

**First Forum
Seoul, Republic of Korea, 24-26 October 2011**

**Asia-Pacific Experiences in Developing Common
Frameworks and Methodologies ***

* Submitted by: Mr. Hiroshi Murakami, Professor Abbas Rajabifard, and Mr Greg Scott,
Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP)

Permanent Committee on GIS Infrastructure
for Asia and the Pacific (PCGIAP)

Established in 1995 by a United Nations Resolution

PCGIAP Paper for the 1st High Level Forum on
United Nations Global Geospatial Information Management
Seoul, Korea, 24-26 October 2011

Asia-Pacific Experiences in Developing Common Frameworks and Methodologies

Dr Hiroshi Murakami, Professor Abbas Rajabifard, and Mr Greg Scott
Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP)

1. INTRODUCTION

The effective use of geospatial information has been increasingly recognized to help address many of the challenges the current world is facing, including; climate change, natural disasters, pandemics, famines, population displacement and food and economic crises. The majority of these challenges are cross-border in nature, and require policy responses that transition from local to global. Over the years, in order to cope with these challenges, many national, regional and global efforts have been made to build infrastructure for the gathering, sharing and dissemination of geospatial information. Spatial data infrastructures (SDI's) are a critical aspect of the national, regional and global geospatial information infrastructure. With multiple components (Figure 1), many national SDI's have been developed and have enhanced national capability to develop and share geospatial information. As for regional SDI's, European countries legislated a Directive in May 2007 to establish an Infrastructure for Spatial Information in the European Community (INSPIRE) and have made significant progress in developing the regional SDI in Europe.

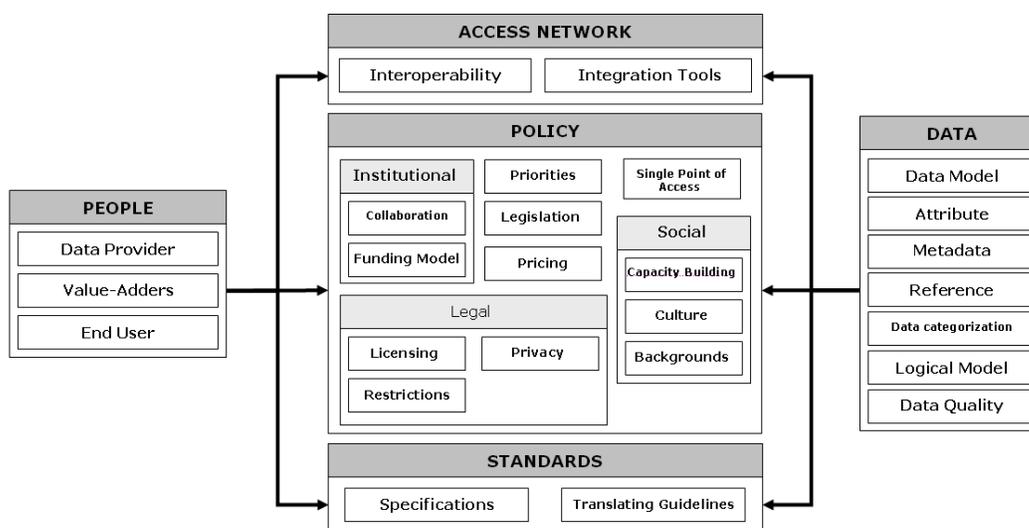


Figure 1: SDI and its technological components

These successful SDI's have been supported by many global initiatives, such as ISO/TC211, OGC, GSDI and Global Mapping, in developing technical standards and base geospatial data as well as providing best practices in SDI development. The United Nations Secretary-General's report (E/2011/89) May 2011 on global geospatial information management states that *"It is increasingly recognized, however, that the major barriers and impediments to building geospatial information infrastructure will not be technical in nature, but rather institutional and organizational, including the ability to bring countries together to cooperate with and learn from each other, and to promote collaboration on the development of regional and global spatial data infrastructure standards."* This understanding led the Member States of the UN Economic and Social Council (ECOSOC) to adopt a decision (E/2011/L.53) in July 2011 to recognize the need to promote international cooperation in the field of global geospatial information, and to establish the Committee of Experts on Global Geospatial Information Management (GGIM).

One of the objectives and functions defined in the Terms of Reference of the Committee of Experts on GGIM is *"To propose workplans and guidelines with a view to promoting common principles, policies, methods, mechanisms and standards for the interoperability and interchange ability of geospatial data and services"*. This paper intends to contribute to a greater understanding of this work by introducing the experiences of the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP), and its efforts to develop a regional SDI, including common frameworks and methodologies.

Established in 1995, PCGIAP aims to maximise the economic, social and environmental benefits of geographic information in accordance with Agenda 21 of the United Nations Environment Programme (UNEP), by providing a forum for nations from the Asia and Pacific region to:

- Cooperate in the development of a regional geographic information infrastructure;
- Contribute to the development of the global geographic information infrastructure;
- Share experiences and consult on matters of common interest; and
- Participate in any other form of activity such as education, training, and technology transfer.

PCGIAP's efforts to achieve these aims have been built on past experiences and best practices of the aforementioned successful national and regional SDI's.

The Asia-Pacific region represents 60% of the world's population, includes 56 countries as defined by the United Nations, a huge geographic area with diverse levels of economic and social development, and includes many of the world's megacities – those with more than 8 million people. At the same time, the region is characterized by its diversity in; climate, landcover, topography, culture, economic, political and legal systems, and its large expanse of land coverage. Importantly, and emphasised for context, many of the region's nations can be described as developing or transitional, rather than developed. This diversity puts PCGIAP in a strong position to address the challenges and directions the Committee of Experts on GGIM needs to discuss in order to develop common frameworks and methodologies from a global perspective.

This paper presents the current status, activities and challenges from the perspective of developing common frameworks and methodologies in the Asia-Pacific region and extrapolates them to the global context in the following areas:

1. Technical abilities;
2. Geodetic abilities; and

3. Institutional processes.

2. BACKGROUND

Members of PCGIAP are directorates of national surveying and mapping organizations, or equivalent national agencies within Asia and the Pacific. The committee meets annually and reports every three years to the United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP). An executive board comprising of; president, vice-president, secretary, and up to nine other members, administers PCGIAP work and activities. The Committee also seeks to establish links with other relevant United Nations programs and international bodies including the UNRCC for the Americas, PC-IDEA, ISCGM, EUROGI, EUROGEOGRAPHICS, GSDI, ISO/TC211, FIG, ISPRS and ICA.

The objectives of PCGIAP as described in the Statutes are:

- Define the nature of a regional geographic information infrastructure that each country in the region can contribute to in order to meet regional and global mapping and GIS requirements;
- Determine the nature of legislative and administrative procedures and orders appropriate to the acquisition and sharing of spatial data;
- Develop a regional geodetic framework, regional topographic datasets, national cadastral datasets, and regional geographical names datasets as the basis for regional GIS activity;
- Document the status of key geographic datasets and key agencies in each member nation, and develop a framework for the exchange of such information;
- Prepare guidelines and strategies to assist member nations for the implementation of cadastral development to meet individual member nation needs;
- Determine the need for research, training and technology and policy exchange in relation to the beneficial impact of geographic information on the social, economic and environmental objectives of member nations of Asia and the Pacific region; and
- Explore opportunities for aid funding to support development needs of member nations and for the development of a regional spatial data infrastructure.

In short, PCGIAP aims include developing a regional SDI, i.e. an Asia-Pacific SDI (APSDI), as an enabling platform. This platform will facilitate the efficient development of, access to, and integration of, a wide range of geospatial data from various custodians and agencies and at different jurisdictional levels in the region. Successful development of a regional SDI relies heavily on the interoperability of geospatial data and related systems among different organizations in the region (Figure 2). Unfortunately this implies challenges with regard to both technical and non-technical impediments that are affected by legal, policy, institutional and social factors. Consequently, the development of common frameworks and methodologies is essential to the successful and sustained development of APSDI, as it will provide standards for the effective management and sharing of information across agency boundaries.

The next section describes some of the major activities of PCGIAP and the current status of the APSDI in terms of establishing common frameworks and methodologies, as identified through the

latest 'Questionnaire on Status of SDI in PCGIAP, September 2011' (the questionnaire) results from member countries.

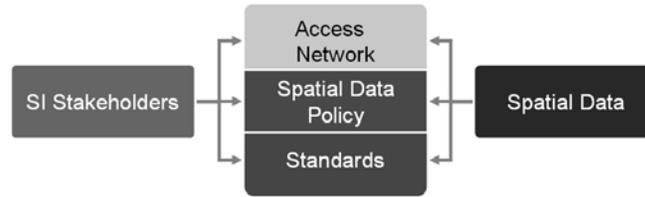


Figure 2: Integration elements in the SDI model

3. PCGIAP ACTIVITIES

PCGIAP has established working groups to undertake projects in pursuit of the organization's aims and objectives. At present, most of the activities of PCGIAP and its working groups are directed towards developing and implementing the components of the APSDI. From these activities, this paper focuses on technical abilities, geodetic abilities, and institutional processes, as they are related to the development of common frameworks and methodologies. In order to understand the current regional status of these themes, a questionnaire to all PCGIAP member nations was conducted in September 2011. While the number of responses to the questionnaire is still limited at the time of writing, a preliminary analysis on responses provides some insight into the current status of SDI development of member countries in the region.

3.1 TECHNICAL ABILITIES

The current body of developed international standards used to promote interoperability in geospatial information and applications have been primarily spearheaded by the International Organization for Standards' Technical Committee on Geographic Information (ISO/TC211) (established in 1994) and the Open Geospatial Consortium (OGC). These two organizations and their partners have developed a set of important standards and specifications that enable the industry to discover, access, exchange and share geospatial information through the use of common formats and/or interoperable software applications. PCGIAP has endorsed the use of these standards and is now in the dissemination phase, in which those standards are to be adopted, or adapted if necessary, by each country so that all transactions in geospatial information are based on consistent international standards.

Taking advantage of these established technical standards, PCGIAP has developed a fundamental geospatial database of the region as part of the efforts to develop the regional SDI. A regional framework dataset (administrative boundaries, roads, hydrography and populated places) was developed as a seamless vector dataset covering 22 countries, starting with the countries affected by the Indian Ocean tsunami in 2004. This dataset was developed with close collaboration between; national mapping organizations, PCGIAP, the International Steering Committee for Global Mapping (ISCGM), and the Secondary Administrative Level Boundary (SALB) project. A prototype of a metadata profile for the region was also developed in close cooperation with ISO/TC211. The development of the clearinghouse, which focuses on the provision of standard protocols and guidelines for training purposes, is currently in progress.

PCGIAP had limited knowledge and understanding of the number of countries which have adopted the international standards on geospatial information, or who have used them as mandatory or common practice in their data transactions. To address this knowledge gap, the questionnaire results were used to discern the current use of international standards in data sharing. The questionnaire sought to provide insight into the practices of geospatial information provision and distribution by member nations and organizations. In addition to standards and formats, the questions were also pertinent to regulations surrounding the provision of metadata (standards used or recommended for this purpose) as well as determining the use of mechanisms such as clearinghouses to facilitate access to information.

The preliminary results of the questionnaire show that out of fourteen respondents, only four countries use standards based on ISO/TC211 for the distribution of their geospatial data, nine countries have a regulation or guideline that requires government offices to prepare metadata, and eight countries having a clearinghouse. While PCGIAP has been promoting the adoption of well-established international standards, the progress of adoption in the member countries seems to be slow and may need some research on the cause of such deterrence, as well as further promotion.

3.2 GEODETIC ABILITIES

A fundamental requirement of any SDI, including a regional SDI, is a common underpinning geodetic layer that defines the location of every piece of geospatial information based on a standard geodetic datum. In the past, each country locally defined its own geodetic datum, which does not necessarily provide the same coordinates for a particular location as those defined by a different datum in a neighbouring country. Since the introduction of space geodesy, and measurements using GPS, international organizations have been providing the parameters for a common geocentric datum, including an International Terrestrial Reference Frame (ITRF) that is regularly updated in order to incorporate changes caused by the earth's crustal activities. It is very important for countries in the region to adopt a common geocentric datum so that all geospatial information in the region will become interoperable. PCGIAP has been assisting member countries in introducing a geocentric datum.

a. Annual GNSS/GPS Campaign

In order to densify the ITRF in the Asia-Pacific Region, PCGIAP's annual one-week GNSS/GPS campaign - the Asia Pacific Regional Geodetic Project (APRGP) - has been held to provide an opportunity to connect national geodetic networks and to determine site velocities. The first campaign was undertaken in October 1997 and included very long baseline interferometry, satellite laser ranging, and global positioning system (GPS) geodetic techniques. From 1998 to 2011, 14 regional campaigns have been undertaken to build a primary network of sites with known location and movement velocities. From 2006 to 2011, Geoscience Australia (GA) coordinated six APRGP campaigns. GA also carried out the preliminary re-processing of APRGP data sets from 1997 to 2008, as well as combining the data from all campaigns. This includes a data set of 437 points and site movement velocities for all points with multiple occupations.

The success of the regional geodetic field campaigns, and the technology transfer to many nations, has been evidenced by their ability to process and analyse regional geodetic networks at high levels of accuracy. Regional solutions using these data have been processed by Australia, Japan, Malaysia, and China, and a combined solution is available from GA. Solutions from these

campaigns provide primary ITRF 2000 values. China, Japan, Korea and Australia are also densifying their GPS networks whilst Indonesia and Philippines are planning to build and/or densify their continuous GPS networks.

In addition to the permanent GPS sites which supply continuous GPS data to the International GPS Service (IGS), countries that have supplied GPS campaign observation data include: Australia, Brunei, Cambodia, Cook Islands, Fiji, Hong Kong (China), Japan, Kiribati, India, Indonesia, Iran, Laos, Macau (China), Malaysia, Republic of Maldives, Mongolia, New Caledonia, New Zealand, Papua New Guinea, Philippines, Samoa, South Korea, Tonga, Thailand, Tuvalu, Vanuatu and Vietnam, and some other Pacific island sites.

With the establishment of a regional geodetic reference infrastructure, guidelines for preparation of transformation parameters have been presented during PCGIAP annual meetings. These will assist countries to readjust their geodetic network directly into the regional datum, or to develop transformation parameters to facilitate the shift of dependent geospatial data onto a regional datum. For example, Korea began to develop its precise geoid model in 2007, and China's datum became geocentric in 2008.

According to the questionnaire results, five of the fourteen countries that responded still use a locally established geodetic datum. Two of the five has no plan of introducing a geocentric datum in the near future. In light of the increasing use of Global Navigation Satellite Systems (GNSS) in geospatial information applications, as well as in surveying and mapping, the adoption of a geocentric datum in all member countries is indispensable. Necessary assistance, including technology transfer, should be provided to these countries to ensure that they can obtain the full benefit of GNSS and its applications.

b. Regional geodetic framework development

As one of the regional projects of PCGIAP, a regional geodetic framework (datum) is being developed for the region. The Asia-Pacific Reference Frame (APREF) Project is modelled on the European Reference Framework (EUREF) Network, is a frame based on continuous GPS tracking stations, and is developed through integration of national geodetic networks and appropriate linkages to global reference frames. APREF aims to coordinate geodetic activity in the region and regional densification of the terrestrial reference, provide monitoring of crustal deformation, and further develop the APRGP activities for the future. Once developed, it will help those countries that have not yet adopted a geocentric datum to introduce and use GNSS technologies.

3.3 REGULATORY FRAMEWORK

The development and implementation of SDI's sometimes face challenges when different geospatial datasets are to be shared or integrated, based on the conventional frameworks and methodologies. This section provides two of those examples that PCGIAP now considers important to deal with for the successful delivery of regional SDI's.

a. Integration of land administration data

Amongst geospatial data, cadastral and topographic datasets are the most important for describing the built and natural environment. These datasets are the 'foundation data' in modern market

economies. However, in almost all countries these foundation datasets are developed to serve different purposes and are usually managed separately. This separation is recognised as a barrier to implementation of sustainable development. Duplication imposes unjustifiable costs on data collection and maintenance. The datasets should adopt the same overarching philosophy and data model to achieve multi-purpose data integration, both vertically and horizontally. Technological opportunities for data sharing alone cannot facilitate holistic comprehension of land as a composite of its built and natural components, and non-technical opportunities such as the development of a regulatory framework are just as important.

Traditionally, PCGIAP has been focusing mainly on subjects related to SDI development based on topographic mapping. However, PCGIAP has recently found that there is growing interest and need in the region, for better, more formal, land administration. Starting from an international workshop in 2007 in Mongolia, three additional international workshops have been successfully convened in the region (Malaysia, Iran, and Australia), on land administration. Such elevated interests on land administration in the region, and the importance of the role that land administration and the cadastre plays in providing large-scale, people-relevant geospatial data within SDI's, led the 18th UNRCC-AP in 2009 to adopt a resolution recommending PCGIAP facilitate an annual land administration forum within the bounds of spatially enabled governments.

b. Business practices

Geospatial information is receiving growing attention from industry and the private sector, as it often provides a completely new frontier for many companies to expand their business. Consequently, there has been a huge increase in the amount of geospatial information made freely available for public viewing and usage. This information can sometimes be very detailed, up-to-date, and highly sensitive – potentially leading to compromises in national security or personal privacy. Some countries have already taken specific actions against services that could potentially jeopardize national security or privacy. There is also a question of whether countries in the region are concerned with applications that utilise detailed geospatial information to provide enhanced services, and whether there is a need or desire to restrict the activities of private companies to control the use of geospatial information. Alternatively, the question could be posed to industry to determine if they are willing or ready to apply common business practices in the use of geospatial information in their services.

Based on the preliminary results of the questionnaire in the region, twelve of the fourteen countries that responded agree on the need for a regional/global regulatory framework for detailed geospatial information that can be shared on the Internet. Seven countries actually have regulations to restrict the use of high resolution imagery on the Internet. In view of such a large percentage of countries that agree on the need for a regulatory framework, actions should be taken to initiate discussions regarding such a framework and to develop associated guidelines.

4. AGENDA FOR GGIM

Based on experiences in developing the APSDI, and the results of preliminary analysis of the questionnaire, PCGIAP proposes a number of priority areas to be further discussed in the High Level Forum on UNGGIM and the UN Committee of Experts on GGIM regarding the development

of common frameworks and methodologies. These areas include geodetic, technical, and regulatory frameworks, which are elaborated in the following subsections.

a. Geodetic framework

A common geodetic framework is the most fundamental framework in GGIM, as it will underpin and 'position' all geospatial information on a standard geocentric datum. PCGIAP has been conducting a GPS observation campaign with many member countries in the region as well as developing the APREF, a regional geocentric datum. These projects have provided much technical information and support in introducing a geocentric datum to those nations that have been using a local datum. While the number of member countries that adopt a geocentric datum seems to be increasing in the region, there are still a number of member countries that have not done so. This impedes those countries from easy data integration with their neighbouring countries, and from taking advantage of the latest geodetic technologies, including GNSS. In order to provide technical assistance and maintenance of their infrastructures as part of a global geodetic network on a sustainable basis, both regional and international organizations should work together under the leadership of the UN Committee of Experts on GGIM. They should develop and provide technical guidelines and assistance, and organize a forum for addressing global problems concerning fundamental geodetic networks.

b. Technical framework

In order to effectively integrate geospatial data; standards and specifications are required to deal with technical inconsistencies including; metadata, quality, attribution and logical consistency. If not standardized, any attempt to integrate geospatial data is confined to the framework of single initiatives. In addition to the geodetic reference system discussed in the previous section, diversity in scales and formats hinders easy data integration and requires time and cost to cope with data preparation. Integration of data models facilitates a greater degree of cross-dataset analysis from both geospatial and non-geospatial perspectives.

The preliminary questionnaire result on the adoption of international standards in the member countries demonstrates that not every country in the region has adopted international standards on geospatial information as their national standards. This implies that data discovery and sharing may not be straightforward within each nation, let alone between the nations of the region. While most data sharing may be possible by using de facto data formats of commercial software applications, the lack of any mechanisms in searching and finding existing geospatial data may cause a duplication of effort in data development. International organizations and countries in the region should work together to assist those countries that have not fully employed international standards on geospatial information through the sharing of best practices.

In this context, GGIM, in close cooperation with regional organizations including PCGIAP and PC-IDEA and related international organizations, should first conduct a global questionnaire on the technical standards adopted in the Member States and review these regularly to monitor the progress in the dissemination of international standards. Based on the result of the questionnaire, workplans and guidelines should be prepared to promote common standards for the interoperability and interchange ability of geospatial data and services among the Member States.

c. Regulatory framework

In the context of SDI's and geospatial information management, comprising distributed capabilities that are under different ownership, and are developed and operated independently, the role of coordination is critical. As the coordinator for the Asia-Pacific region, the aims and objectives of PCGIAP (as described earlier in this report) have remained virtually unchanged since they were defined in 1995. The past 15 years has seen tremendous changes at every level, most impressively in socio-economic and technological aspects. During this period we have seen geospatial information and SDI's play an increasingly important and diverse role, while their potential has been continuously explored and expanded. Commensurate with this, we are seeing significant changes in the "traditional" functions and operational roles of national mapping agencies, not only within the Asia-Pacific region, but around the globe.

The daily business of mapping agencies is no longer just about coordination and delivery of cartographic products and related activities. To some degree, it is no longer just about GIS and SDI. The message and motivation is consistent across many forums, how geospatial information and related technologies can be applied to the contemporary problems facing the world today. It is not just about the data and technology, but the policy and governance to enable the information to be leveraged, integrated and delivered appropriately under necessary regulations and in a timely manner. For example, as discussed above on the detailed geospatial information available on the Internet; there is a need for a regional and global regulatory framework for information made publicly available. UN GGIM is expected to play an important role in developing such a framework in close cooperation with national and regional organizations.

At the same time, in order for such a regulatory framework to be effective and appropriately observed in all Member States, each country will need strong leadership on the management of geospatial information. While some mapping agencies are now playing a leading role in their governments on policy development for geospatial information, other mapping agencies may not have enough capacity or capability to adapt and implement such a framework in their respective governments. In this case, the role of such mapping agencies should be leveraged with, if necessary, a new mandate on the management of geospatial information.

5. MOVING FORWARD

PCGIAP welcomes the UN initiative on GGIM, which has been introduced in a very timely manner as an apex on geospatial information management for the world. Strong UN leadership is required to facilitate effective use and management of geospatial information in addressing many of the challenges, including: climate change, natural disasters, pandemics, famines, population displacement, and food and economic crises. Such a UN initiative will only be made effective when it is supported by the national and regional bodies, particularly those represented by the UN Member States in the geospatial information community.

The networks built upon linkages with other global and regional organizations, and associated liaison activities, have proved very effective and productive. These relationships have facilitated and promoted information and data sharing, and implementation of collaborative projects across national and regional boundaries. In SDI's, interoperability is a growing trend and a key for further successful development and application of geospatial data. However, the whole SDI community has to work together to adopt common approaches and methodologies in efforts to remove barriers

and enhance institutional and legal systems so that it can meet challenges presented by the ever changing and evolving needs of the day. There is no doubt that geospatial technologies are now reaching a stage of advancement and maturity so that the issues and challenges can be confronted head on.

PCGIAP has actually found that it is most effective when its activities not only address its own mission, but also address the problems faced by the individual member countries in the region. In this respect, over fifteen years of experience of PCGIAP in the development of regional SDI in close cooperation with the UN Secretariat and the member countries in the region, will prove to be an indispensable resource for the furtherance of GGIM under the UN leadership. Representing the largest and most populous region with possibly the highest economic development potential, PCGIAP is fully committed and looking forward to supporting the UN initiative on GGIM by representing the Asia and the Pacific region in close cooperation with the member countries.

REFERENCES

- Box, P., and Rajabifard, A. 2009, 'SDI Governance- to Steer or Row ', GIM, February 2009, Vol. 23, Issue 2, pp 12-15.
- Holland, P., Williamson, I., Rajabifard, A., and Manning, J. 2005. Making the SDI Concept Relevant to Asia-Pacific Countries – the PCGIAP Experience. From Pharaohs to Geoinformatics, FIG Working Week 2005 and GSDI-8. Cairo, Egypt April 16-21, 2005. Accessed at http://www.fig.net/pub/cairo/papers/ts_50/ts50_03_holland_etal.pdf
- Matsuzaka, S., and Cheng, P. 2009. Report for 15th PCGIAP Meeting at 18th United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP), Working Group 1: Regional Geodesy. 26 October 2009, Bangkok, Thailand.
- Mohammadi, H., Rajabifard, A., Binns, A., and Williamson, I. 2006. Development of a framework and associated tools for the integration of multisource spatial datasets. 17th UNRCC – AP (September 18 – 22). Bangkok, Thailand.
- Mohammadi M., and Rajabifard, A. 2010. Development of an interoperable tool to facilitate spatial data integration in the context of SDI, International Journal of Geographical Information Science, Vol 20, No 7, International Journal of GIS, 727-741.
- PCGIAP, 1994. Resolutions adopted by the 13th UNRCC – Beijing, 1994. Online <<http://www.gsi.go.jp/PCGIAP/unrcc/may94.htm#res16>>.
- Rajabifard, A., 2011. Scoping Paper for the 2nd Preparatory Meeting of the Proposed UN Committee on Global Geographic Information Management, New York, USA 10-11 October 2011.
- Rajabifard, A., Binns, A., Masser, I., and Williamson, I.P. 2006. The Role of Sub-national Government and the Private Sector in Future SDIs, Vol 20, No 7, International Journal of GIS, 727-741.
- Scott, G. 2009. Report of PCGIAP to the 18th United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP) for the period 2006-2009. Accessed at http://unstats.un.org/unsd/geoinfo/RCC/docs/rccap18/IP%20pres/18th_UNRCCAP_econf.100_3_presentation.pdf
- Scott, G., and Simpson, A. 2009. Disaster Risk Reduction and Climate Change Adaptation in the Australia-Pacific Region. Accessed at http://unstats.un.org/unsd/geoinfo/RCC/docs/rccap18/IP/18th_UNRCCAP_econf.100_IP7.pdf
- Syafi'i, M.A. 2006. The Integration of Land and Marine Spatial Dataset as Part of Indonesian SDI Development. 17th UNRCC-AP, Bangkok, Thailand, 18-22 September 2006.
- UN Secretary-General, 2011. Report of the Secretary-General on global geographic information management. Substantive session Geneva, 4-29 July 2011, Item 13 (k) of the provisional agenda** Economic and environmental questions: cartography Global geospatial information management