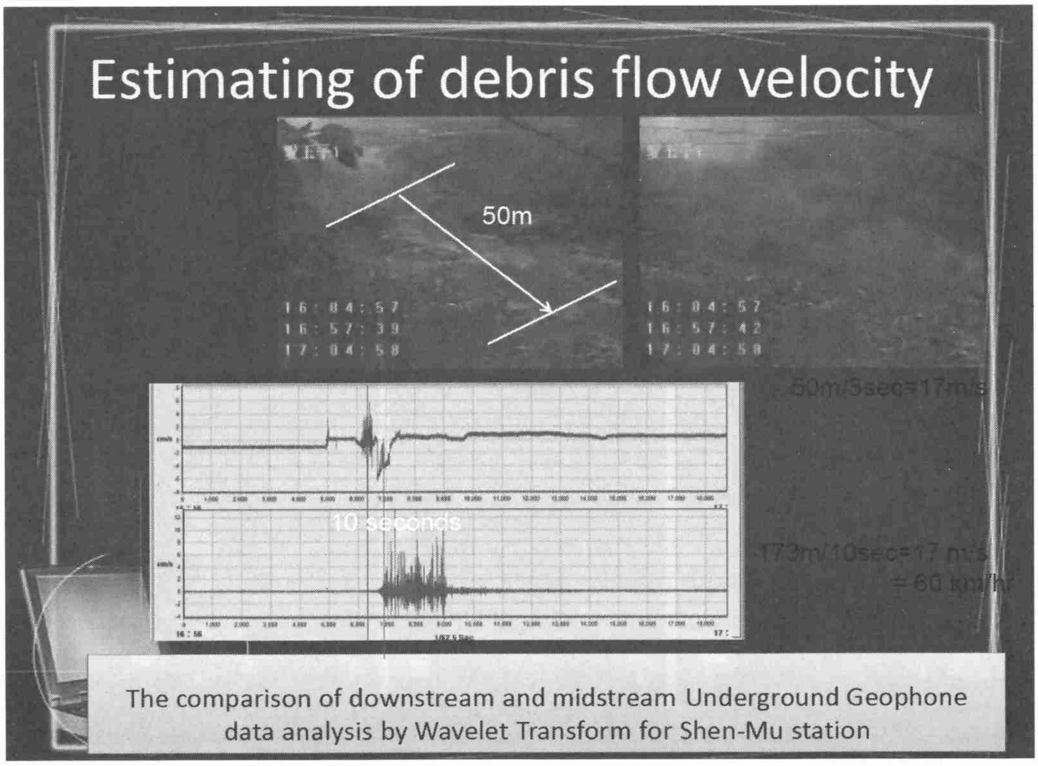

Geospatial Standards
• SOA
• Geospatial standards
• Cloud computing
Big Data
Spatial Context
Open

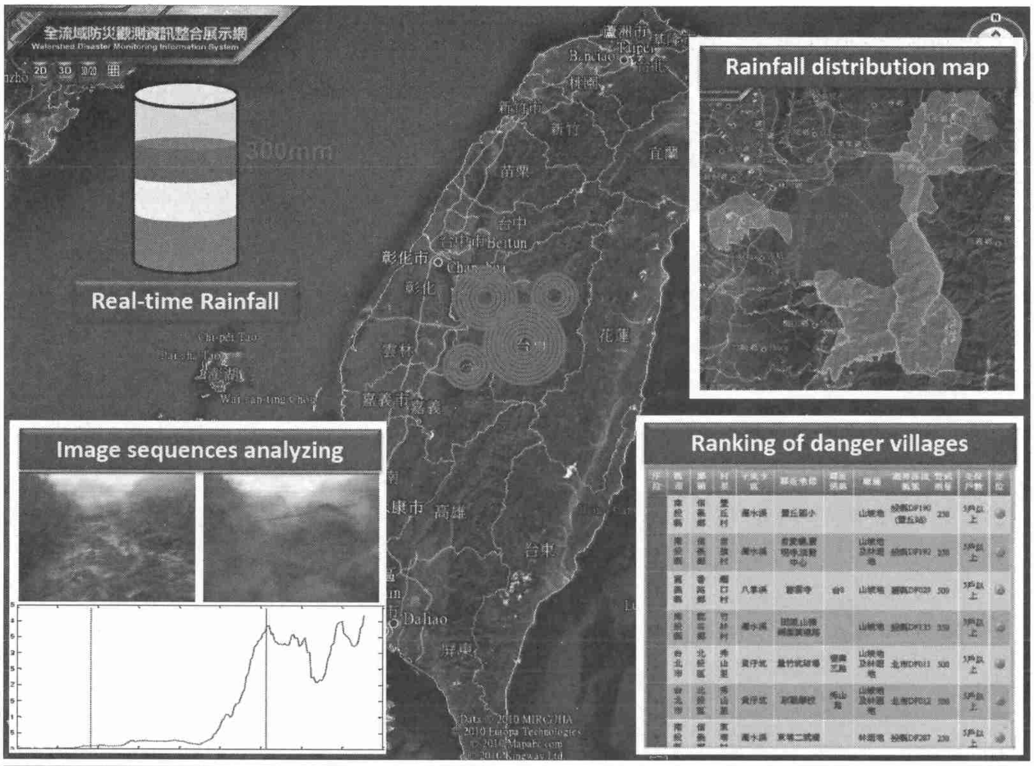

Big Data
Spatial Context
Open
Geospatial Standards
The Practice :Sensor Web Enablement
Geologic Sensor Web
Ecosystem Monitoring Sensor Web
Weather Forecasting Sensor Web
UAV
Buoy Sensor Web
Modeling
鷹
眼

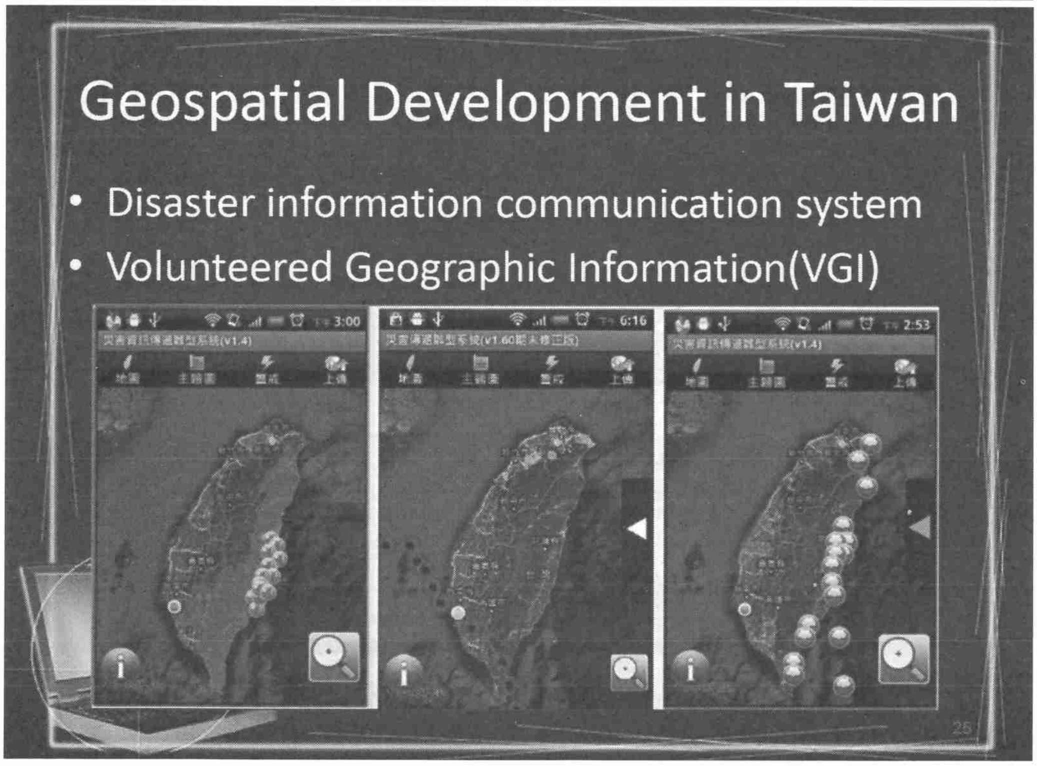

Basin-wide monitoring
Transmitting to ERC
Upstream
Midstream
Downstream
Portable Units
Mobile Station
On-Site Station
Time

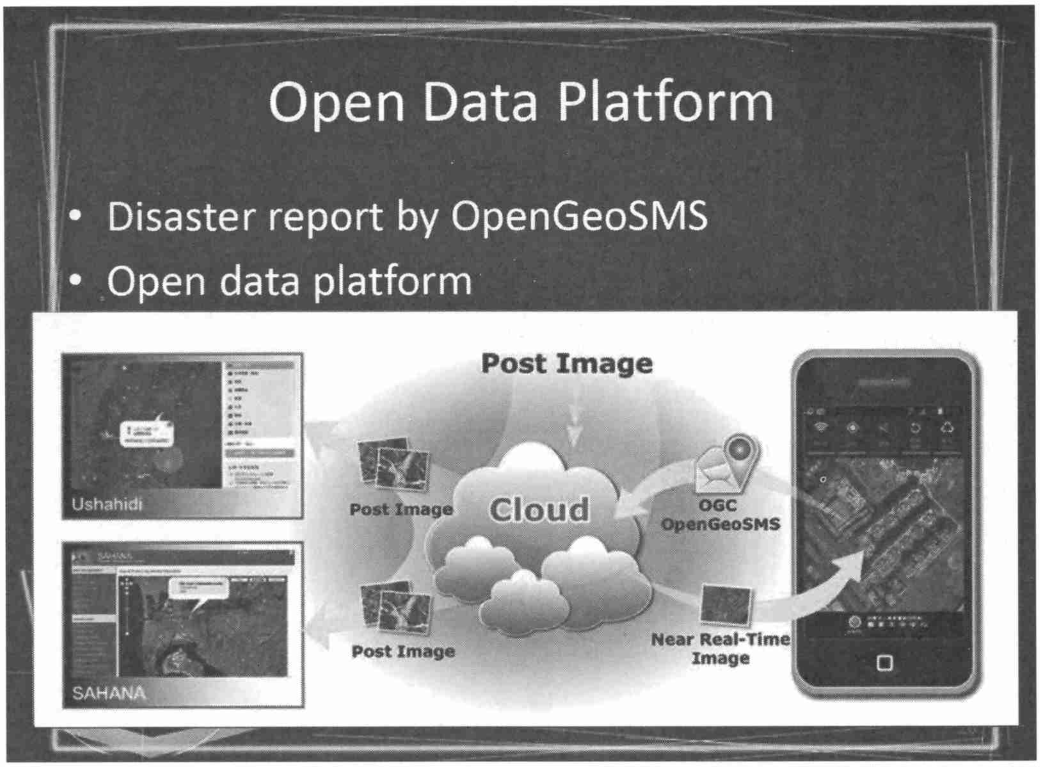

Monitoring System
UAV
Fiber
GPRS
ADSL
3G
satellite
Monitoring Information Center
Internet
3.5G
Notification
Cell phones
政府單位
民眾
災害管理單位
學術單位
WEB
Display Platform
Risk Management

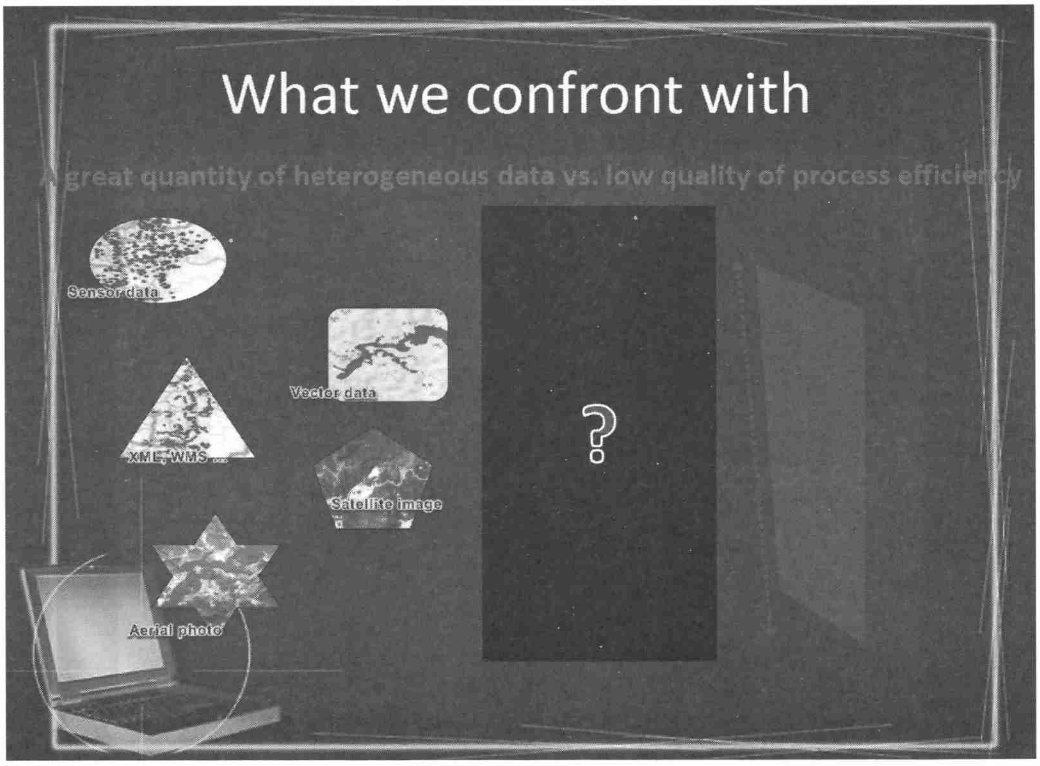

Debris Flow Event of ShenMu Village (8/8 16:57)
2009/08/08,16:04:57
2009/08/08,17:04:58
2009/08/08,16:57:14
CCD image (front)
CCD image (side)

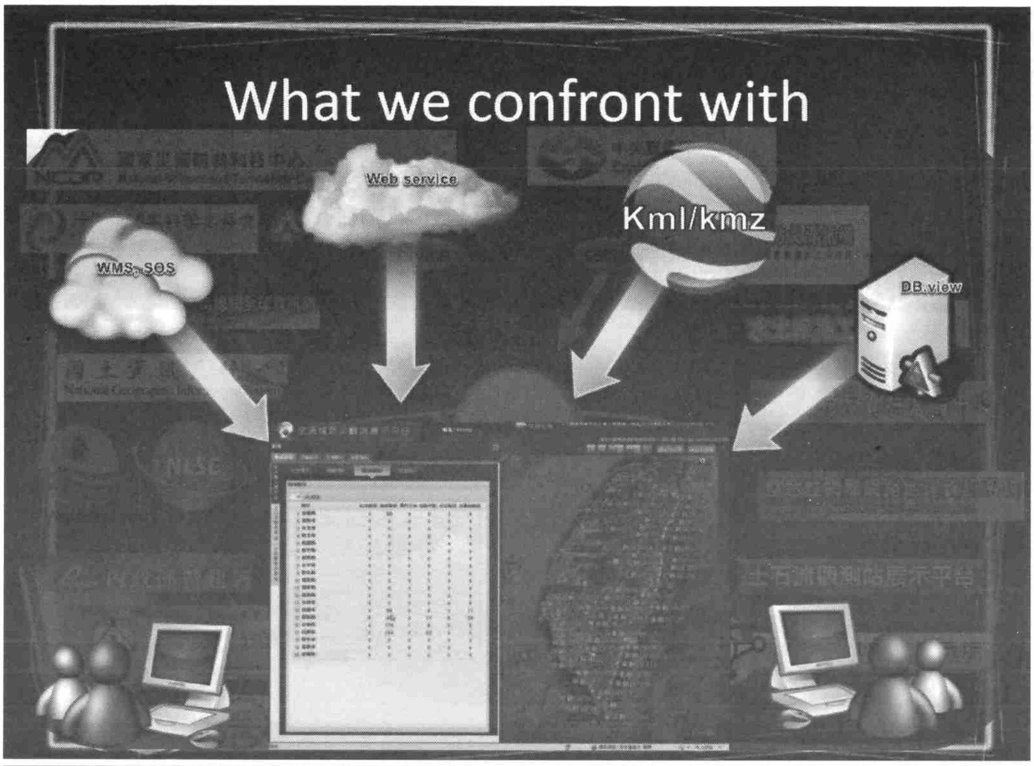

Estimating of debris flow velocity
50m
16:04:57
16:57:39
17:04:58
16:04:57
16:57:42
17:04:58
50m/3sec=17m/s
10 seconds
173m/10sec=17 m/s
= 60 km/hr
The comparison of downstream and midstream Underground Geophone data analysis by Wavelet Transform for Shen-Mu station

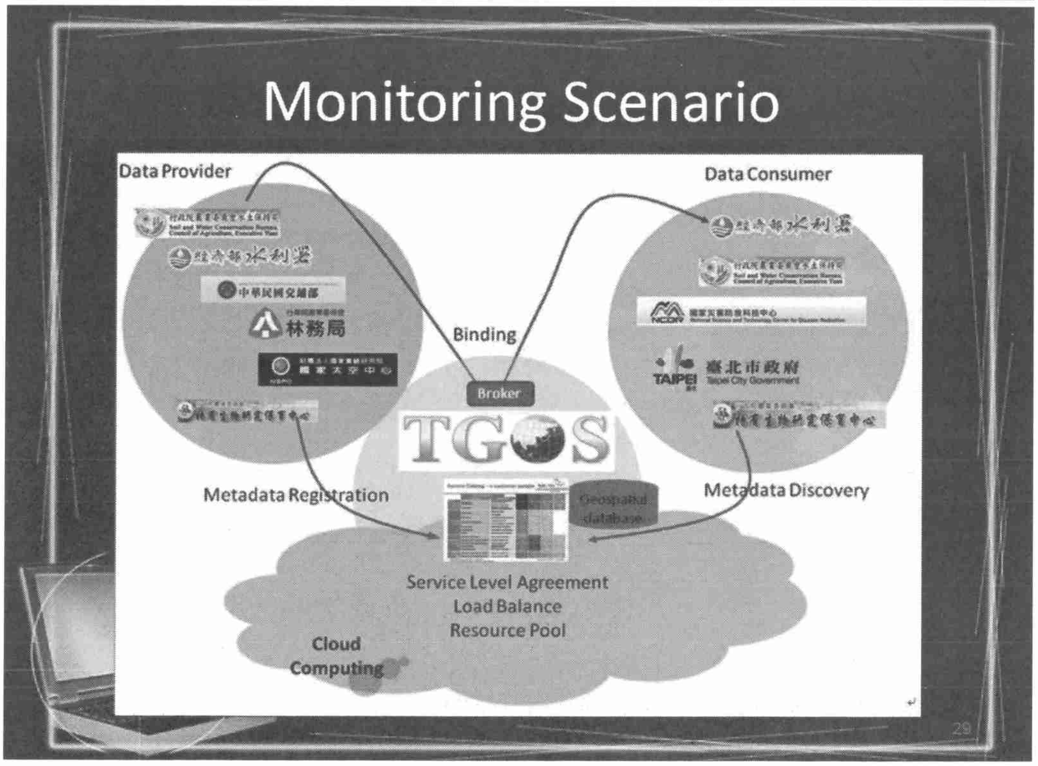

全流域防災觀測資訊整合展示網
Watershed Disaster Monitoring Information System
300mm
Real-time Rainfall
Rainfall distribution map
Image sequences analyzing
Ranking of danger villages
台中
彰化
雲林
嘉義
高雄
台東
花蓮
屏東
苗栗
新竹
宜蘭

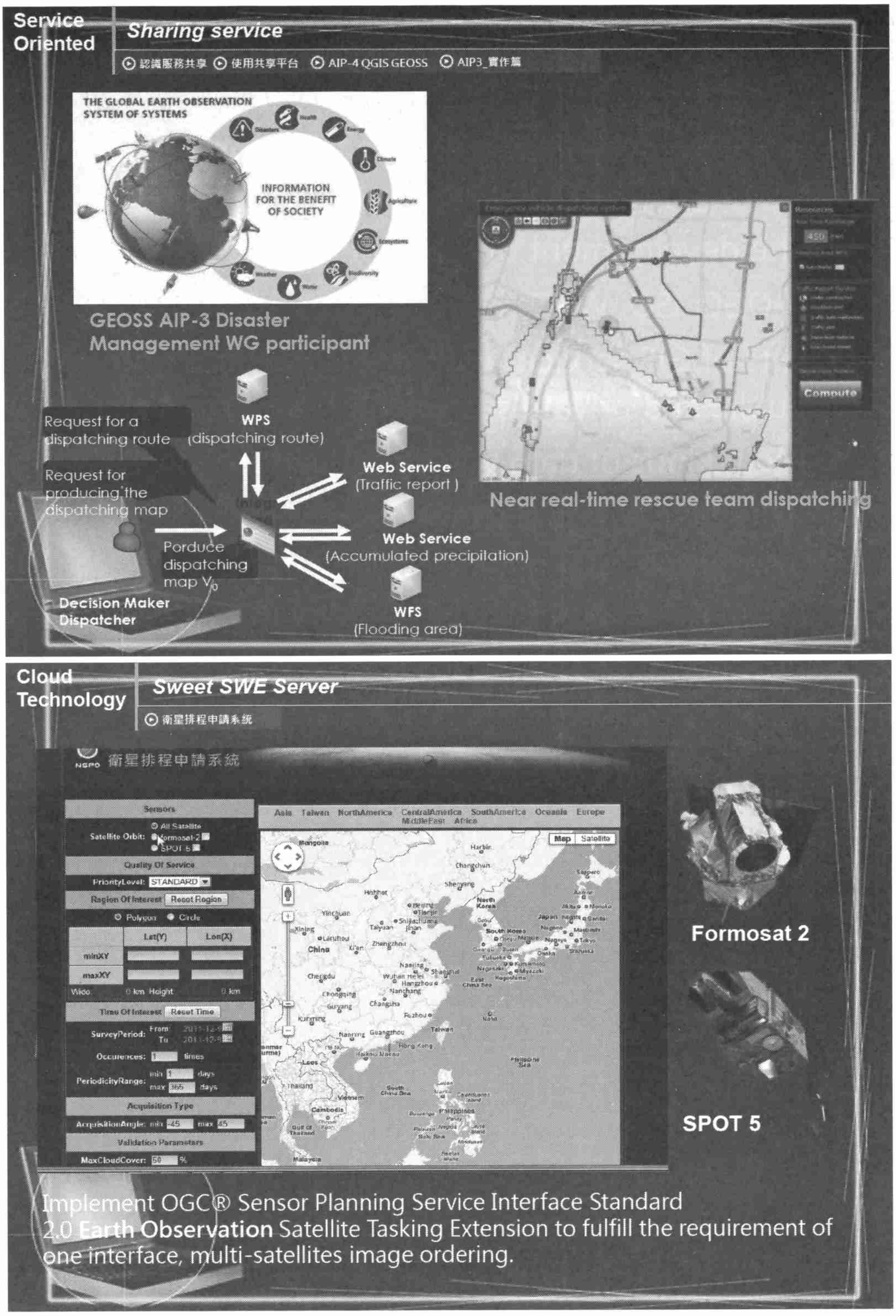

Geospatial Development in Taiwan
• Disaster information communication system
• Volunteered Geographic Information(VGI)
25

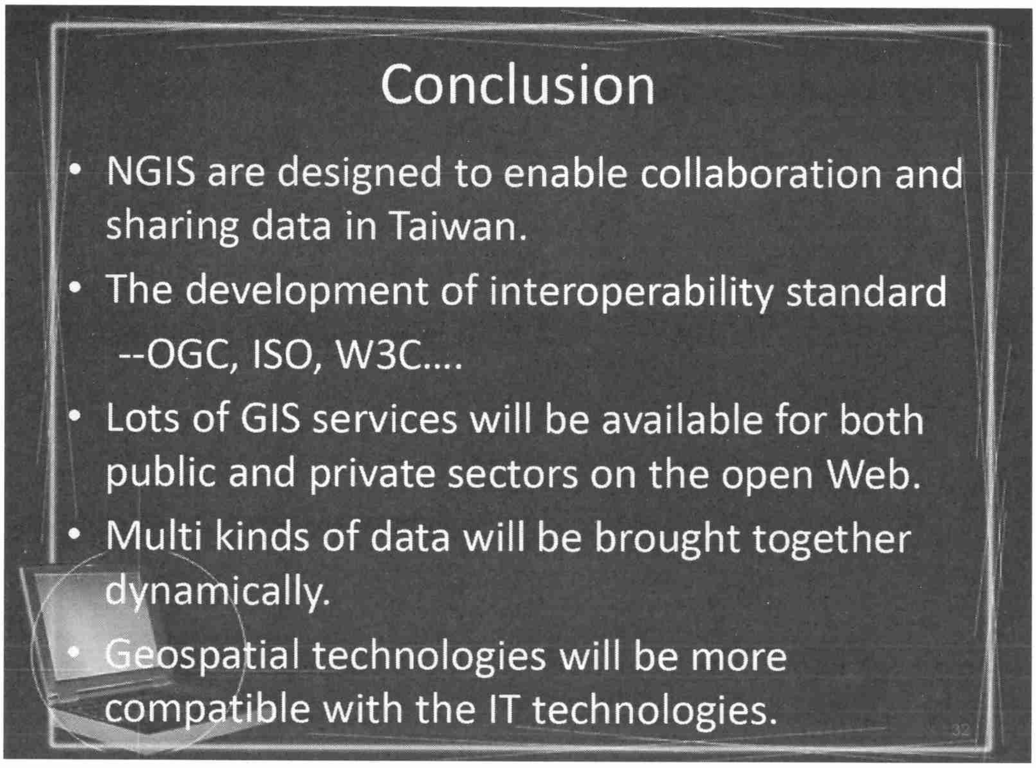

Open Data Platform
• Disaster report by OpenGeoSMS
• Open data platform
Post Image
Ushahidi
Post Image
Cloud
OGC
OpenGeoSMS
SAHANA
Post Image
Near Real-Time
Image


What we confront with
A great quantity of heterogeneous data vs. low quality of process efficiency
Sensor data
Vector data
XML, WMS ...
Satellite image
Aerial photo
?


What we confront with
Web service
WMS, SOS
Kml/kmz
DB.view


Monitoring Scenario
Data Provider
Data Consumer
Binding
Broker
TGOS
Metadata Registration
Metadata Discovery
林務局
臺北市政府
TAIPEI
Taipei City Government
Service Level Agreement
Load Balance
Resource Pool
Cloud
Computing
29


Service Oriented
Sharing service
AIP-4 QGIS GEOSS
THE GLOBAL EARTH OBSERVATION SYSTEM OF SYSTEMS
INFORMATION FOR THE BENEFIT OF SOCIETY
GEOSS AIP-3 Disaster Management WG participant
Request for a dispatching route
WPS (dispatching route)
Request for producing the dispatching map
Web Service (Traffic report)
Porduce dispatching map V0
Web Service (Accumulated precipitation)
WFS (Flooding area)
Decision Maker Dispatcher
Compute
Near real-time rescue team dispatching
Cloud Technology
Sweet SWE Server
衛星排程申請系統
Formosat 2
SPOT 5
Implement OGC® Sensor Planning Service Interface Standard 2.0 Earth Observation Satellite Tasking Extension to fulfill the requirement of one interface, multi-satellites image ordering.


Conclusion
• NGIS are designed to enable collaboration and sharing data in Taiwan.
• The development of interoperability standard
--OGC, ISO, W3C....
• Lots of GIS services will be available for both public and private sectors on the open Web.
• Multi kinds of data will be brought together dynamically.
• Geospatial technologies will be more compatible with the IT technologies.
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[Session 1]

Geo Innovations and Supporting Policies in East Asian Countries

6

GeoCloud and Geosocial Network:
Policy Implications of Spatial Information Industry in Korea

Prof. Il-Young Hong

(NamSeoul University, Korea)

GeoCloud and Geosocial Network: Policy Implications of Spatial Information Industry in Korea

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Abstract

Recently, Cloud computing and Social Network are the key IT paradigm that affects to Spatial Information Industry. These IT trends generates new terms such as GeoCloud and Geosocial Network. In this paper, the technical features of these trends and the impacts and policy implication to industry are examined.

Keywords: GeoCloud, Geosocial Network, Spatial Information

1. Introduction

Since the 2007 global economic crisis, the IT sector in an effort to reduce costs through more efficient computer operation. Cloud computing has emerged as a new paradigm for fast internet due to the many advantages that benefit is based on the technical and cost problems. Cloud computing which relies on various technologies such as the Internet, virtualization, utility computing and web services is affecting the GIS sector and GeoCloud such as Google Fusion tables and ESRI's ArcGIS Online are emerging. On the other hands, Geosocial platform in smart phone such as Twitter, Facebook has grown as an important field in the utilization of spatial information. This paper identify the characteristics of the cloud and social networks and analyze how these can be the benefit in GIS industry and examine what are the risk factors were.

2. GeoCould: Architectural feature and its policy implication in Korea

2.1 Cloud: Concept and Service Model

There are a lot of the definition of cloud computing(Yoo, 2011 ; Vouk, 2008 : Jager et al, 2008). McKinsey argue that there are more than twenty two different definition about the cloud(Vaquero et al, 2009). In fact, there is still no standard definition of cloud computing. However, cloud means that there is something more complex ones beyond the clouds and cloud remote environments such as the Internet. In addition, in these variety of definitions, there are somthing that appears in the common features. First is that a user-oriented service and the second is the communication networks based on the Internet which everyon can have free access. It is quite diffcult to find a definition of Cloud computing but there are four major service model being discussed in cloud computing, depending on the technical characteristics.

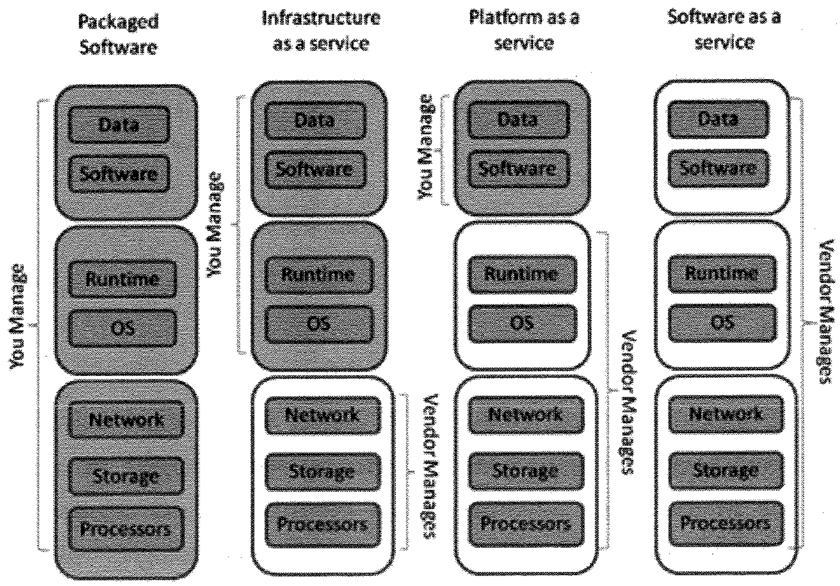

Figure 1. Cloud computing service model
(Source:https://www.eeducation.psu.edu/cloudGIS/node/91)

First is Infrastructure as a Service (IaaS). It provides IT environment of Virtual machine or the server overall computer storage devices, such as the provision of infrastructure through the Internet. IaaS stands for data processing and storage, access and computing resources available to hire for help.

Secound is Platform as a Service (PaaS). In PaaS, each application are operated in remotely via the Internet. Before the cloud, applications were operated on the local hardware, operating systems and databases. After the cloud, application developers can spread and load their software in the remotely located cloud.

Third is Software as a Service (Saas). In SassS, applications are delivered as web service in Internet. There is no need to install software management over the Internet and software does not have access to the complex administrative burden. It carried out through the Internet to support a wide range of business activities in the private and public organizations.

Fourth is Data as a Service (DaaS). DaaS are not restricted to the geographic location of the user to use the data, or the organization to which the user belongs or software environment which is dependent of the data type. Service-oriented architecture (SOA) or Web mashup technology is a good example of DaaS. DaaS can take advantage the data over the Internet.

The major merit of the Cloud is the economic benefits and along with a large resource that can be used quickly and easily to Internet user. On the other hands, the biggest impediments of cloud is the security problems that can occur to store the data remotely and due to the lack of services related to regulatory and tax of confusion.

However, the technical features of the cloud is exptected to give many benefits to SMEs(Small and Medium-sized Enterprises), government agencies, education and health care. Government, the expansion of communication between government agencies, prevent duplication, and in the various activities of the government for greater efficiency is possible. It is also expected to reduce costs, and increase transparency through the sharing of computing resources and residents residing in the active communication and information of alienation, anti-central government and local government. Next in education and health care, expensive education, limited educational opportunities, likely to solve the problem of degraded quality of education is much larger view(Sultan, 2010). It is expected that the initial cost for the case of SMEs, was reluctant to take advantage of IT systems and solutions at the expense of small businesses utilize IT resources in a cloud environment.

On the other hand, there is a dispute about whether regulation of the overseas corporate information stored in the data center, data ownership and access to the issues that are involved in the spread of cloud. Regulations and policies such as support for the resolution of such problems are needed.

2.2 GeoCloud : Clound in GIS

It can be said that spatial information industry is the IT sector of goverment. Goverment data and information platforms are needed to be shared to public(Chappell, 2010; Intergraph, 2011). Due to these features, cloud computing is expected to have a significant impact on the field of spatial information technology. In terms of cloud service model, NSDI has the feature of DaaS and in terms of PaaS, GeoPortal can be found the importance of spatial information platform. NSDI has the purpose of data collection, use, and trying to help a lot in improving decision-making through the sharing of spatial data between users.

> ..... *National Spatial Data Infrastructure defined as the technologies, policies, and people necessary to promote sharing of geospatial data throughout all levels of government, the private and non-profit sectors, and the academic community... (source: www.fgdc.gov)*

DaaS model helps a lot in the sharing of geographic data. DaaS as a low-cost uses the data storage space more efficiently by utilizing data sharing between agencies through the sharing of resources, between government agencies, and search capabilities, and improve the management. In addition, DaaS can help the financial support of the NSDI through business model.

On the other hand, the use of spatial data using the cloud causes the problem of data security issues. Companies asks the cloud providers to protect the property rights and the security of personal data. Addion to this, deployed when the data center from the cloud to users, the data for copyright protection is needed. It can be said that INSPIRE is DaaS model and utilize the most representative cases of NSDI (see Fig. 1).

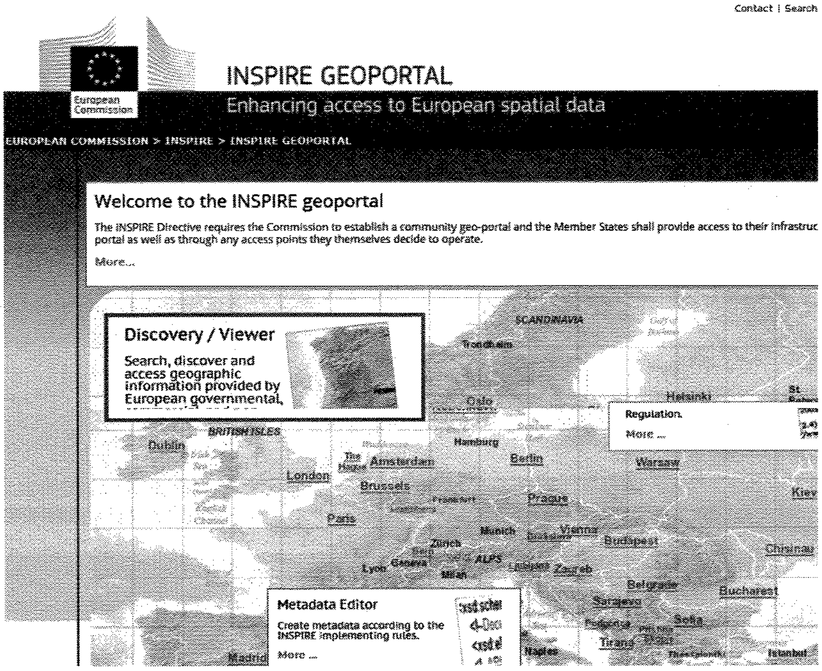

Figure 1. INSPIRE - INfrastructure for SPatial InfoRmation in Europe
(source: www.inspire-geoportal.eu)

Recently, the federal government geographic data managers considered Geospatial portal as the potential future of the program. they want geoportal to be improved as the the government framework to discuss the needs of the local government, policy, etc. Geoportal promotes in cooperation with the NSDI. Geoportal as a archtectureal standard promotes the technical standards and accessibility to the geospatial data. Geoportal as a geospatial platform provides the application for goverment and partners and share the geospatial data on Internet. GeoCommon is an example of the most common geoportal for their data in the cloud, non-commercial use and geoprocessing and analysis are possible.

In Korea, vworld(vworld.kr) is the example of geoportal which is a kind of PasS model. Korea began the service, vworld, at this year to build the spatial information open platform. V World utilizing space of web-based information to support the use of the private information of the state space for the system. Korean goverment has held a variety of information and programs that can take advantage of this space.

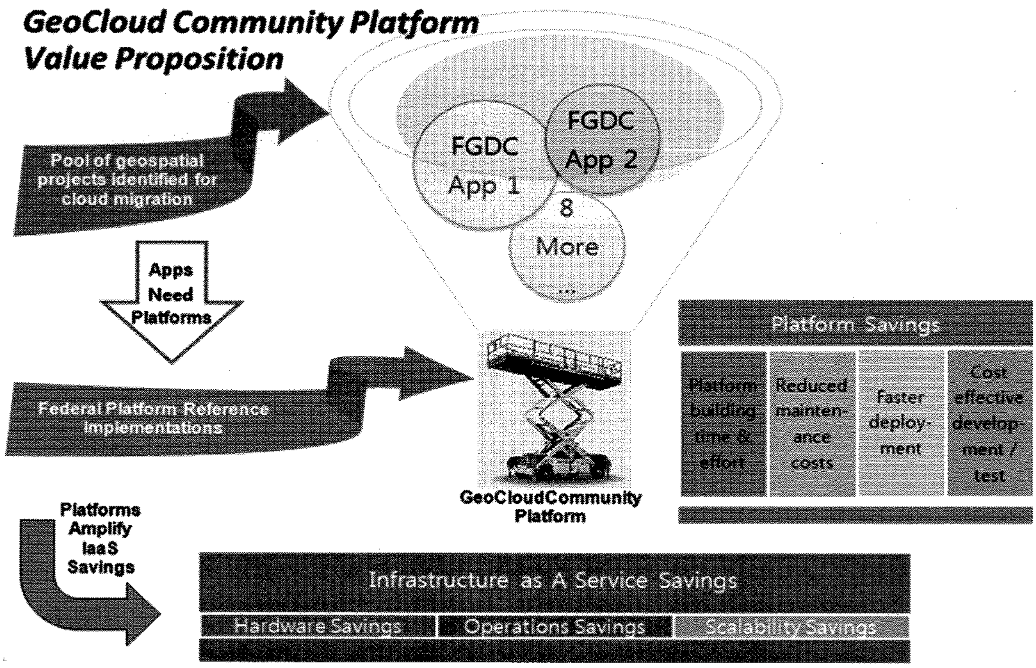

Figure 2. GeoCloud Sandbox Initiative: Geospatial Platform-as-a-Service
(Source: http://www.fgdc.gov/initiatives/geoplatform/geocloud)

3. Geosocial Network

Geosocial networks is a type of social network that is used to activate the additional services, such as geocoding and geotagging features(Fischer, 2009; Lampos& Cristianini, 2010 ; Pierce-Grove, 2007 ; Liu, 2009). Location-based services technology helps to adjust the regional user on the basis of data submitted by the user location and people and events that match your interests(ESRI, 2006; O'Reilly, 2005). The biggest difference with the existing web-based services such as messanger is that geosocial network uses mobile devices such as smartphones. Mobile social network improves the user's interests to transfer the message with location information.

The rapid growth of location-based geosocial network is closely related to the spread of smartphones. The smartphone is the foremost point of contact to access information that can be the hub of day-to-day network. GIS to contribute in the smartphone-centric service applications can be summarized into two major categories. First is the mobile web GIS which is going to extend existing wired WebGIS. Second is geosocial network services as the center of the rapidly evolving mobile social platform using location-based services.

It can be seen that mobile web GIS is the integrated wireless access to geographic information on the SW / HW framework. Mobile web GIS is a work in the field of traditional GIS, such as the collection of geographic data, updated and added to the database, or to update the properties of an existing data. On the other hand, location-based services means that services are centered on the location of the user such as navigation, pathfinding, location, and location tracking. The most important difference between the two is the exsitance of spatial data editing functions. Mobile GIS has the function for spatial data input, modification and editing features. However, In case of location-based services, spatial data are used as a background and reference material for the service and display of location-centric services such as navigation and vehicle tracking incoming revolves.

Location-based services, according to the user's request can be divided into the Push-based services to provide appropriate services to users by filtering services and the movement of the user's Pull-based search by location to provide services while continuously monitoring. Push of Pull-based services is to respond to a request for the user's temporary compared to the user's location at specific time intervals for continuous monitoring, Context-aware and location-aware, such as a rich and powerful set of user-centric services to enable. However, Push rather than Pull-based service location-based services are provided by the mobile phone until now. It was caused by the limits of wireless communications infrastructure, such as technical problems and due to constraints such as the protection of personal information.

In addition to the existing location-based services, there were many constraints such as the numbers of cell tower and communication base stations which limits the hundreds meters of accuracy in outdoor service. Increase the number of base stations with various ubiquitous telecommunications network equipment, including WiFi, enable the realization of new services and increased to cover the higher accuracy, and both outdoor and indoor. Push content-centric smartphone platform location-based services in the future will play the most critical role of the smartphone expected to further amplifies.

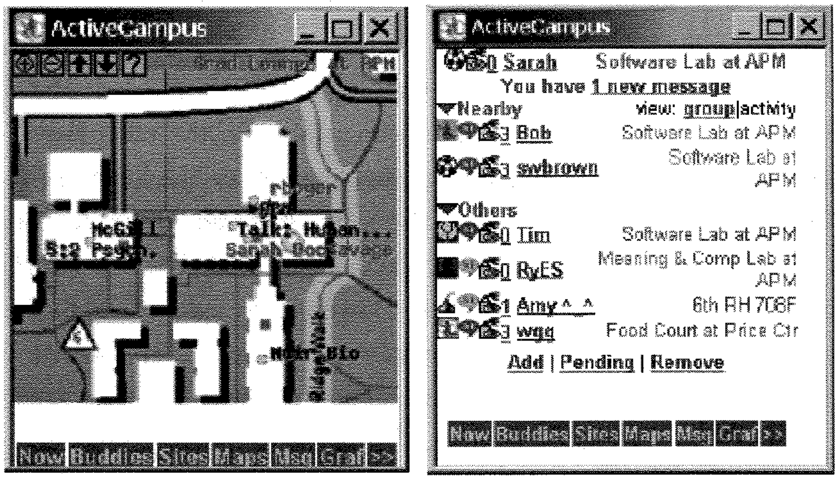

Figure 3. Geosocial network development project, ActiveCampus
(source: http://activecampus.ucsd.edu/)

Currently smartphone is a critical tool to send and receive information in the network between people, rather than simply a means of communication. In addition, smartphone has become a tool of our family, friends, co-workers now telling what from where, and what is the new. One study reported that twenty-five percent of all users's SMS messages is about checking where they or their family is right now or other similar purposes. Thus, geosocial network services is expected to be the smartphone-oriented newly-platform.

Smartphone overcome a whole lot of limits to implement GIS and location-based services in a mobile environment. Existing mobile GIS worked on a PDA and location-based services has grown on vehicle navigation that utilize GPS. Including WiFi for the growth of a variety of communications infrastructure, PNS (Personal Navigation Systems) for smartphone will be in the era rather than GPS navigation. Comparing to the application of existing applications to access information, Touchscreen UI (User Interface) based on the user's location can provide more easy accessibily to the public and take advantage of the Internet rapidly wireless web. Numerous spatial information services for the general public will be developed for wireless web and smartphone users can expect these changes.

VGI(Volunteered Geographic Information) voluntarily provide to individuals geographic data and a processing tool that can be deployed is the utilization. An example of this phenomenon WikiMapia, OpenStreetMap and Google Maps. The contribution of VGI in GIS is data collection capabilities of a participatory approach. Web sites, events and offers users a variety of base map information typically represented on the map for specific information whcih everybody can create. VGI can be seen as part of the geosocial networks as it includes user-created content.

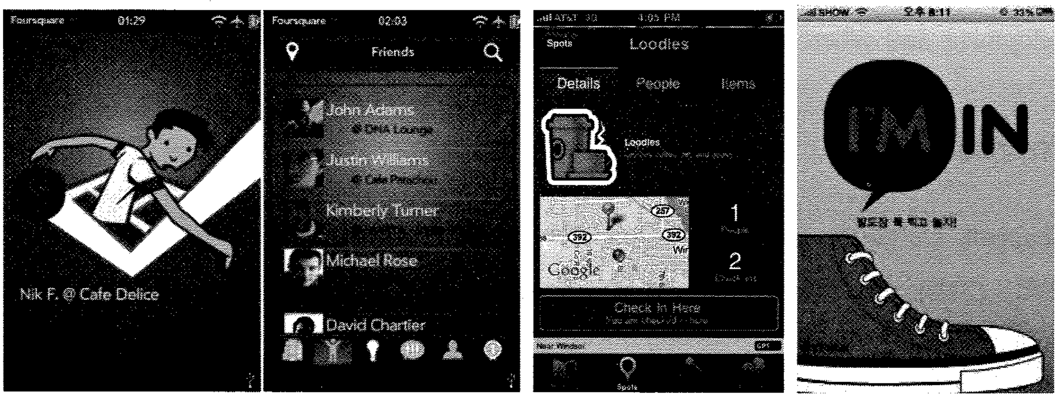

Figure 4. Geosocail Network Services

It is the expected application area for location-based services of geocial network such as where should automatically throw and look forward to take advantage of a variety of features, such as location-based on location-aware advertising, marketing, traffic, alarm, and security alarms. Smartphone as a mobile platform, the exact target for the sale of their products to local business and advertisers who more clearly makes. Service management based on their location and situation, as user services to best meet their needs that business operators who service consumption will increase.

4. Conclusion

Cloud computing can provide a variety of services in a manner which is not previously experienced in computing and it can be a new computing paradigm. It has been proven that the cloud computing can reduce cost and increase efficiency and the environment from the perspective of the organization, as well as to take advantage of the technical improvement. GeoCloud use the each cases of cloud service model such as DaaS and PaaS. To take advantage of government-centered public data, NSDI may be the most representative DaaS model and the geoportal and geospatial platform are examples of PaaS. In addition, Microsoft Bing Maps and Google Maps can be said that the example of the SaaS business model.

iPhone blows a lot of people already drawn to the appeal of the smartphone. Countless users who purchase the smartphone has experienced the geosocial network sevice and their life is changing. These are tailored to the user to provide higher service levels by leveraging a wide variety of services through GIS and location-based mobile Web. In both of cases, the security and reliability of geospatial data is the critical issus for further development and where the goverment policy should take care of.

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GeoCloud and and Geosocial Network: Policy Implications of Spatial Information Industry in Korea

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1

Background on GeoCloud and GeoSocial

- Since the 2007 global economic crisis, the IT sector in an effort to reduce costs through more efficient computer operation
- Cloud computing has emerged as a new paradigm for fast internet due to the many advantages that benefit is based on the technical and cost problems
- Geosocial platform in smart phone such as Twitter, Facebook has grown as an important field in the utilization of spatial information
- identify the characteristics of the cloud and social networks and analyze how these can be the benefit in GIS industry and examine what are the risk factors were

2

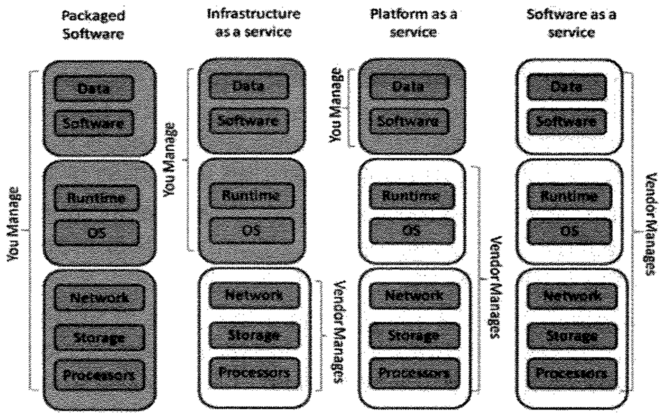
Cloud: Concept and Service Model

- There are a lot of the definition of cloud computing(Yoo, 2011 ; Vouk, 2008 : Jager et al, 2008). McKinsey argue that there are more than twenty two different definition about the cloud(Vaquero et al, 2009).
- In fact, there is still no standard definition of cloud computing. However, cloud means that there is something more complex ones beyond the clouds and cloud remote environments such as the Internet.
- In addition, in these variety of definitions, there are somthing that appears in the common features.
  - First is that a user-oriented service
  - the second is the communication networks based on the Internet which everyon can have free access

3

Cloud: Concept and Service Model

- there are four major service model being discussed in cloud computing, depending on the technical characteristics



4

Cloud Service Model

- Infrastructure as a Service (IaaS).
  - It provides IT environment of Virtual machine or the server overall computer storage devices, such as the provision of infrastructure through the Internet.
  - IaaS stands for data processing and storage, access and computing resources available to hire for help.
- Platform as a Service (PaaS).
  - In PaaS, each application are operated in remotely via the Internet.
  - After the cloud, application developers can spread and load their software in the remotely located cloud.
- Software as a Service (Saas).
  - applications are delivered as web service in Internet.
  - no need to install software management over the Internet
  - software does not have access to the complex administrative burden
- Data as a Service (DaaS).
  - not restricted to the geographic location of the user to use the data,or the organization to which the user belongs or software environment which is dependent of the data type.
  - Service-oriented architecture (SOA) or Web mashup technology is a good example of DaaS

5

Merit of the Cloud

- the economic benefits and along with a large resource that can be used quickly and easily to Internet user.
- the technical features of the cloud is exptected to give many benefits to SMEs(Small and Medium-sized Enterprises), government agencies, education and health care.
  - Government:, the expansion of communication between government agencies, prevent duplication, and in the various activities of the government for greater efficiency is possible.
  - education and health care, expensive education, limited educational opportunities, likely to solve the problem of degraded quality of education is much larger view(Sultan, 2010).
  - It is expected that the initial cost for the case of SMEs, was reluctant to take advantage of IT systems and solutions at the expense of small businesses utilize IT resources in a cloud environment

6

Demerit of the Cloud

- Most security problems stem from:
  - Loss of control
  - Lack of trust (mechanisms)
- Consumer's loss of control
  - Data, applications, resources are located with provider
  - User identity management is handled by the cloud
  - User access control rules, security policies and enforcement are managed by the cloud provider
  - Consumer relies on provider to ensure
    - Data security and privacy
    - Resource availability
    - Monitoring and repairing of services/resources
- data ownership and access to the issues that are involved in the spread of cloud. Regulations and policies such as support for the resolution of such problems are needed.

7

GeoCloud : Clound In GIS

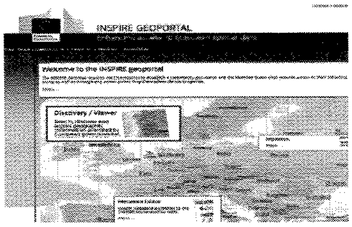
- Spatial information industry is the IT sector of goverment.
  - Goverment data and information platforms are needed to be shared to public
  - Cloud computing is expected to have a significant impact on the field of spatial information technology
- In terms of cloud service model, NSDI has the feature of DaaS
  - NSDI has the purpose of data collection, use, and trying to help a lot in improving decision-making through the sharing of spatial data between users

..... ***National Spatial Data Infrastructure*** *defined as the technologies, policies, and people necessary to promote sharing of geospatial data throughout all levels of government, the private and non-profit sectors, and the academic community... (source: www.fgdc.gov)*

8

GeoCloud, DaaS model, NSDI

- DaaS model helps a lot in the sharing of geographic data.
  - DaaS as a low-cost uses the data storage space more efficiently by utilizing data sharing between agencies through the sharing of resources, between government agencies, and search capabilities, and improve the management.
  - the use of spatial data using the cloud causes the problem of data security issues.
  - Companies asks the cloud providers to protect the property rights and the security of personal data.
- Addion to this, deployed when the data center from the cloud to users, the data for copyright protection is needed.
  - INSPIRE is DaaS model and utilize the most representative cases of NSDI



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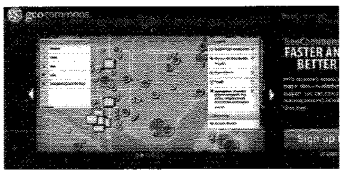
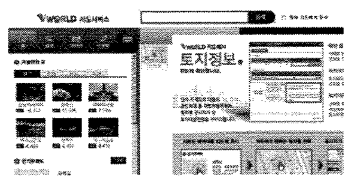
GeoCloud, PaaS model, GeoPortal

- geoportal to be improved as the the government framework to discuss the needs of the local government, policy, etc.
- Geoportal promotes in cooperation with the NSDI.
- Geoportal as a archtectureal standard promotes the technical standards and accessibility to the geospatial data.
- Geoportal as a geospatial platform provides the application for goverment and partners and share the geospatial data on Internet.

•GeoCommon is an example of the most common geoportal for their data in the cloud, non-commercial use and geoprocessing and analysis are possible.

•In Korea, vworld(vworld.kr) is the example of geoportal which is a kind of PasS model.





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Geosocial Network

- Geosocial networks is a type of social network that is used to activate the additional services, such as geocoding and geotagging features
- Location-based services technology helps to adjust the regional user on the basis of data submitted by the user location and people and events that match your interests

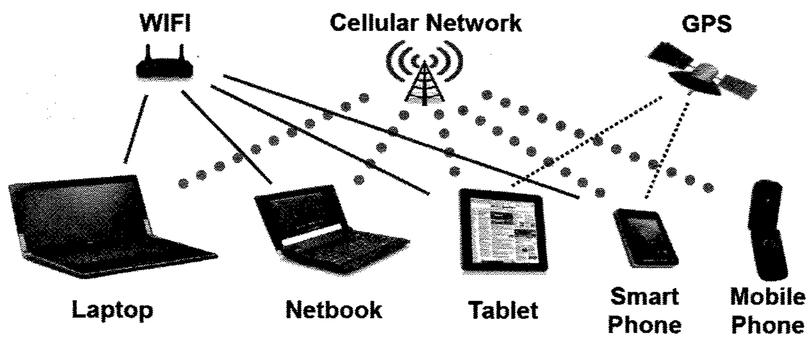
•The biggest difference with the existing web-based services such as messanger is that geosocial network uses mobile devices such as smartphones.

• Mobile social network improves the user's interests to transfer the message with location information.

11

Technical Background

- The rapid growth of location-based geosocial network is closely related to the spread of smartphones.
- The smartphone is the foremost point of contact to access information that can be the hub of day-to-day network.
- GIS to contribute in the smartphone-centric service applications can be summarized into two major categories.
- Ilocation-based services means that services are centered on the location of the user such as navigation, pathfinding, location, and location tracking.



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Location-based services

- Location-based services, according to the user's request can be divided into the Push-based services to provide appropriate services to users by filtering services and the movement of the user's Pull-based search by location to provide services while continuously monitoring.
- Push of Pull-based services is to respond to a request for the user's temporary compared to the user's location at specific time intervals for continuous monitoring, Context-aware and location-aware, such as a rich and powerful set of user-centric services to enable.
- In addition to the existing location-based services, there were many constraints such as the numbers of cell tower and communication base stations which limits the hundreds meters of accuracy in outdoor service.
- Increase the number of base stations with various ubiquitous telecommunications network equipment, including WiFi, enable the realization of new services and increased to cover the higher accuracy, and both outdoor and indoor.
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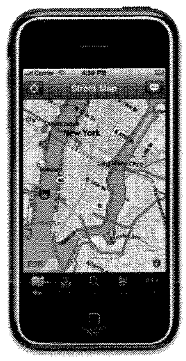

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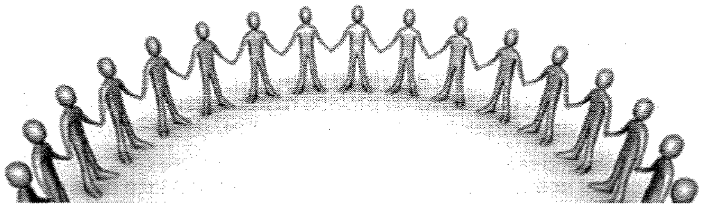

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Geosocial vs LBS killer apps for SmartPhone

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16

Conclusion

- Cloud computing can provide a variety of services in a manner which is not previously experienced in computing and it can be a new computing paradigm.
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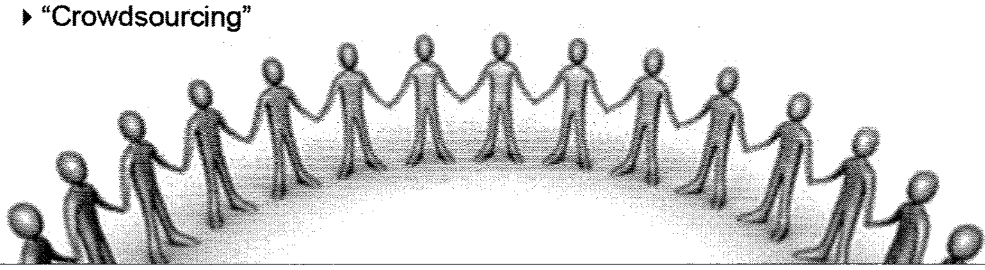
- GeoCloud use the each cases of cloud service model such as
  - DaaS and PaaS. To take advantage of government-centered public data, NSDI may be the most representative DaaS model
  - the geoportal and geospatial platform are examples of PaaS.
  - Microsoft Bing Maps and Google Maps can be said that the example of the SaaS business model
- Countless users who purchase the smartphone has experienced the geosocial network sevice and their life is changing.
  - These are tailored to the user to provide higher service levels by leveraging a wide variety of services through GIS and location-based mobile Web
  - the security and reliability of geospatial data is the critical issus for further development and where the goverment policy should take care of.

17

Why Use Social Media?

- It's where the students are
- Provides a sense of community
- Seen as a forum to postulate views
- Fun way to stay connected with old friends or make new friends
- Forum for communication (individual/group/mass) and collaboration
- Allows for self-expression and self-representation
- "Democratizing innovation"
- "Crowdsourcing"



What Are The *Security* Risks?

- **Malware distribution**
- **Cyber-bullying** ("trolling," emotional abuse)

November 20, 2008

First cyber-bullying trial hears how Megan Meier, 13, killed herself after online taunts

- **"Shelf-life" of information** (lives forever in cyberspace)

How Tweet It Is!: Library Acquires Entire Twitter Archive

April 14th, 2010 by Matt Raymond

- **Privacy concerns**
  - Information about you that *you* post
  - Information about you that *others* post
  - Information about you the *social networking sites* collect and share with others

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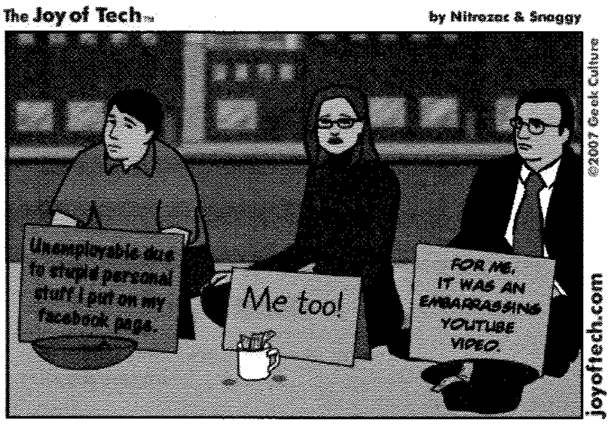
What Are The *Security* Risks?

- Can result in social engineering, identity theft, financial fraud, infected computers, stalking, child abuse, sexual predation, defamation, lawsuits, mad boyfriend/girlfriend/spouse/parent, unwanted legacy, embarrassment, ...



Signs of the social networking times.

20

If cloud computing is so great, why isn't everyone doing it?

- The cloud acts as a big black box, nothing inside the cloud is visible to the clients
- Clients have no idea or control over what happens inside a cloud
- Even if the cloud provider is honest, it can have malicious system admins who can tamper with the VMs and violate confidentiality and integrity
- Clouds are still subject to traditional data confidentiality, integrity, availability, and privacy issues, plus some additional attacks

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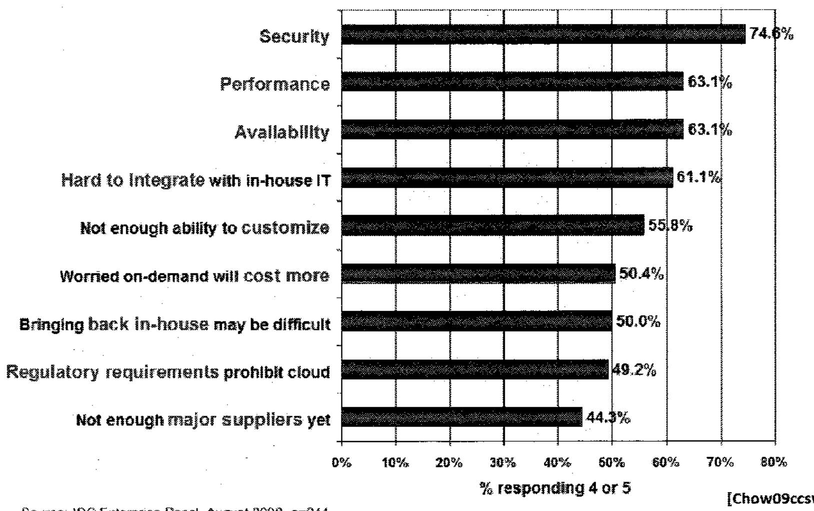
Companies are still afraid to use clouds

Q: Rate the challenges/issues ascribed to the 'cloud'/on-demand model

(1=not significant, 5=very significant)



[Chow09ccsw]

Source: IDC Enterprise Panel, August 2008 n=244

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Causes of Problems Associated with Cloud Computing

- Most security problems stem from:
  - Loss of control
  - Lack of trust (mechanisms)
  - Multi-tenancy
- These problems exist mainly in 3rd party management models
  - Self-managed clouds still have security issues, but not related to above

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Loss of Control in the Cloud

- Consumer's loss of control
  - Data, applications, resources are located with provider
  - User identity management is handled by the cloud
  - User access control rules, security policies and enforcement are managed by the cloud provider
  - Consumer relies on provider to ensure
    - Data security and privacy
    - Resource availability
    - Monitoring and repairing of services/resources

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Lack of Trust in the Cloud

- A brief deviation from the talk
  - (But still related)
  - Trusting a third party requires taking risks
- Defining trust and risk
  - Opposite sides of the same coin (J. Camp)
  - People only trust when it pays (Economist's view)
  - Need for trust arises only in risky situations
- Defunct third party management schemes
  - Hard to balance trust and risk
  - e.g. Key Escrow (Clipper chip)
  - Is the cloud headed toward the same path?

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Opportunities and Challenges

- The use of the cloud provides a number of opportunities:
  - It enables services to be used without any understanding of their infrastructure.
  - Cloud computing works using economies of scale:
    - It potentially lowers the outlay expense for start up companies, as they would no longer need to buy their own software or servers.
    - Cost would be by on-demand pricing.
    - Vendors and Service providers claim costs by establishing an ongoing revenue stream.
  - Data and services are stored remotely but accessible from "anywhere".

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Opportunities and Challenges

- In parallel there has been backlash against cloud computing:
  - Use of cloud computing means dependence on others and that could possibly limit flexibility and innovation:
    - The others are likely become the bigger Internet companies like Google and IBM, who may monopolise the market.
    - Some argue that this use of supercomputers is a return to the time of mainframe computing that the PC was a reaction against.
  - Security could prove to be a big issue:
    - It is still unclear how safe out-sourced data is and when using these services ownership of data is not always clear.
  - There are also issues relating to policy and access:
    - If your data is stored abroad whose policy do you adhere to?
    - What happens if the remote server goes down?
    - How will you then access files?
    - There have been cases of users being locked out of accounts and losing access to data.

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Advantages of Cloud Computing

- Lower computer costs:
  - You do not need a high-powered and high-priced computer to run cloud computing's web-based applications.
  - Since applications run in the cloud, not on the desktop PC, your desktop PC does not need the processing power or hard disk space demanded by traditional desktop software.
  - When you are using web-based applications, your PC can be less expensive, with a smaller hard disk, less memory, more efficient processor...
  - In fact, your PC in this scenario does not even need a CD or DVD drive, as no software programs have to be loaded and no document files need to be saved.

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Advantages of Cloud Computing

- Improved performance:
  - With few large programs hogging your computer's memory, you will see better performance from your PC.
  - Computers in a cloud computing system boot and run faster because they have fewer programs and processes loaded into memory…
- Reduced software costs:
  - Instead of purchasing expensive software applications, you can get most of what you need for free-ish!
    - most cloud computing applications today, such as the Google Docs suite.
  - better than paying for similar commercial software
    - which alone may be justification for switching to cloud applications.

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Advantages of Cloud Computing

- Instant software updates:
  - Another advantage to cloud computing is that you are no longer faced with choosing between obsolete software and high upgrade costs.
  - When the application is web-based, updates happen automatically
    - available the next time you log into the cloud.
  - When you access a web-based application, you get the latest version
    - without needing to pay for or download an upgrade.
- Improved document format compatibility.
  - You do not have to worry about the documents you create on your machine being compatible with other users' applications or OSes
  - There are potentially no format incompatibilities when everyone is sharing documents and applications in the cloud.

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Advantages of Cloud Computing

- Unlimited storage capacity:
  - Cloud computing offers virtually limitless storage.
  - Your computer's current 1 Tbyte hard drive is small compared to the hundreds of Pbytes available in the cloud.
- Increased data reliability:
  - Unlike desktop computing, in which if a hard disk crashes and destroy all your valuable data, a computer crashing in the cloud should not affect the storage of your data.
    - if your personal computer crashes, all your data is still out there in the cloud, still accessible
  - In a world where few individual desktop PC users back up their data on a regular basis, cloud computing is a data-safe computing platform!

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Advantages of Cloud Computing

- Universal document access:
  - That is not a problem with cloud computing, because you do not take your documents with you.
  - Instead, they stay in the cloud, and you can access them whenever you have a computer and an Internet connection
  - Documents are instantly available from wherever you are
- Latest version availability:
  - When you edit a document at home, that edited version is what you see when you access the document at work.
  - The cloud always hosts the latest version of your documents
    - as long as you are connected, you are not in danger of having an outdated version

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Advantages of Cloud Computing

- Easier group collaboration:
  - Sharing documents leads directly to better collaboration.
  - Many users do this as it is an important advantages of cloud computing
    - multiple users can collaborate easily on documents and projects

- Device independence.
  - You are no longer tethered to a single computer or network.
  - Changes to computers, applications and documents follow you through the cloud.
  - Move to a portable device, and your applications and documents are still available.

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Disadvantages of Cloud Computing

- Requires a constant Internet connection:
  - Cloud computing is impossible if you cannot connect to the Internet.
  - Since you use the Internet to connect to both your applications and documents, if you do not have an Internet connection you cannot access anything, even your own documents.
  - A dead Internet connection means no work and in areas where Internet connections are few or inherently unreliable, this could be a deal-breaker.

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Disadvantages of Cloud Computing

- Does not work well with low-speed connections:
  - Similarly, a low-speed Internet connection, such as that found with dial-up services, makes cloud computing painful at best and often impossible.
  - Web-based applications require a lot of bandwidth to download, as do large documents.
- Features might be limited:
  - This situation is bound to change, but today many web-based applications simply are not as full-featured as their desktop-based applications.
    - For example, you can do a lot more with Microsoft PowerPoint than with Google Presentation's web-based offering

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Disadvantages of Cloud Computing

- Can be slow:
  - Even with a fast connection, web-based applications can sometimes be slower than accessing a similar software program on your desktop PC.
  - Everything about the program, from the interface to the current document, has to be sent back and forth from your computer to the computers in the cloud.
  - If the cloud servers happen to be backed up at that moment, or if the Internet is having a slow day, you would not get the instantaneous access you might expect from desktop applications.

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Disadvantages of Cloud Computing

- Stored data might not be secure:
  - With cloud computing, all your data is stored on the cloud.
    - The questions is How secure is the cloud?
  - Can unauthorised users gain access to your confidential data?
- Stored data can be lost:
  - Theoretically, data stored in the cloud is safe, replicated across multiple machines.
  - But on the off chance that your data goes missing, you have no physical or local backup.
    - Put simply, relying on the cloud puts you at risk if the cloud lets you down.

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Disadvantages of Cloud Computing

- HPC Systems:
  - Not clear that you can run compute-intensive HPC applications that use MPI/OpenMP!
  - Scheduling is important with this type of application
    - as you want all the VM to be co-located to minimize communication latency!
- General Concerns:
  - Each cloud systems uses different protocols and different APIs
    - may not be possible to run applications between cloud based systems
  - Amazon has created its own DB system (not SQL 92), and workflow system (many popular workflow systems out there)
    - so your normal applications will have to be adapted to execute on these platforms.

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The Future

- Many of the activities loosely grouped together under cloud computing have already been happening and centralised computing activity is not a new phenomena
- Grid Computing was the last research-led centralised approach
- However there are concerns that the mainstream adoption of cloud computing could cause many problems for users
- Many new open source systems appearing that you can install and run on your local cluster
  - should be able to run a variety of applications on these systems

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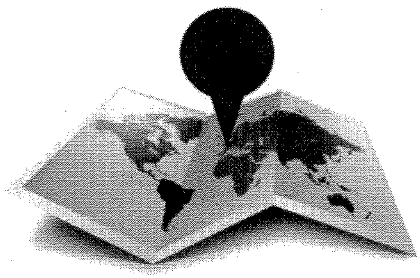
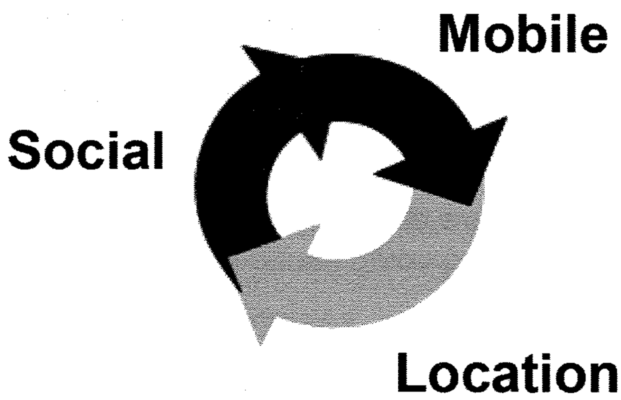
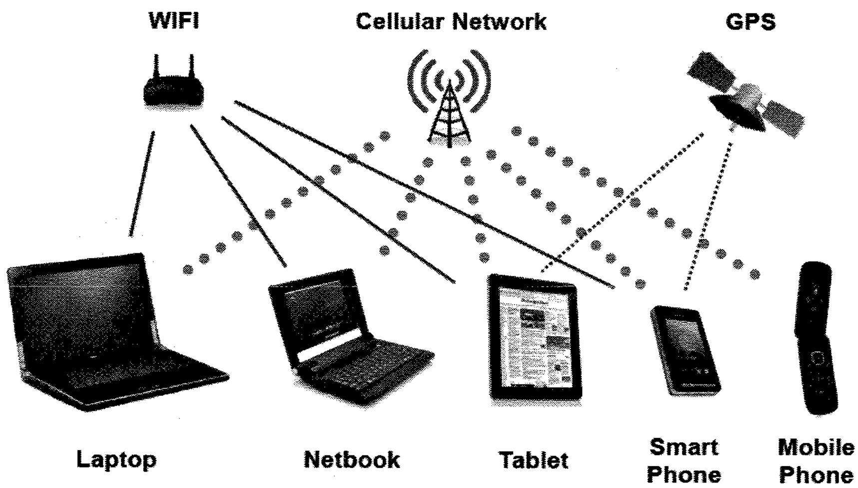
1. What is geosocial?



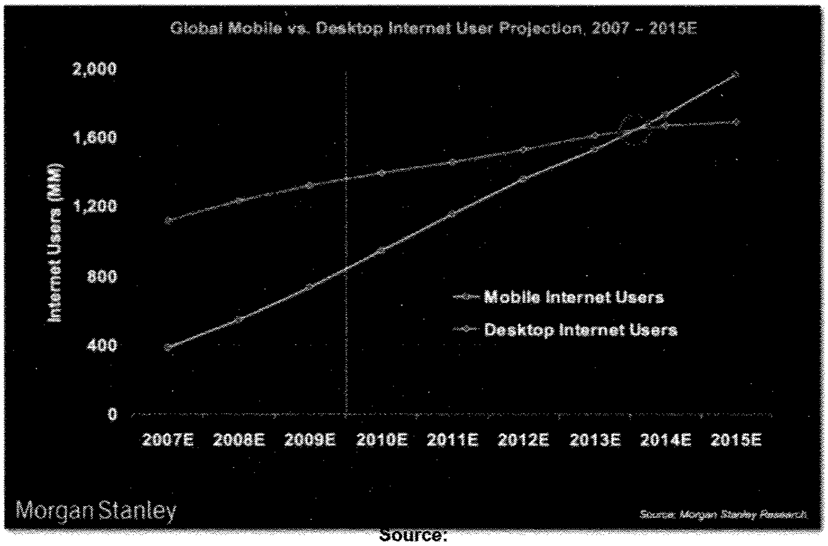
The Perfect Storm ...



Wide Range of Mobile of Devices & Connection Options Today ...



Mobile web access is expected to exceed PC access by 2014 ...



Source:
http://www.morganstanley.com/institutional/techresearch/mobile_internet_report122009.html

What is geosocial?

- Many of your customers will have and use a smartphone / tablet with robust computing capability.
- Those devices are automatically aware of their own location and able to share content with location based attributes.
- Using those devices, users will share / check-in / search and act related to their location.

Types of Geo-social …

- **Social Networks** – We post about our activities, experiences …
- **Specific Location Based Services** - Foursquare, Loopt, Gowalla, Scvngr, Yelp, etc.
- **Genere / Focus Specific Location Services** – Dating, Food, Sports, etc. …

[Session 1]

Geo Innovations and Supporting Policies in East Asian Countries

7

Needs on Geospatial Technologies for Sustainable Development in Asia and the Pacific and Expectation for Collaborative Partnership

Mr. Yusuke Muraki

(Space Technology Specialist,
Asian Development Bank)

ICG-TEK 2012

International Conference on sharing Geospatial
Technology, Experience and Knowledge

Needs on Geospatial Technologies for Sustainable Development in Asia and the Pacific and Expectation for Collaborative Partnership

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Abstract

Asian Development Bank (ADB) is a regional development bank to facilitate economic development and poverty reduction in developing member countries (DMCs) in Asia and the Pacific. ADB has been employing geospatial technology (GT) such as remote sensing (RS) and Geographic Information System (GIS) to address various development challenges and implement bank operation more efficiently and effectively. As ADB recognizes the effectiveness of GT for sustainable development, it expects further collaborative partnership with external partners to address some challenges to apply it through joint activities such as knowledge sharing of best practices of GT and discussion about effective total solutions to introduce GT in DMCs in sustainable manner.

Keywords: Sustainable Development, GIS, Remote Sensing

1. Introduction of Asian Development Bank

Asian Development Bank (ADB) is a regional development bank to facilitate economic development and poverty reduction in developing member countries (DMCs) in Asia and the Pacific. It provides loans, grants, and technical assistance (TA) with knowledge to address development issues. $15.3 billion was approved for financing in 2011 with around 3,000 employees from 55 countries out of 67 member countries.

ADB has been contributing to the following fields: Agriculture, Rural Development, and Food Security; Education; Energy; Environment; Climate Change; Financial Sector Development; Gender Equity; Health; Public Management and Governance (Including Disaster Risk Management); Public-Private Partnership; Regional Cooperation and Integration; Social Development and Poverty; Transport; Urban; and Water. It has been recognized that Geospatial Technology (GT) such as GIS can be an effective tool to improve the efficiency and effectiveness of its development activities and knowledge sharing in all of these sectors.

2. ADB's approach to apply GT

ADB has recognized the necessity of employing new technologies including GT. The operational plans for each sector emphasize the necessity of application of technologies. Water Operational Plan 2011-2020 mentions about technology application to areas such as Integrated Water Resource Management (IWRM) and Water-related Disaster Risk Management, and suggest the establishment of Asian Water Information System. Sustainable Transport Initiative Operational Plan mentions Intelligent Transport System (ITS) for real-time and accurate traffic monitoring, efficient management of congestion and infrastructure, and decision support of traffic design. Urban Operational Plan mentions about technology application for Integrated Urban Planning.

With such recognition, ADB has been trying to apply GT through its operations. ADB's approach of the GT application can be categorized into three: (i) introducing GT in DMCs, (ii) applying GT for thematic assessments, and (iii) applying GT in ADB operations.

2.1 Introducing GT in DMCs

ADB has been contributing to support DMCs to introduce GT such as GIS and RS applications through project implementation such as capacity development technical assistance (TA) and knowledge sharing through workshops. There have been several projects which provided GT systems and the capacity development programs for staffs and stakeholders in DMCs so that they can sustainably use it for their daily operations.

As examples of this approach, Figure 2.1a shows the concept of GIS-based Municipal

Information System in Nepal introduced in ADB TA 7355-NEP: Institutional Strengthening of Municipalities Project, and Figure 2.1b shows the concept of Interactive Web-GIS for Great Mekong Subregion (GMS) developed in ADB TA 6289-REG: Core Environment Program and Biodiversity Conservation Corridors Initiative in the Greater Mekong Subregion.

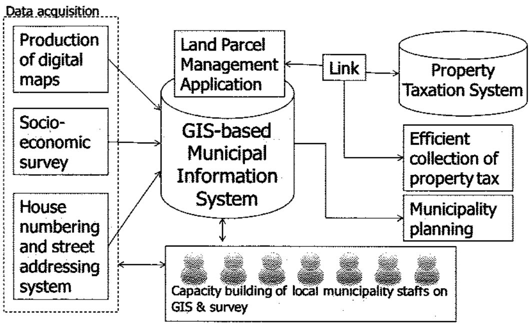

Figure 2.1a. GIS for Urban mapping in Nepa

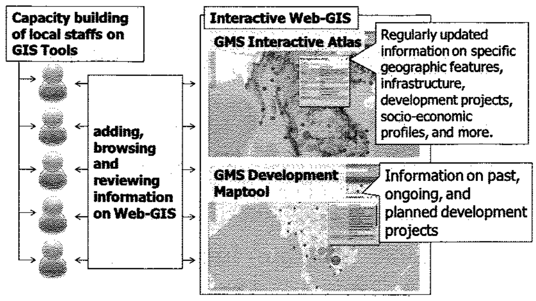

Figure 2.1b. Web GIS for decision making in GMS

Various projects have also been implemented to support agencies in DMCs to introduce RS application. Figure 2.1c shows the improved flood prediction and warning system with satellite-based precipitation and geographic data to be developed in on-going TA 8074-REG: Applying Remote Sensing Technology in River Basin Management in Bangladesh, Viet Nam, and Philippines. Based on the partnership agreement with Japan Aerospace Exploration Agency (JAXA), ADB has been conceptualizing more projects applying RS with their technical support.

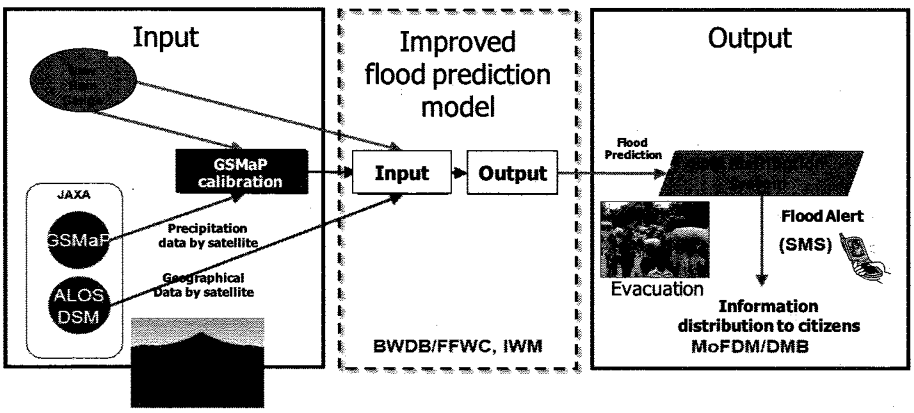

Figure 2.1c. Improved flood prediction using remote sensing

2.2 Applying GT for thematic assessments

ADB has been applying GT for its thematic assessments and analyses in each sector. As an example, ADB developed Web-GIS system for identification of suitable area for reusable energy and climate change impact risk maps in ADB TA 7274-REG: Climate Resilience for Natural Resources Investment in Central and West Asia.

2.3 Applying GT in ADB operations

GIS has been used for the project design of infrastructure and other projects mainly by consultants. The use of GIS for this purpose in ADB has not been widely spread yet. Field survey using GPS has also been conducted to collect necessary information for the project preparation. Satellite imagery and its processed data, especially those freely available in Google Earth have been also widely used by many ADB staff to check the situation of project sites.

Web GIS has been applied to manage technical assistance project information in Energy sector for the internal use. Based on the understanding of the effectiveness of GIS for this project information management purpose, ADB is now exploring to establish Web GIS to share all project information with public, which would be the system like Mapping for Results operated by World Bank. The establishment of the bank-wide Integrated GIS platform has also been studied for multiple purposes including: (i) Project information sharing on maps; (ii) Project planning; (iii) Archive for procured map data and satellite imagery; (iv) Geospatial analysis tool; (v) and map making.

3. GT for sustainable development

ADB understands that GT contributes to address various challenges for sustainable development such as: (i) climate change and disaster risk management; (ii) rapid urbanization; (iii) water security; and (iv) access to infrastructure service. Information obtained with GT and geospatial analyses provides better understanding of the situation for decision making.

For climate change and disaster risk management, risk maps made with outputs of simulation models and other geospatial information have been widely used for understanding the risk and impact of climate change and disaster risks. Figure 3a shows the example of climate change impact assessment on urban drainage and ground water availability in Bangladesh conducted in ADB TA-7197 BAN: Strengthening the Resilience of the Water Sector in Khulna to Climate Change.

For rapid urbanization, urban maps derived from historical satellite data and socio-economic analyses on spatial structure of urban development have been conducted in various urban projects to have better understanding of the situation.

For water security, geospatial analyses have been conducted in river basins and urban areas to visualize the situation of water security. Figure 3b shows the concept of Water Security Index obtained by overlaying different relevant information.

For infrastructure services, for example in the transport sector, geospatial analyses using GIS which overlay road data, village location with population data have been conducted in various regions to identify gaps in infrastructure accessibility as information resource for planning of infrastructure development.

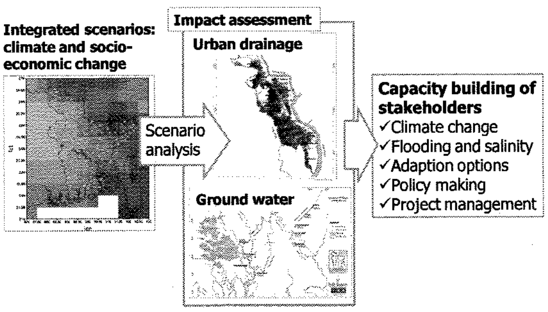

Figure 3a. Impact assessment for the climate change

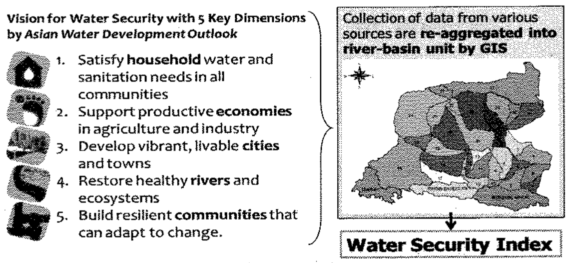

Figure 3b. Impact assessment for the climate change

4. Issues to apply GT and Expectation for Collaborative Partnership

Although ADB recognizes the importance of the application of GT in its operations, there are still issues that need to be addressed to realize its actual application in DMCs. Major issues are: (i) difficulty to design total solution with the consideration of sustainability; (ii) GT application cost in DMCs; and (iii) necessity to have enough validation results before introduction.

In order to introduce GT to DMCs through ADB projects in sustainable manner, it is indispensable to design the total solution with the consideration of sustainability including: (i) cost (initial and operational); (ii) human resources; (iii) institutional arrangement (who to fund, who to operate, etc); and (iv) incentive mechanism. The information about the effectiveness of technology is not satisfactory itself. Therefore, collaborative partnership between technology providers, governmental agencies, development partners, researchers, and others is important to create such total solutions taking into account aspects other than technology.

Moreover, the cost for the application of new technology is still a big problem in DMCs. Optimizing specifications of products to the use in DMCs, where too much high quality function is not required and cheap labor cost is available, might be one effective way to make the solution affordable in DMCs. Employment of labor intensive manual approach as a part of the system instead of development of expensive software might be also effective. ADB would like to have a discussion with technology providers to come up with such localized effective approach in DMCs.

Also, in order to employ new technology in DMCs, results of practical use or enough validation in pilot projects are required. The results of a research or study only are not satisfactory. Collaborative partnership to conduct such pilot activities to fill such gap for the actual application in DMCs is also effective.

Collaborative partnership can be through: (i) joint knowledge work; and (ii) joint demonstration activity including co-financing and private sector participation. As the GT applications that have been applied by ADB were mainly Geospatial analysis, GIS and RS applications, ADB also would like to learn new GT applications effective to address challenges for sustainable development.

5. Conclusion

ADB recognizes that GT have great potential for ADB and its projects in DMCs. ADB has demonstrated several projects in which GT played an important role and would like to promote its application further. However, there are still issues and challenges to promote GT applications in ADB projects and DMCs. In order to address the issues, ADB is eager to strengthen partnership and scale up joint activities with external partners.

Needs on Geospatial Technologies for Sustainable Development in Asia and the Pacific and expectation for collaborative partnership

Presentation by
Yusuke Muraki
Space Technology Specialist
Asian Development Bank
11 October 2012

1 ADB

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1. Introduction of ADB
2. ADB's approach to Geospatial Technology (GT)
3. GT for sustainable development
4. Issues to apply GT and Expectation for Collaborative Partnership
5. Concluding remarks

2 ADB

1. Introduction of ADB

3 ADB

1. Introduction of ADB

- Regional development bank to facilitate economic development and poverty reduction in development member countries (DMCs) in Asia and the Pacific.
- Provides loan, grant, and technical assistance (TA) with knowledge to address development issues.
- $15.3 billion in approved financing in 2011, and 3000 employees from 55 countries

4 ADB

1. Introduction of ADB

- Sectors (CoP: Community of Practice)
  - Agriculture, Rural Development, and Food Security
  - Education
  - Energy
  - Environment (Inc. Climate change)
  - Financial Sector Development
  - Gender Equity
  - Health
  - Public Management and Governance (Inc. Disaster Risk Management)
  - Public-Private Partnership
  - Regional Cooperation and Integration
  - Social Development and Poverty
  - Transport
  - Urban
  - Water

5 ADB

2. ADB's approach to geospatial technologies

6 ADB

2. ADB's approach to geospatial technologies

- Operational plans emphasize technologies
  - Water Operational Plan 2011-2020:
    - Integrated Water Resource Management
    - Water-related Disaster Risk Management
    - Establishment of Asian Water Information System
  - Sustainable Transport Initiative Operational Plan:
    - Intelligent transport system (ITS) for real-time and accurate traffic monitoring, efficient management of congestion and infrastructure, and decision support of traffic design.
  - Urban Operational Plan: Integrated urban planning
  - Etc.

- Geospatial technologies (GT), especially GIS, are recognized as efficient tools for development and knowledge sharing

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2. ADB's approach to geospatial technologies

1. Introducing GT in DMCs
2. Applying GT for thematic assessments
3. Applying GT in ADB operations

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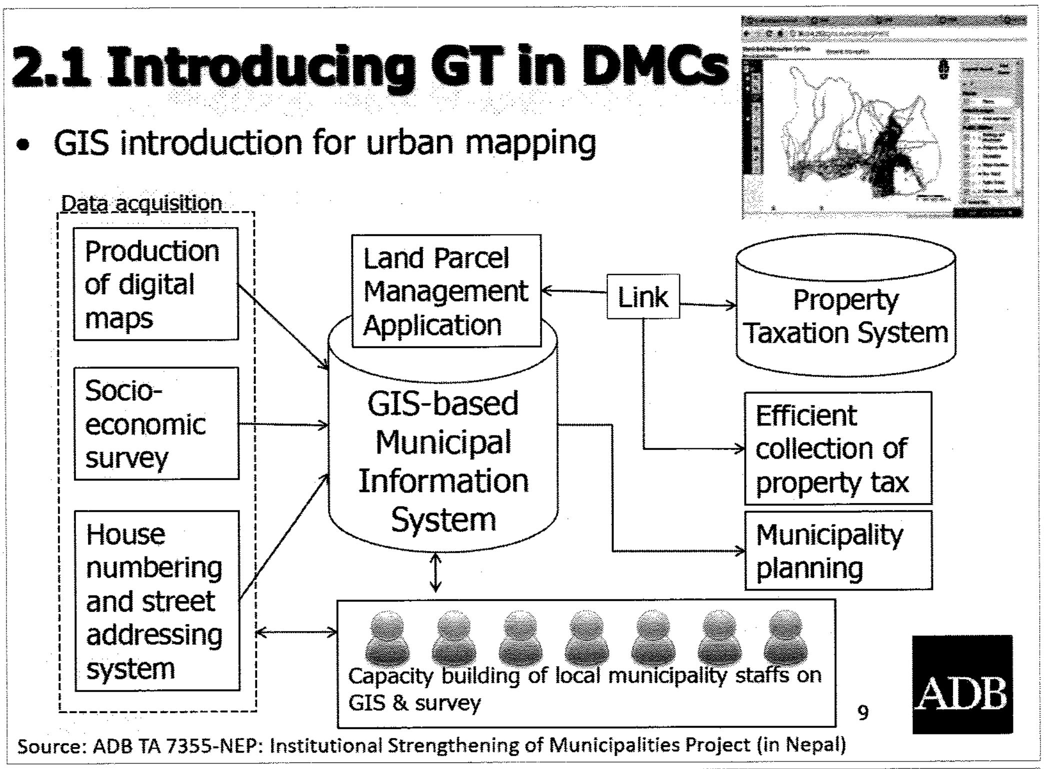
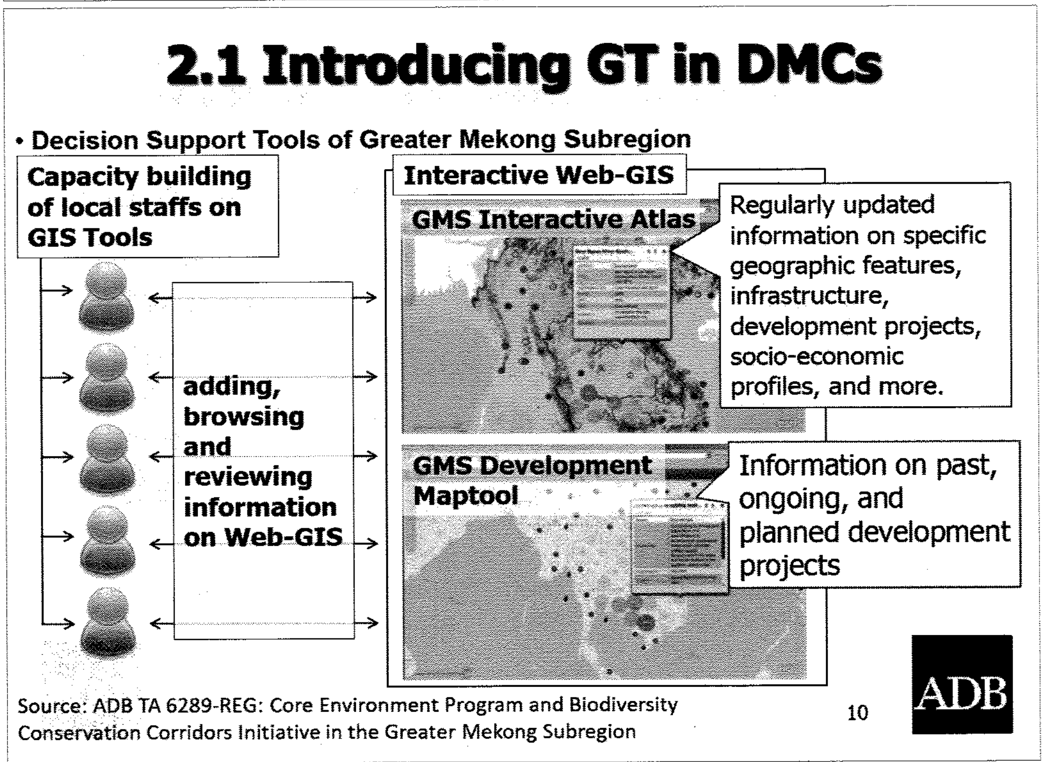
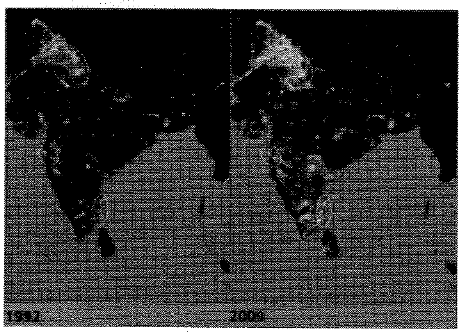

2.1 Introducing GT in DMCs
• GIS introduction for urban mapping
Data acquisition
Production of digital maps
Socio-economic survey
House numbering and street addressing system
Land Parcel Management Application
GIS-based Municipal Information System
Link
Property Taxation System
Efficient collection of property tax
Municipality planning
Capacity building of local municipality staffs on GIS & survey
9
ADB
Source: ADB TA 7355-NEP: Institutional Strengthening of Municipalities Project (in Nepal)


2.1 Introducing GT in DMCs
• Decision Support Tools of Greater Mekong Subregion
Capacity building of local staffs on GIS Tools
adding, browsing and reviewing information on Web-GIS
Interactive Web-GIS
GMS Interactive Atlas
Regularly updated information on specific geographic features, infrastructure, development projects, socio-economic profiles, and more.
GMS Development Maptool
Information on past, ongoing, and planned development projects
Source: ADB TA 6289-REG: Core Environment Program and Biodiversity Conservation Corridors Initiative in the Greater Mekong Subregion
10
ADB

2.2 Applying GT for thematic assessments

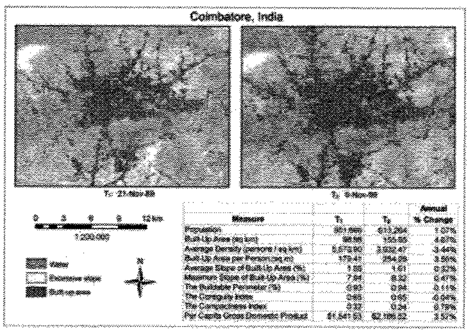
-Monitoring urban development by satellite remote sensing

Night-time light images compared in two times



Cited from Energy for All: Asia's Night Skies Reveal Growth and Gaps in Electrification, September 2011, ADB.

Analysis on spatial structure of urban development



Cited from The Dynamics of Global Urban Expansion, S. Angel *et al*, 2005, The World Bank.

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2.3 Applying GT in ADB Operations

- GIS application for project design and data management
- GPS applications for field survey
- Satellite imagery applications for project planning and monitoring (e.g. Google Earth)

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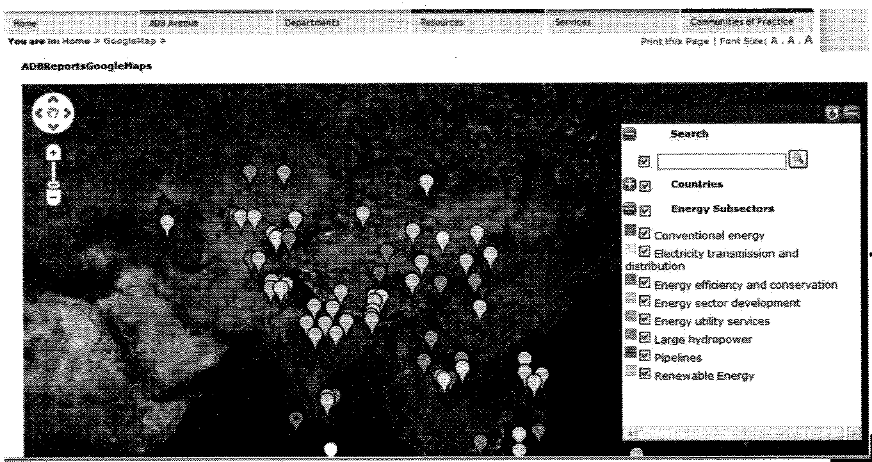
2.3 Applying GT in ADB Operations

- Web GIS for Archive of CoP project information

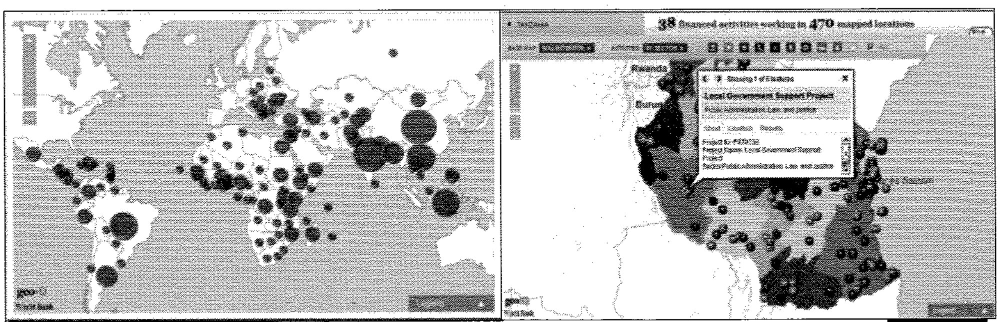


17 ADB

2.3 Applying GT in ADB Operations

(Future Plan) Mapping project information

- Improves public transparency of ADB projects
- c.f. World Bank's Mapping for Results

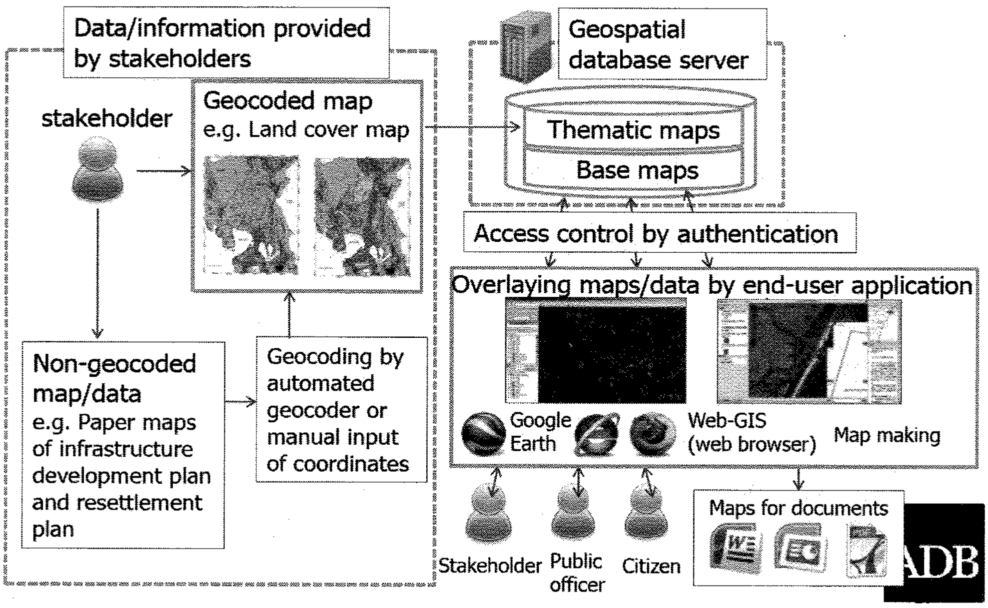


THE WORLD BANK
Working for a World Free of Poverty

Cited from http://maps.worldbank.org/

18 ADB

(Future plan) Integrated geospatial information system for improved knowledge sharing



3. Geospatial technologies for sustainable development

Development Challenges

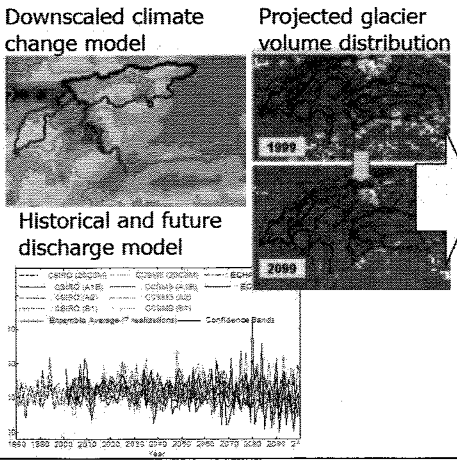
Geospatial technologies contributes to address development challenges:

- Climate Change and Disaster Risk Management
- Rapid Urbanization
- Water Security
- Access to Infrastructure Service

ADB

Example of Climate Change and Disaster Risk Management:
Climate Change Impact Assessment in the Pyanj River Basin

Modeling climate change and river environment



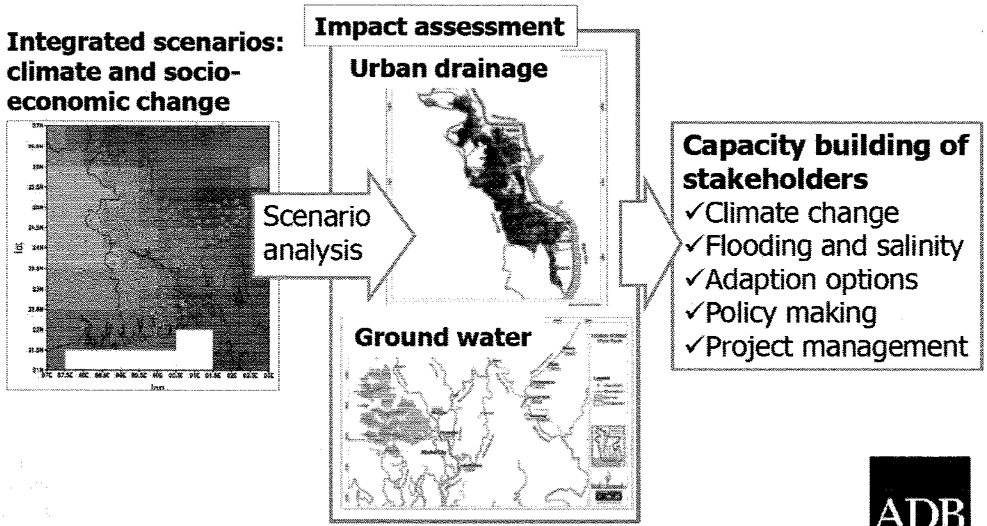
Assessment of climate change impact and frequency

		Definition (Summary)
Impact	Low	No loss of life or houses, Minor damage to land and infrastructure, Damage less than $0.1 M.
Impact	Medium	No loss of life, Significant damage to land and infrastructure, Damage $0.1-$1.0 M.
Impact	High	Loss of life, Destruction of to land and infrastructure, Damage greater than $1.0 M.
Frequency	Low	More than 10 years between events
Frequency	Medium	5-10 years between events
Frequency	High	Less than 5 years between events
Adaptive	Low	Little or no capacity to ameliorate CC impacts
Adaptive	Medium	Limited capacity to respond to CC
Adaptive	High	Significant capacity to plan for and to manage CC impacts

ADB

Source: TA Final Report, ADB TA 7599-TAJ: Climate Resilience for Natural Resources Investment

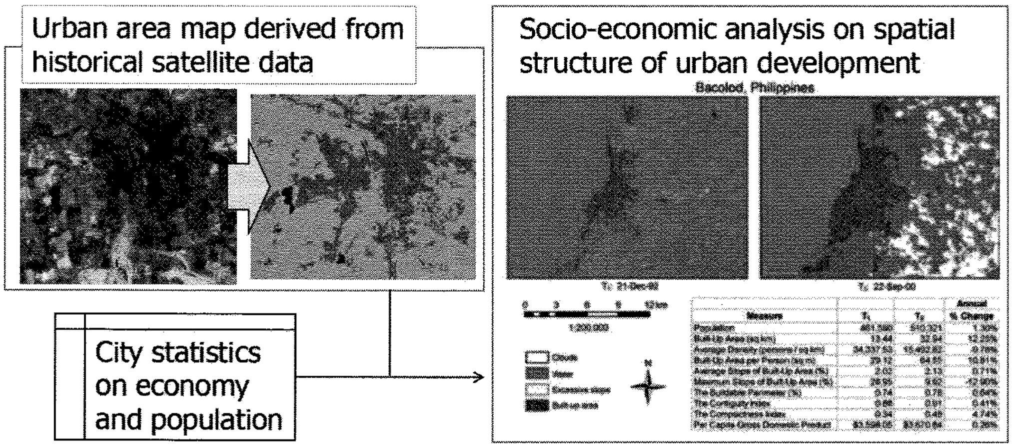
Example of Climate Change and Disaster Risk Management: Strengthening the Resilience of the Water Sector in Khulna to Climate Change



Source: TA Consultants' Reports, ADB TA-7197 BAN:
Strengthening the Resilience of the Water Sector in Khulna to Climate Change

ADB

Example of Rapid Urbanization: Satellite-based urban area mapping

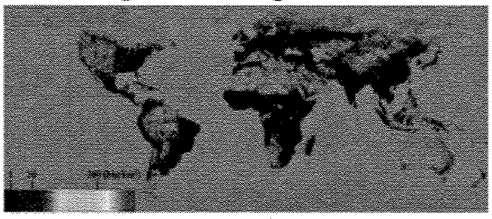


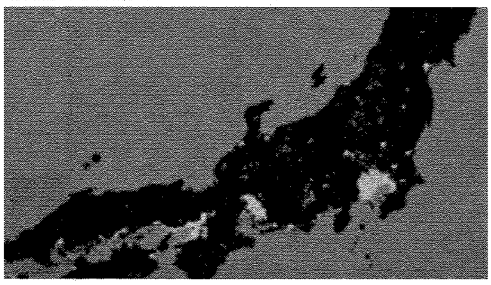
Source: The Dynamics of Global Urban Expansion, S. Angel *et al*, 2005, The World Bank.

ADB

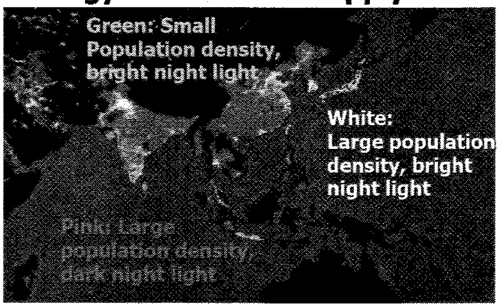
Example of Rapid Urbanization: Night-time light observation for socio-economic data

Grid-based GDP data estimated from night-time light





Illuminating gaps in energy demand and supply



Source: Energy for All: Asia's Night Skies Reveal Growth and Gaps in Electrification, 2011, ADB.

Grid of total economic activity in millions of dollars per km2 pixel. Source: Ghosh, T. *et al.* ,2010, Shedding light on the global distribution of economic activity, *The Open Geography Journal* (3), 148-161.

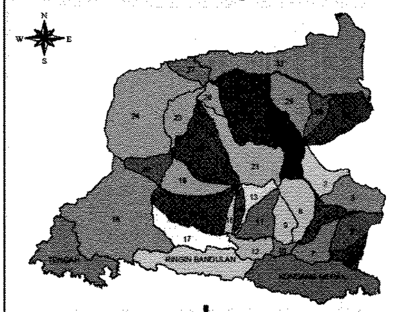
ADB

Example of Water Security: Water Security Assessments in River Basins

Vision for Water Security with 5 Key Dimensions by *Asian Water Development Outlook*

1. Satisfy **household** water and sanitation needs in all communities
2. Support productive **economies** in agriculture and industry
3. Develop vibrant, livable **cities** and towns
4. Restore healthy **rivers** and ecosystems
5. Build resilient **communities** that can adapt to change.

Collection of data from various sources are **re-aggregated into river-basin unit by GIS**



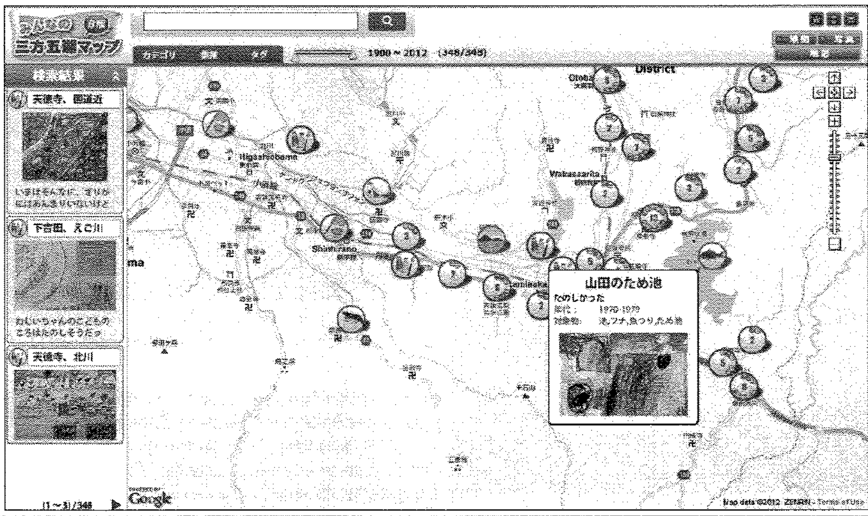
Water Security Index

ADB

Example of Water Security:

Crowd sourcing/Public participation GIS for monitoring the river

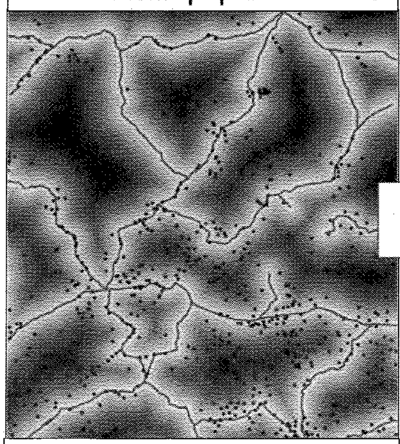
Mikatagoko-Lake Map by CSIS, The University of Tokyo:
Mapping photos and children's drawings and sharing them with stakeholders.



Example of Access to Infrastructure Service:

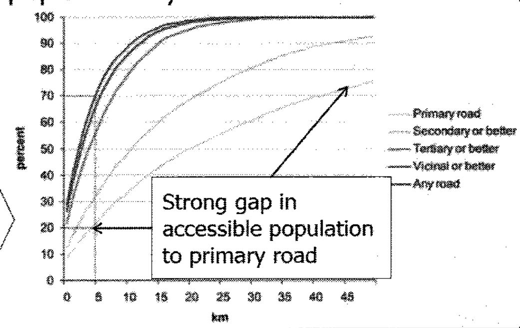
Identifying gaps in infrastructure accessibility

Overlaying road data, village location with population data



Blue dot: villages; Blue line: roads
Red-Pink: distance from roads

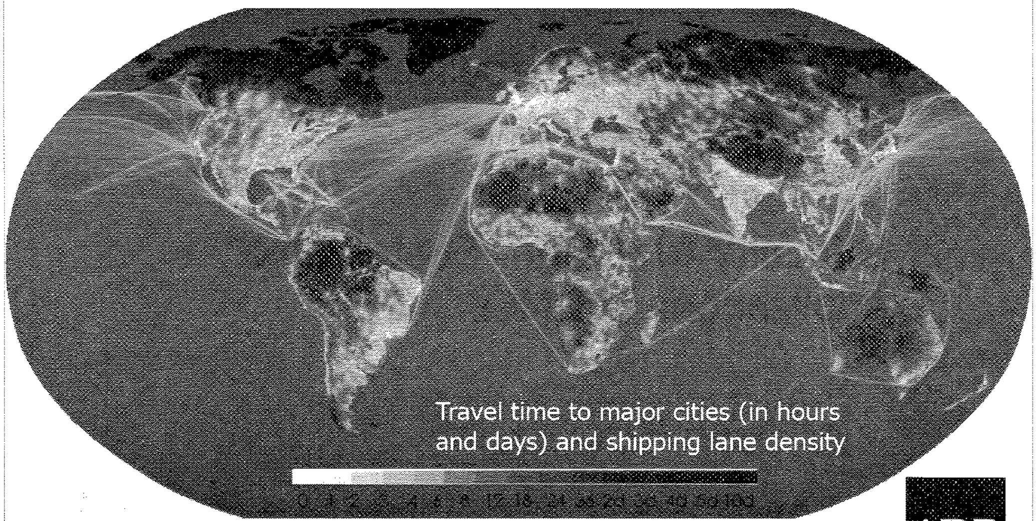
Cumulative percent of rural population by distance from roads



Information resource for planning of infrastructure development

Source:Uwe Deichmann, 2007, Use of GIS in road sector analysis, World Bank.

Example of Access to Infrastructure Service:
Accessibility to major cities



Source: European Commission Joint Research Center, 2010, Travel time to major cities: A global map of Accessibility, http://bioval.jrc.ec.europa.eu/products/gam/index.htm

ADB

4. Issues to apply GT and Expectation for Collaborative Partnership

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ADB

Issues to apply GT

1. Few examples of applications which have been put to practical use

2. Difficulty to design "Sustainable" applications in DMCs

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Issues to apply GT

- Design of sustainability in ADB projects

A) Cost (Initial and Operational)
B) Human Resources
C) Institutional Arrangement
D) Mechanism (Incentive)

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Issues to apply GT

How does ADB address the issues?

Policy Dialogue

↓

Partnership

↓

Knowledge sharing / Capacity development

↓

Project development – TA, Grant, and loan

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ADB

Expectation for Collaborative Partnership

1. Localize technologies for DMCs
2. Sharing practical experience of sustainable operation of GT
3. Joint demonstration activities for scaling up

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ADB

Localize technologies for DMCs

- Reducing cost to be affordable for DMCs
  - **Optimizing specifications:** Products in developed countries are generally unaffordable for DMCs owing to its high specifications. Extra cost could be saved by proper localization.
  - **Maximum use of local resources:** Human resources are generally available with lower cost than that in the developed countries. Labor-intensive works would be cost-effective by hiring local people.
- Localizing products and services
  - **Specification and operation preferred by local people:** Products and services in developed countries are not necessarily universal. Consideration on characteristics, education, and social structure is required.
  - **Implementing on existing systems** are appreciated, not entirely replacing it with new system.

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Sharing practical experience of sustainable operation of geospatial technologies

- Institutional and organizational structure for sustainable operation
  - Management of administrative database, including updating and sharing data by local governments
  - Mechanism of financial support
- Showing best practices to DMCs and ADB
  - National spatial data infrastructure
  - Local government GIS
  - Environmental resource management (forest, agriculture, urban, water etc.)
  - Disaster management

36 ADB

Joint demonstration activities for scaling up

- Inter-agency coordination
- Conduct joint knowledge work and pilot demonstration activity with ADB in DMCs
- Scaling up the activities through ODA, Co-financing, and Private sector participation

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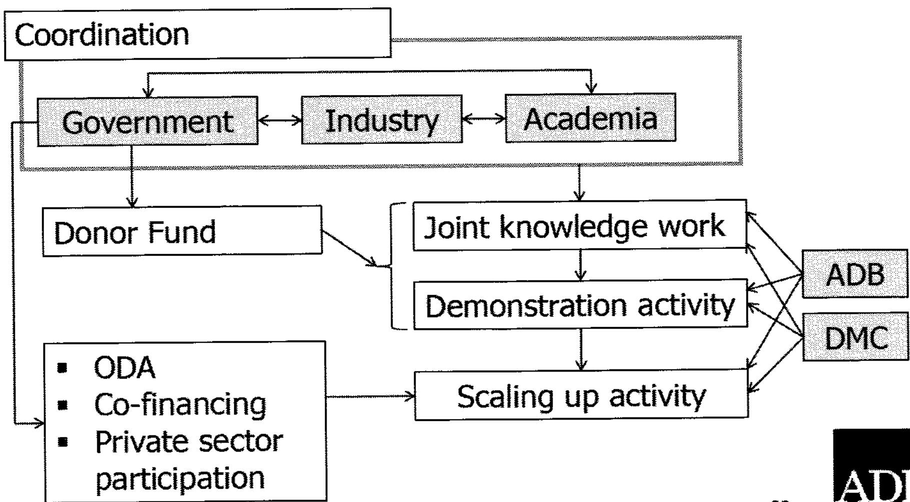
ADB

Strategic coordination of industry, government, and academia



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5. Concluding remarks

- Geospatial technologies have great potentials for ADB and its projects in DMCs.
- ADB has demonstrated some projects in which geospatial technologies played an important role.
- ADB is eager to strengthen partnership and scale up joint activities.

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