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## The Nature of Regional Spatial Data Infrastructures

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### ABSTRACT

Today, more than ever, it is important to look beyond our national boundaries. The world as we know it is changing. Economies worldwide are undergoing a process of profound and continuing structural change, and the global village is becoming a reality driven by information and communication technologies.

With this background, many countries throughout the world believe they can benefit both economically and environmentally from better management of their spatial information by taking a perspective that starts at a local level and proceeds through state, national and regional levels to a global level. This has resulted in the development of the Spatial Data Infrastructure (SDI) concept at these levels, with the National SDI and Global SDI receiving much attention.

While there is increasing interest being given to Regional SDIs, such as promoted by the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) and the European Umbrella Organisation for Geographic Information (EUROGI), and a recognition that these Regional SDIs will promote economic development and environmental management within these regions, the concept and justification of Regional SDI is still not clear. The purpose of this paper is to describe the nature of Regional SDI and its benefits. Moreover, the paper will review the difficulties inherent in RSDI development and will suggest some factors for the success of a RSDI initiative.

**KEYWORDS:** Spatial Data, Spatial Data Infrastructure, Regional Spatial Data Infrastructure, SDI hierarchy.

## INTRODUCTION

Many countries throughout the world are developing spatial data infrastructures (SDIs) to better manage and utilise their spatial data assets. An increasing number of publications document the various aspects of the development of these national SDIs in recent years (Masser 1998, Onsrud 1998). Increasingly, these countries are finding it necessary to cooperate with other countries to develop regional multinational SDIs to assist in decision-making that has an important impact across national boundaries. These SDIs are called regional SDIs.

This paper provides an overview of the relatively new entity of a regional SDI. The paper begins with a brief description of the concept of a SDI and the different aspects of the nature of a SDI. Based on this concept, the nature of and the needs for a regional SDI are elaborated using the experience of the first author as the National Mapping/GIS representative of I.R of Iran, and an Executive Board member of the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) in the past five years. The paper then argues that the development of a regional SDI involves some unique factors other than those basic to a SDI, and concludes by discussing the issues inherent in the development and implementation of a regional SDI (RSDI).

## SPATIAL DATA INFRASTRUCTURES

The Federal Geographic Data Committee (1997) defines the United States' national SDI as an umbrella of policies, standards, and procedures under which organisations and technologies interact to foster more efficient use, management, and production of geospatial data. It further explains that SDIs consist of organisations and individuals who generate or use geospatial data and the technologies that facilitate use and transfer of geospatial data.

The Australian and New Zealand Land Information Council (ANZLIC 1998) defines a national SDI as comprising four core components: an institutional framework, technical standards, fundamental datasets, and clearing house networks. The institutional framework defines the policy and administrative arrangements for building, maintaining, accessing and applying the standards and datasets. The technical standards define the technical characteristics of the fundamental datasets. The fundamental datasets are produced within the institutional framework and fully comply with the technical standards. The clearing house network is the means by which the fundamental datasets are made accessible to the community, in accordance with policy determined within the institutional framework, and to the agreed technical standards.

After reviewing a number of definitions of SDI, including the two cited above, Coleman and McLaughlin (1998) define the Global SDI as encompassing 'the policies, technologies, standards and human resources necessary for the effective collection, management, access, delivery and utilisation of geospatial data in a global community'. The principal objective of developing a SDI is to provide a proper environment in which all stakeholders, both users and producers, of spatial information can cooperate with each other in a cost-efficient and cost-effective way to better achieve their targets. In this context, Coleman and McLaughlin regard the ANZLIC definition of SDI as data-centric, not taking into consideration the interactions between the suppliers and users of spatial data which is a key driving force in SDI development. Based on these selected samples of definitions of a SDI, it is suggested that a SDI comprises not only the four basic components identified for the Australian SDI, but also an important additional component, namely, people. This is illustrated in Figure 1. The SDI includes the spatial data users and suppliers and any value-adding agents in between, who interact to drive the development of the SDI. This view of a SDI has been previously also supported by two of the authors (Chan and Williamson 1999a).

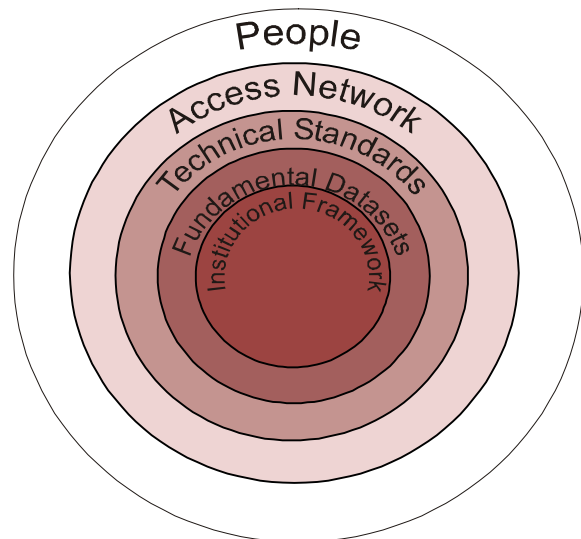


Figure 1. Five Basic Components of a SDI

Hoffmann (1999) suggests a "Spatial (data/information/knowledge/expertise) infrastructure" should be more than a geographic information infrastructure. It is the spatial integration component for an information society system, which is the important interoperability element of a future information society. Chan and Williamson (1999b) argue in their paper presented at this conference that there is a hierarchy of SDIs that include SDIs developed at different political-administrative levels. In the order of the decreasing size of the political-administrative unit, these SDIs are:

- Global Spatial Data Infrastructure (GSDI);

- Regional Spatial Data Infrastructure (RSDI);
- National Spatial Data Infrastructure (NSDI);
- State or Provincial Spatial Data Infrastructure (SSDI);
- Local Spatial Data Infrastructure (LSDI); and
- Corporate Spatial Data Infrastructure (CSDI).

There can be two views regarding the nature of this hierarchy of SDIs as illustrated in Figure 2. The first view is the umbrella view (Figure 2A) in which the SDI at a higher level, say the global level, encompasses all the five components of the SDIs at the levels below. This suggests that, ideally at a global level, there is in place the necessary institutional framework, the technical standards, the access network and the people necessary to support sharing of spatial fundamental datasets kept at the lower levels, such as the regional and national levels. The second is the building block view (Figure 2B), in which SDIs at a lower level, say the state level, serve as the supporting building blocks to provide spatial data needed by SDIs at a higher level in the hierarchy such as the national or regional levels. This realises the visions of data sharing and partnerships and reduces the overall cost of data collection. Based on these two views, the SDI hierarchy creates an environment in which decision-makers working at any level can draw on data from other levels, depending on the themes, scales, currency and coverage of the data needed (Figure 3).

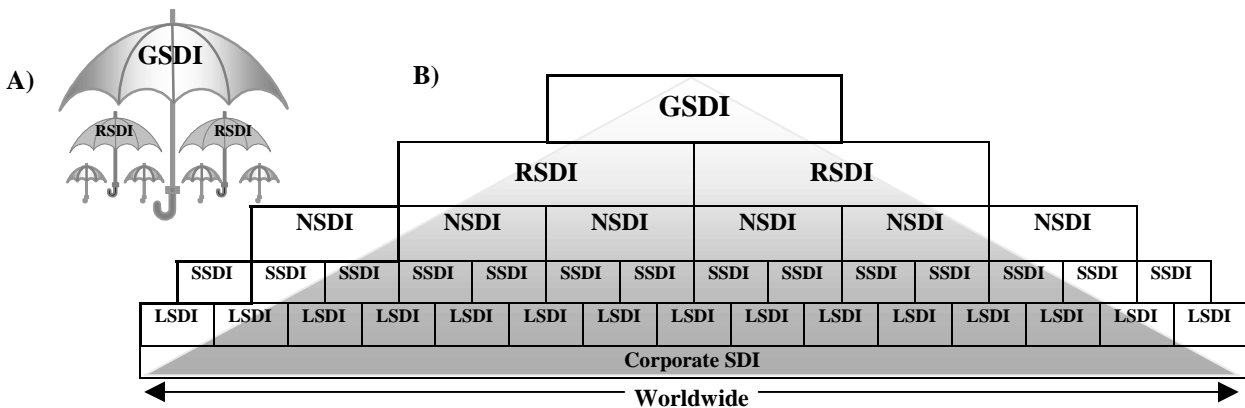


Figure 2: A) The Umbrella View of SDI; B) The Building Block View of SDI.

The double-ended arrow in Figure 3 represents the continuum of the relationship between different levels of detail for the data to be used at the different levels of planning corresponding to the hierarchy of SDIs. As Figure 3 illustrates, users at different levels of planning can have access and need to have access to a certain level of detail to take full advantage of using the SDI. However, it is quite difficult to define a boundary for detail data that can satisfy all user needs at a specific level. Sometimes due to the unavailability or inaccessibility of the preferred level of data required, different users may be required to compromise and use the available data for satisfying their needs.

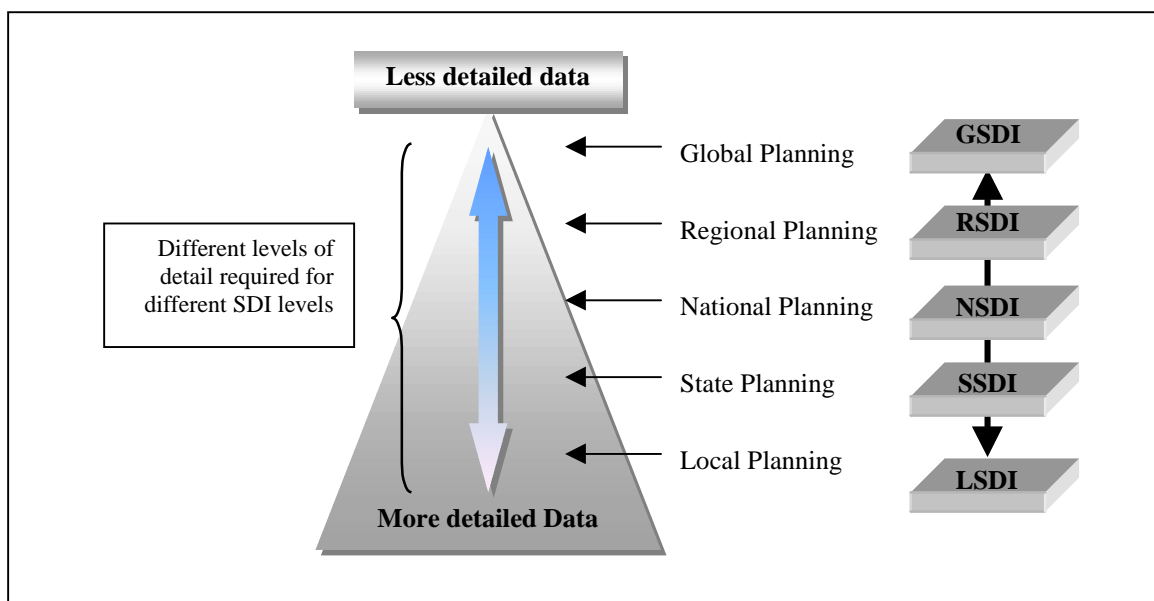


Figure 3: Relationship between Data and different level of SDIs

In summary, there is understandably no clear agreement on what “spatial data infrastructure” and “geographic information infrastructure” efforts should or should not include (Coleman and McLaughlin 1998). Both the existing infrastructure and the most appropriate implementation strategies will necessarily vary from country to country. Further, they listed the variations between a number of proposed SDIs. According to their proposed working definition (previously referred to), policies, technologies, standards and human resources were identified as SDI components.

These components of SDIs can be classified as the basic components of SDIs. The number of the basic components of any SDI is the same, but the content of each component of a SDI might be different from the same component of another SDI.

## THE NEED FOR A REGIONAL SDI

There are many regional organisations and groups that are made up of countries from a particular region. These organisations and groups often cooperate to address common economic, social and environmental issues. The primary purpose of this cooperation is to organise economic activity in such a way as to maximise regional and individual country benefit. In today’s world, regional and global cooperation that is dedicated to centralised planning on a world or regional scale as reported by Suter (1992), is increasingly important. Such organisations and groups as are organic structures in which each part is expected to serve the whole. The cooperative body measures its successes and failures not by the balance sheet of an individual subsidiary, or the suitability of particular products, or its social impact in a particular nation, but by growth in regional and global profits and market shares (Suter 1992). The authors would add that the regional growth must be reflected in benefits shared and enjoyed by individual members. Regional and global cooperation presents serious challenges to prevailing ideas about the world being constructed out of a collection of building blocks described as nation-states.

Other reasons for regional and the global cooperation are that the major players in world economic affairs and their evolution is taking the world from a collection of separate national economies to a single global economy. Suter (1992) also supports this view and he believes that there is only one economy – the global one. The process of profound and continuing structural change to global economies is also giving rise to the global village with the help of modern information and communication technologies. Some current trends in cooperation are to promote regional peace and stability, development assistance, human resources development, political and economic facilitation, science and technology transfer, commercial facilitation, business development, and the establishment of networks and institutional linkages.

Based on these trends, some of the regional interests that encourage different governments to cooperate with each other in the context of RSDI development and also encourage them to form different regional groups, can be summarised as follows:

- Geodetic networks,
- Regional mapping,
- Regional emergency management,
- Regional security,
- Regional access to health care resources,
- Regional resources management,
- Regional environmental monitoring and management ,
- Establishing a regional cooperation unit,
- Shared oceans surroundings,
- Fishing,
- Shipping and transport,
- Economic development and cooperation,
- Agricultural and forestry management,
- Partnership (initially with emphasis on technical assistance to the regional members).

Information at a regional level provides the basis for strategic decision making. Every day in our lives we are hearing about disasters, which impact upon us, our businesses and perhaps even our national economies. When a disaster does occur civil protection forces, environmental groups, agricultural and fisheries departments, hospitals and medical associations all ask the same questions. When will the fallout arrive? How bad is the situation? How many people will be injured or die? How long will it take to recover from the disaster? How much economic damage can be expected? Since disasters have happened before, it is expected that emergency services, analytical teams, disaster relief organisations and the like are all well prepared; but can they exchange information quickly and efficiently to enable cooperation? (GI-2000, 1996).

Other examples at the regional level which demand cooperation are a proposal for a new dam on a river which drains a catchment area covering millions of hectares and crossing several national boundaries; or a plan for a new industrial complex, to be built near a convenient port as reported in GI-2000 (1996) also happens to lie in an estuary of special environmental importance. Another example requiring reactive initiative is a major flood occurring on a major regional

waterway not confined to a single nation state which needs to be dealt with immediately. In these examples the cross-border geographic information is a common need.

In the Asia-Pacific region as an example, there exist many of these cooperative organisations such as; the Asia-Pacific Economic Cooperation (APEC), the Asian and Pacific Coconut Community (APCC), the Association of South East Asian Nations (ASEAN), the Asian Clearing Union (ACU), the Asian Development Bank (AsDB), the Association of Natural Rubber Producing Countries (ANRPC), the Economic Cooperation Organisation (ECO), the South Asian Association for Regional Cooperation (SAARC), and others. These organisations work and cooperate on different areas of regional interest. Their objectives include:

- Acceleration of economic growth, social progress and cultural development in the region;
- Promotion of regional peace and stability;
- Promotion of active collaboration and mutual assistance on matters of common interest in the economic, social, cultural, technical, scientific and administrative field;
- Provision of assistance to each other in the form of training and research facilities in the educational, professional, technical and administrative spheres;
- To collaborate more effectively to improve the agricultural, industrial, trading, transport and communications sectors of the economy;
- Promotion of regional cooperation for ecological and environmental protection,
- Promoting regional studies;
- The close and beneficial cooperation with existing international and regional organisations with similar aims and purposes.

To achieve these objectives, all those regional bodies need to access accurate and consistent regional spatial databases to make the right decisions and to implement and resulting regional initiatives. These databases might need to contain data and information about the whole or part of the region.

However, the required databases containing regional data of sufficient accuracy and detail do not exist. The Asia-Pacific Regional SDI (APSDI), which is an initiative currently under development by the Permanent Committee on GIS Infrastructure for Asia-and the Pacific (PCGIAP), has the potential to provide the fundamental data set needed by different users in the region.

## THE CONCEPT OF REGIONAL SPATIAL DATA INFRASTRUCTURES

The Regional Spatial Data Infrastructure (RSDI) is an initiative intended to create an environment as an infrastructure that a wide variety of users who require a regional coverage, will be able to access and retrieve a complete and consistent data sets in an easiest and secure way. Its roots are in the regional governments and their cooperation. The current complexity of communications between the various countries and regional bodies in the Asia and the Pacific region as an example is illustrated in Figure 4(A). These users must develop one-on-one agreement with each and every other user within the region for sharing regional data. If there are  $n$  users a complete communication network requires  $n(n-1)$  communication channels. However, as shown in Figure 4(B), this complexity is reduced to  $2n$  channels to a centralised RSDI built upon the cooperation of the regional users. The establishment of a RSDI will form a fundamental framework to exchange data across many countries in a region. This will also provide a clear picture to support and improve existing or even new bilateral and multilateral relations and structures.

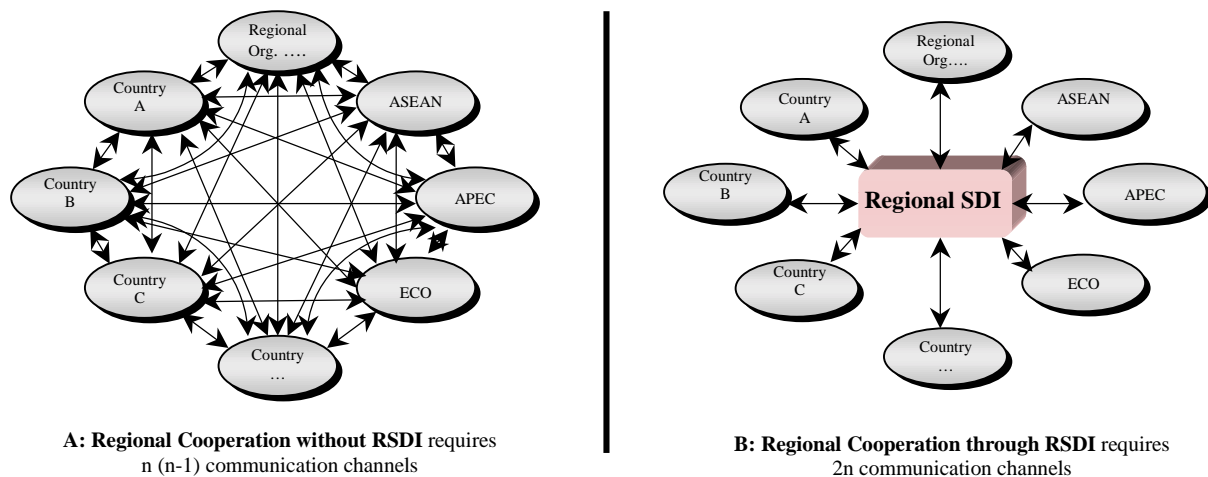


Figure 4: Reduced complexity associated with a RSDI

Further, a RSDI can provide the institutional, political and technical basis to ensure the regional consistency of content to meet regional needs in the context of sustainable development. Within this regional framework, the fundamental data set can be collected and maintained through partnerships. This data set will include all data necessary to understand the region, in both spatial and non-spatial forms.

The regional infrastructure should ensure that national efforts are focused and coordinated, thereby maximising the benefit from investment in data collection and maintenance from both a regional perspective and that of the individual members.

A RSDI ideally should provide benefits for all member nations. In particular the needs of the cooperating member nations must be met but there must exist provision for joining by previously non-participating nations. As the membership grows the data pool widens and there are further economies and benefits realised.

Much geographic data development effort is based on the developer learning from the experience of others. The RSDI and its fundamental data sets represent the combined results of such experience. Further benefits of a RSDI additional to those already outlined are:

- Reduced costs of data production and elimination of duplication of effort;
- Developing applications more quickly and easily by using existing data and data development standards;
- Provide better data for decision making;
- Save development effort by using fundamental and standardised data, guidelines, and tools;
- Perform analysis, decision making, and operations in cross-jurisdictional areas;
- Expanding market potential and program funding through recognition and credibility as a RSDI participant;
- Providing consolidated directions to vendors regarding required technical features.

To realise the advantages of a RSDI and to speed up its development, at least six key factors should be considered. These factors are:

- awareness of GI and SDIs;
- cooperation between the various stakeholders;
- involvement of the politicians concerned;
- knowledge about the type, location, quality and ownership of data;
- accessibility of data sets; and
- the successful widespread use of the data sets.

All stakeholders, including politicians and technical people, should be aware of the potential and advantages of GI and SDIs. The organisation responsible for a RSDI initiative must help to raise this awareness. The development of a RSDI is a matter of regional cooperation. The involvement of those politicians concerned with the RSDI development is essential. The politicians' support provides legitimacy and encourages the necessary financial investment for the RSDI development. Knowledge about the types of data, its location and quality is also required. It is also important to provide access to the data as the measure of success of the RSDI will be the widespread use that is made of it and an appreciation by its users that it is providing the promised benefits which were the justification for establishing the RSDI.

## **Components of a RSDI**

The Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) and the European Umbrella Organisation for Geographic Information (EUROGI) are two organisations each seeking to develop a RSDI for their respective regions. They have each developed a model for their regional SDIs (PCGIAP, 1998; GI-2000, 1995). The two models are similar in comprising four core components, similar to those basic components of a SDI previously referred to. These models provide a valuable contribution and will form the basis of a conceptual model for a RSDI.

In addition to the core components of already defined models, there are other external factors influencing the concept of RSDI. These factors can be classified as specific components of a RSDI. These factors may vary in weight or importance over time or with differing regions. Figure 5 shows the components of a RSDI including the basic components and the external factors, together with their individual contents.

This new vision of the components and external factors of RSDIs is also applicable to the other political-administrative levels of SDIs because a RSDI is only one of the hierarchy levels of SDIs. Examples of external factors are the political system, legal and administrative issues, and social and cultural issues. It is recognised that these factors apply among all levels of SDIs. On the other hand these factors do play a more significant role in the establishment of RSDI.

Recognising and dealing with the external factors of a SDI are usually more important than the other components. This is because these factors can affect the development and implementation of SDIs in general.

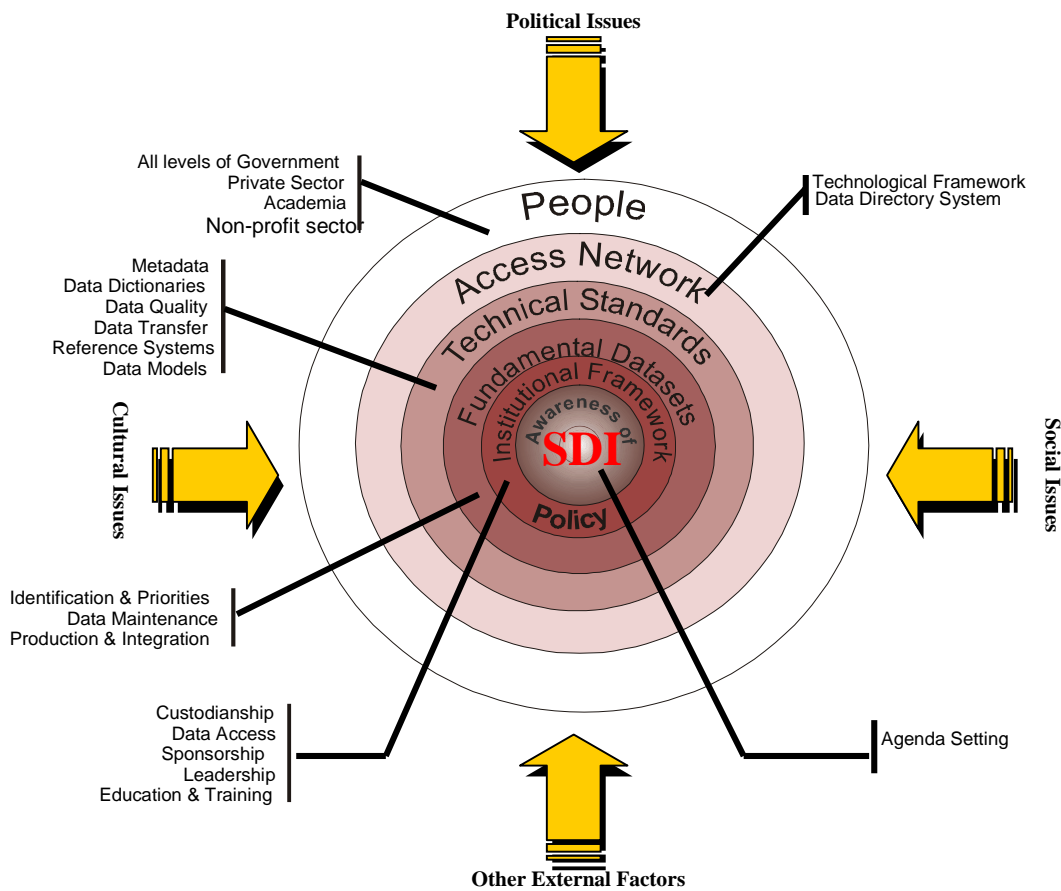


Figure 5: RSDI Components

## Difficulties inherent in RSDI development

The political and organisational issues are the major impediments to the widespread and successful use of RSDI rather than only technical issues. These issues are some of the external factors of a RSDI. There are also some other factors which influence the initiative of a RSDI and make it difficult to prepare an environment for implementation by a large number of potential member nations. These factors are the lack of awareness of the potential usefulness of SDIs, social and cultural diversities, languages, total land area of the nations, and so forth. Figure 6 summarises the different difficulties and factors inherent in the development and implementation of a RSDI.

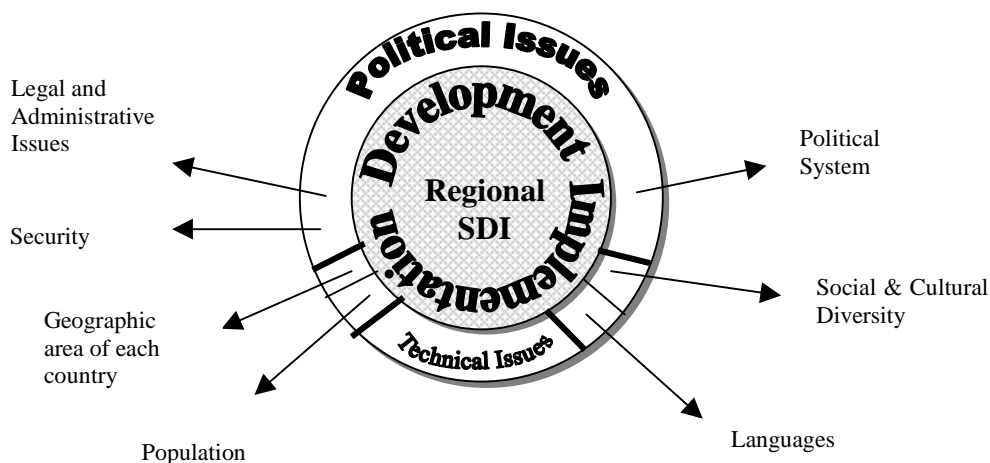


Figure 6: Difficulties inherent in development and implementation of a RSDI



An example of the difficulty arising from political and organisational issues is the diversity of the political systems within a region. These differing political systems result in differing foreign policy cultures which may create two kinds of complications for cooperative international initiatives, as reported by Radtke, et al. (1998). First, a particular foreign policy culture will pose a problem if it is reticent or even averse towards cooperation. Second, problems may also arise out of incompatibilities between foreign policy cultures of cooperating nations.

Further, participating nations may be at different stages of economic development. This can also create difficulties. Some nations in the region may not be able to appreciate the benefits flowing from participating in a RSDI and consequently be reluctant to contribute to the RSDI. Other nations may not possess the national wealth necessary to fully contribute to the RSDI.

Another example of difficulty arises from different legal and administrative structures of different nations. If national mapping and spatial data activities are the responsibility of a nation's military organisation, there may exist a perception that sharing GI will affect national security. This perception could lead to a reluctance to cooperate with mapping and spatial data agencies of other countries. However this issue will increasingly disappear as the new high-resolution (1 meter) satellite imagery becomes common place making the production of maps of scales of 1:10,000 within any nation available to any other nation.

The lack of a regional mandate or policy on spatial information is another example of a difficulty that retards development of joint geographic information strategies. This in turn causes unnecessary expenditure. What is required is a policy to set up and maintain a stable, regional-wide set of standards and procedures for creating and maintaining geographic information within a region. Such a policy must create a favourable business environment for the collection of regional geographic information that is easily identifiable and accessible. The benefits have already been described and are self-evident.

## **CONCLUSION**

The Regional Spatial Data Infrastructure is defined as an initiative intended to bring together the technology, policies, procedures, standards and human resources being devoted to regional spatial information as a regional fundamental data set. Its roots are in the regional governments and their cooperation. The primary purposes of a RSDI are identified as an effort to create an environment as an infrastructure that support a wide variety of users who require a regional coverage.

A vision of the components of SDIs was described. According to this vision, any SDI contains two types of components, namely the basic or the core components and the external influencing factors which were classified as the specific components of SDIs. The external factors will usually impact at regional and global levels.

A spatial hierarchy relationship was outlined among the different types of SDIs. According to this model, by combining each level of SDIs using an umbrella model, it is possible to build the next level of a SDI. In other words, different levels of SDIs can build upon other supporting levels.

Awareness of GI and SDIs, cooperation between the various users, the involvement of politicians, knowledge about availability of data, accessibility to data and use of data, are introduced as six key factors for the success of a RSDI. Political issues are also suggested as an important factor and potential restricting difficulty the development and implementation of a RSDI.

Even though there appears to be many difficulties to be faced in developing RSDIs, there is no doubt that the development of the SDI concept at a regional level is inevitable as a result of globalisation and the development of a global economy.

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