The Journal of GIS Association of Korea, Vol. 16, No. 4, pp. 499-511, December 2008

The Prescriptive NSDI Model

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ABSTRACT

To solve the emerging geospatial problems, more creative and effective spatial information infrastructures are required. To solve the emerging geospatial problems at a national level, this study assumes that the current Korean NSDI considered descriptive needs to be more prescriptive. The future NSDI will require a more useful integration vehicle for matters and places of national importance such as national security and emergency prevention and management.

The purpose of this study is to identify "What can be done for the Korean NSDI to be more prescriptive?" This study reviews previous researches and new SDI concepts, analyzes the Korean NSDI in terms of a descriptive NSDI, and proposes a prescriptive NSDI model for Korean geospatial problems. The model includes new aspects of an advanced NSDI and several tasks for the future prescriptive Korean NSDI.

Keywords : NSDI, descriptive, prescriptive, NeoSDI, Neography, VGI

요 약

다양한 공간문제 해결을 위한 효율적인 국가공간정보기반 구축 및 활용은 중요한 과제이다. 우리나라가 1995년 1차 국가GIS사업을 시작한 이래 3차 국가GIS사업을 추진하고 있는 현시점에서, 본 논문은 우리나라의 국가공간정보기반이 미국의 911사태와 같은 국가안전이나 재해관리 등 국가적 이슈해결을 위한 통합적인 도구로 활용되기 위해서는 부족한 점이 있다고 판단한다. 수치지도 생산중심의 서술적 NSDI에서 문제해결을 위한 처방적 NSDI로 발전시켜 나아가야 NSDI의 의미가 부각되고 활용성이 높아진다는 것을 주장한다.

우리나라 NSDI를 처방적으로 발전시키기 위해, 우선 선진 SDI에 관한 기존 연구와 이론적 검토 그리고 현재까지의 우리나라 NSDI 현황분석을 수행하였다. 이를 통해 현재 우리나라 NSDI를 서술적 NSDI 단계라고 파악하고, 처방적 NSDI를 위해 새로운 요소와 개념을 소개하였다. 이러한 처방적 NSDI의 새로운 발전양상을 처방적 NSDI모델로 종합하고, 마지막으로 이

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를 위한 추진과제를 제시하였다.

주요어 : 국가공간정보기반, 서술적, 처방적, 신공간정보기반, 신지리학, 개인제공지리정보

1. Introduction

Nowadays, a global world is rapidly changing, increasingly complex, challenging and crowded. With the increase of population and continuing quality improvement of life, development will happen continuously on the earth and increase complexity of our geospatial problems. To solve the emerging geospatial problems, more creative and effective spatial information infrastructures are required. As seen in the Korean NSDI (National Spatial Data Infrastructure) that can be defined as descriptive, the future NSDI should serve each country as a useful integration vehicle for matters and places of national importance (Dangermond, 2007) such as national security and emergency prevention and management (Figure 1). In the USA, the 911 accident provided a historical momentum to recognize importance of geospatial data and transform the existing NSDI to a more integrated and problem -solving structure. To meet the emerging requirements properly, more specific data at the level of local government and the broader range of existing framework data are needed. Initially, the bottom-up approach of the NSDI in the USA now phases into a compromised stage with the top-down approach exemplified in the geospatial profile in the Federal Enterprise Architecture and geospatial bluebook.

In this context, one important question can be asked, "Is Korean NSDI good enough to deal with complex geospatial problems of national importance and utilize the NGIS(National Geographic Information System) in a citizen perspective?"

The purpose of this study is to identify "What can be done for the Korean NSDI to be more prescriptive?" This study reviews previous researches and new SDI concepts, analyzes the Korean NSDI in terms of a descriptive NSDI, and proposes a prescriptive NSDI model for Korean geospatial problems. The model includes new aspects of an advanced NSDI and several

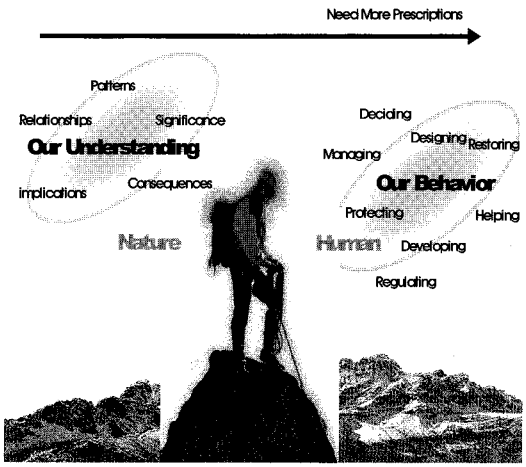

Figure 1. NSDI needs to support our understanding and behavior source: Dangermond (2007)

tasks for the future prescriptive NSDI.

2. Literature review of existing studies for NSDI

According to Williamson(2003), with analysis of SDI (Spatial Data Infrastructure) hierarchy (Figure 2), two generations of NSDI are introduced. In the first generation, data is the key issue for the NSDI development and the main focus is on techno-centric spatial data community. The second generation includes more socio-technical issues and focuses on the people as well as the data.

In other words, for first-generation SDI data was the focus, but the second generation is driven by the needs of users, with the focus on the use of data and data applications as opposed to the data itself (Williamson et al, 2008).

In continuum of SDI development, the first generation SDI focused on a product-based approach, rather the second generation on a process -based approach. The first and second generation SDI model are shown in Figure 3 (Rajabifard et al, 2006).

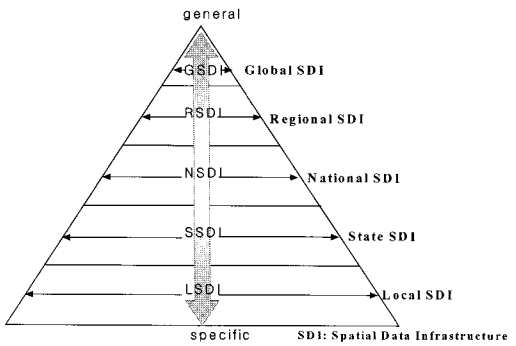

Figure 2. SDI hierarchy (Williamson, 2003)

Also, as moving from the first to the second generation of SDI, the roles of 3 main players of SDI development, national governments, subnational governments and the private sector, are changing as shown in Figure 4 (Rajabifard et al, 2006).

With increase of private user-generated geo-spatial content, Neogeography[1] or Volunteered Geographic Information(VGI) are introduced[2]. While the geographic products of traditional mapping agencies have acquired an authority that derives from each agency's reputation for quality, VGI is sometimes termed asserted geographic information, in that its content is asserted by its creator without citation, reference, or other authority. VGI can be regarded as a phenomenon of the 21st century, focusing on collective intelligence, crowdsourcing, asserted information with the empowerment of millions of private citizens.

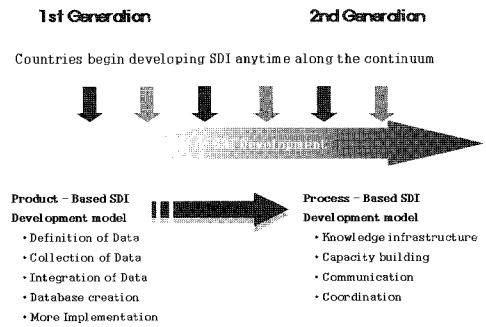

Figure 3. Relationship between the first and second generations of SDIs (Rajabifard et al, 2006)

1) http://en.wikipedia.org/wiki/Neogeography
2) Michael F. Goodchild, "CITIZENS AS SENSORS: THE WORLD OF VOLUNTEERED GEOGRAPHY," 2007

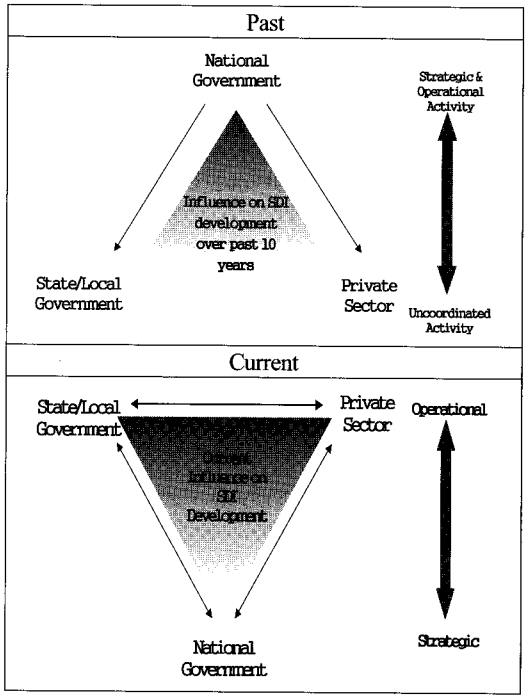

Figure 4. Past and current roles of national governments, subnational governments, and the private sector in SDI development (source: Rajabifard et al, 2006)

VGI clearly fits the future model of NSDI as SDI patchworks. A collection of individuals acting independently, and responding to the needs of local communities, can together create a patchwork coverage. The accuracy of each piece of the patchwork, and the frequency with which it is updated, can be determined by local need (Goodchild, M. F. 2007).

With a transition from the first generation of a product-based SDI approach to the second of a process-based SDI approach, key concepts are moving from data to service, from collection of data and database creation to knowledge infrastructure, communication and coordination, from descriptive to prescriptive, and from a national level to a local level.

Although the development of SDIs is explicitly at a national level, the second generation of the NSDI requires a collaboration model that facilitates greater inter-jurisdictional information exchange from a local level, through to a state, a national, a regional and a global level (Williamson, 2003). In this context, the first generation can be considered "descriptive" and the second "prescriptive".

3. Descriptive NSDI as a present status in Korea

Since the first NGIS phase initiated in 1995, diverse GIS projects have been established in the central and local governments. It is difficult for the present Korean NGIS to be defined as a prescriptive NSDI in terms of a correct NSDI concept. In the previous NGIS master plans, there has not been a clear concept for the SDI hierachy in Figure 2. To a more prescriptive NSDI, the resolution of geographic extent needs to be more specific and the theme of framework data to be expanded (Figure 5 and 6).

So far, in the Korean NSDI concept, digital topographic maps are mostly considered as framework data and the descriptive maps need to be transformed into more applicable geographic information for the prescriptive NSDI (Figure 7).

As shown in Table 1, the scale of the current Korean framework data is consistently on 1:

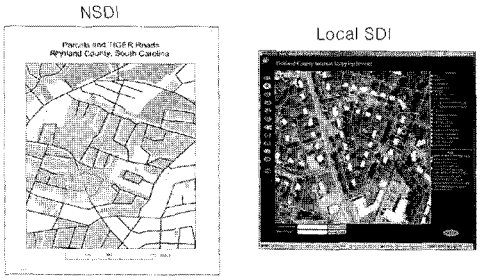

Figure 5. Degree of Specificity in SDIs

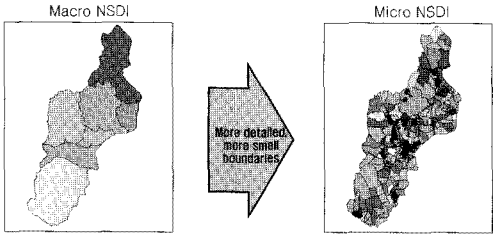

Figure 6. Increasing Demand on Micro Geospatial Information

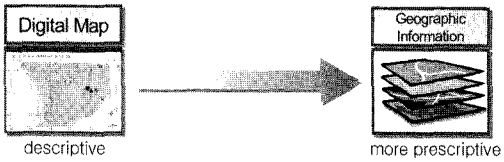

Figure 7. Descriptive Digital Maps and more Prescriptive Geographic Information

5,000, which convers the entire contry but it is hard to deal with local problems.

4. Prescriptive NSDI model for the Korean NGIS

The prescriptive NSDI includes the descriptive NSDI. The two NSDI are not a separate entity and the prescriptive NSDI is more advanced for various recipes. The understanding of patterns, relationships and processes, conceptualizing, modeling and visualizing of data are essential to be prescriptive.

The prescriptive NSDI requires geographic knowledge to solve human problems.

For the prescriptive NSDI, geospatial data as well as geographic information and knowledge are required to deal with diverse human-made problems such as urbanization, human conflicts and crowd. To shift from the descriptive NSDI

Table 1. Current status of framework data in Korea

	Data theme		
	[executive order 16890, revised to 20722 in 2008] NGIS law article15	present status	Scale
Framework data	Administrative units	○	1/5,000
	Transportation	○	〃
	Hydrography	○	〃
	Cadastral	×	-
	Geodetic Control	×	-
	Topography	×	-
	Facilities	○	〃
	Orthoimagery	×	-
	Other extended data theme	×	-
source: http://www.ngis.go.kr (data model proposed:○, not proposed:×)			

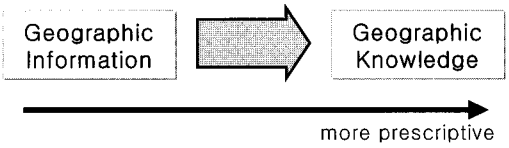

Figure 8. Geographic knowledge for the Prescriptive NSDI

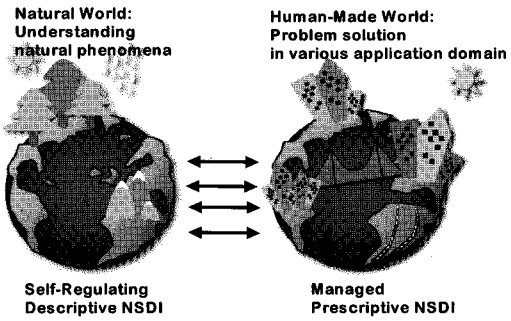

Figure 9. Descriptive and Prescriptive NSDI

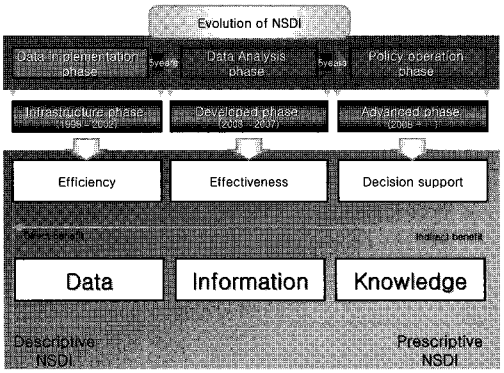

Figure 10. Evolution of NSDI

to the prescriptive NSDI, descriptive geospatial data need to be transformed into information and knowledge (Figure 8, 9, 10).

Geographic knowledge can include maps, datasets, data models, domain models and metadata. Metadata for the other four elements is essential (Dangermond(2005). Because metadata can group the four elements to integrate and transform various data and information into

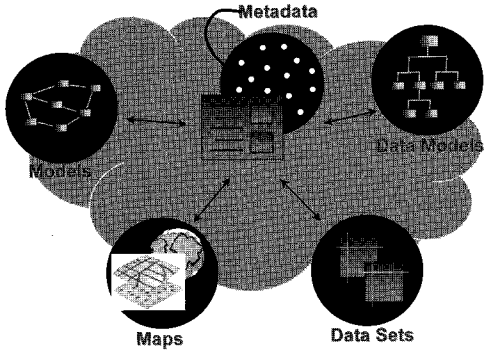

Figure 11. Possible elements of Geographic Knowledge
Source: Dangermondl(2005)

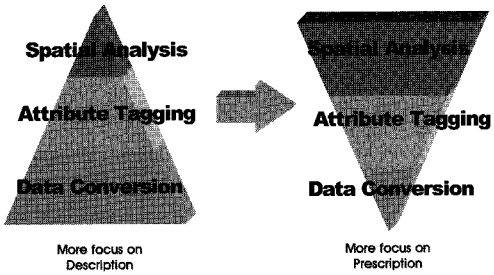

Figure 12. Business Structure of the Descriptive NSDI and the Prescriptive NSDI

knowledge (Figure 11).

As opposed that the descriptive NSDI has focused on data conversion, the prescriptive NSDI can mainly deal with spatial analysis for more added values (Figure 12).

5. The Prescriptive NSDI Model

New aspects of the prescriptive NSDI include the following concepts: 3D SDI, NeoSDI with geospatial web, semantic interoperability, NSDI for decision support and u-City (ubiquitous -City), Geospatial Bluebook, geosatistics, local SDI

and top-down tasks for the prescriptive NSDI.

The prescriptive NSDI model can be a collection of these new aspects with a basis of the descriptive NSDI.

1) 3D SDI with geospatial web

As seen in a 3D SDI for Berlin(2008)[3], advanced NSDIs aim to develop a virtual 3D city model for applications like political issues and consulting, civic participation, marketing, service, promotion for companies and city and urban planning.

The other characteristics of advanced NSDIs using geoweb technologies can be found in a 3D SDI for Berlin(2008) (Figure 13). As shown in the Figure 14, using standardized OGC web services, Google Earth (KML) and online streaming, access to the 3D geodatabase is realized.

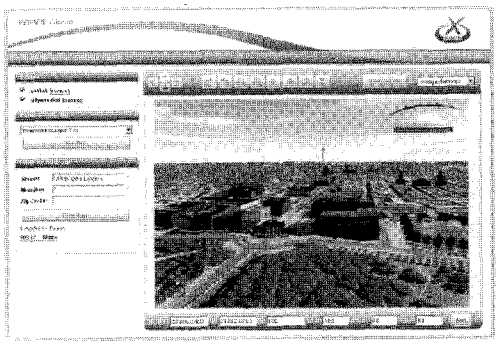

Figure 13. Berlin 3D SDI . Web Perspective View Service (WPVS)

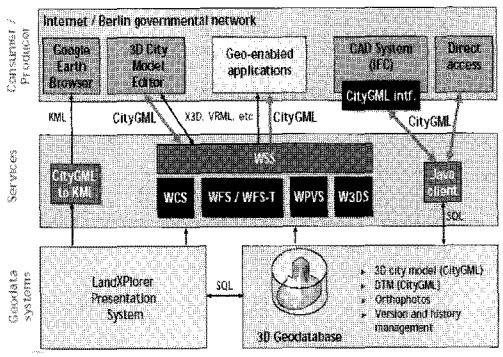

Figure 14. Berlin 3D SDI – Architectural Model source: Claus Nagel, & H. Kolbe(2008)

2) NeoSDI with geospatial web

Emergence of neogeography with geospatial web technology, a new concept of NeoSDI is introduced[4]. Neogeography is an another way of broadening spatial literacy for the public[5]. Increase in user-generated geospatial content and VGI shows unprecedented use patterns of geographic information.

As mentioned above, neogeography prefers specific resolution of geographic information such as local SDI. This trend can be seen in active collection of data such as OpenStreetMap, or passive collection of user-data such as Flickr tags for folksonomic toponyms. Also, in a Map-Oriented Volunteer Program of the USGS Geospatial Information Office, the National Map Corps contribute to web-based direct collections of data.[6] NeoSDI allows more citizen participation through geospatial web. NeoSDI can provide many benefits, such as economic development, tourism, costs reduction, knowledge saturation,

3) Claus Nagel, Thomas H. Kolbe - "A 3D Spatial Data Infrastructure (SDI) for Berlin", Geoweb 2008.

4) Jason Birch, "NeoSDI for Local Government", Geoweb 2008.

5) http://en.wikipedia.org/wiki/Neogeography

6) USGS, "The National MapCorps," 2007.

public engagement, effective disaster response and crowdsourcing. For example, a user on the web, with Google My Maps, can create personalized, annotated, customized local map. Also, a user can add text and upload photos and videos to Google Maps and share them with other users (Figure 15).

3) Semantic Interoperability

To deliver and exchange geospatial context-based knowledge, semantic interoperability can be a key element. Mapping one knowledge domain onto another typically requires human comprehension of both sets of semantics, more automated collaborative identification of semantic mapping is being researched using intelligent agent technologies. For example, semantic interoperability of metadata becomes mandatory in the prescriptive NSDI (Figure 16).

Web 2.0 Metadata focuses on conceptual search by ontologies (OWL, Web Ontology Language), making use of communities for tagging, geodata and building metadata, creating geo-tagged pictures by address and metadata for new data such as pictures and sensors. The processes of building metadata can be enriched by making use of the Web 2.0 development.

The geospatial web will have an impact on the current metadata in building metadata and conceptual search. The hierarchical structure of ISO 19115 makes the alignment with Web2.0 metadata more difficult[7].

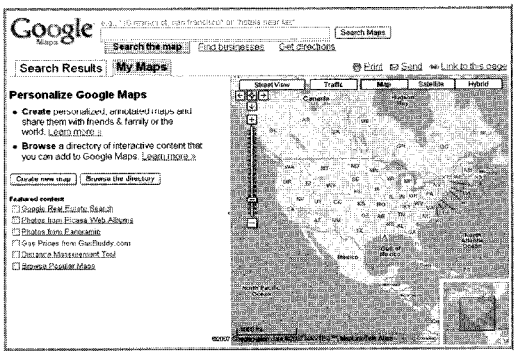

Figure 15. Google My Map– Increasing personal demand for geographic information source: http://maps.google.com

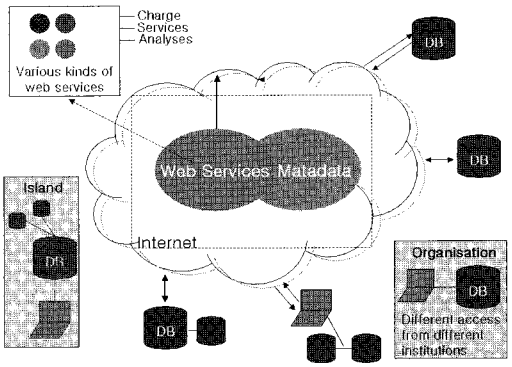

Figure 16. Horizontal interoperability in a national SDI, DB, database(Source: Najar et al. 2008)

4) The Geospatial Bluebook

The "GIS for the Nation" in the USA means GIS for your neighborhood, your town, your state, and your country. The goal is to build an interoperable system that leverages standards and best practices to develop geospatial data infrastructure. The emphasis is on local data needs and local practices, along with data inte-

7) Peter van Oosterom, Creating Spatial Information Infrastructures: Towards the Spatial Semantic Web, 2008, CRC Press, Taylor & Francis Group.

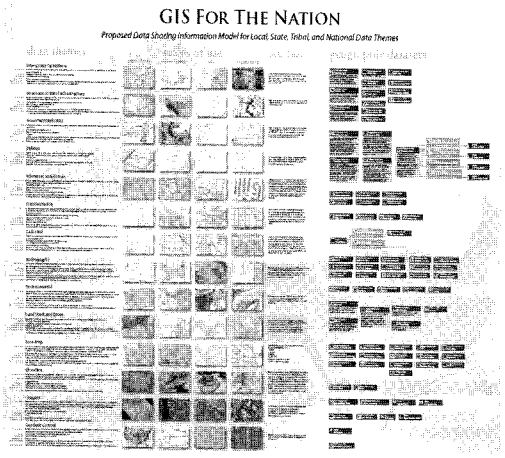

Figure 17. Integrated National Data Sets in the Geospatial Blubook
source: http://support.esri.com/

gration at State/Regional, and ultimately National levels. The project for the Geospatial Bluebook is a set of templates that demonstrate how a GIS for the Nation would be created.

The Geospatial Bluebook begins the process of identifying practices that have served other communities; the goal is to offer a set of national implementation specifications for communities that choose to adopt those specifications.

In addition to the previous 7 data themes of the framework data, the Geospatial Bluebook includes 14 data themes[8] specifications with data capture guidelines, case studies, data models and links to other resources. Each of 14 data themes is available on 4 scales of use - neighborhood, city, regional/country and national /county scale (Table 2).

8) 14 Data themes are geodetic control, imagery, elevation, land use/land cover, base map, environmental, hydrography, cadastral, transportation, addresses, utility, governmental units, structures and emergency operations.

Table 2. Comparison of framework data and dataset of Geospatial Blue-book in the USA

	framework data		Geospatial Bluebook	
data theme	7	Geodetic Control Cadastral Orthoimagery Elevation Hydrography Administrative units Transportation	14	Geodetic Control Cadastral Orthoimagery Elevation Hydrography Administrative(Government) units Transportation
				Landuse/land cover Basemap, environmental Hydrography, Addresses, Utility, Structures Emergency operations
scale	1	Federal	4	national/county
				regional/country city neighborhood
source: http://www.fgdc.gov/framework, USGS(2005)				

5) NSDI for Decision Support

Young Pyo Kim's study(2004) introduces 4 GIS modelings based on system dynamics: descriptive GIS modeling, prescriptive GIS modeling, system dynamics modeling, and predictive GIS modeling. Descriptive GIS modeling is useful for exploration of spatial patterns, Prescriptive GIS modeling for support of spatial decision making, and Predictive GIS modeling for forecast of space-time changes.

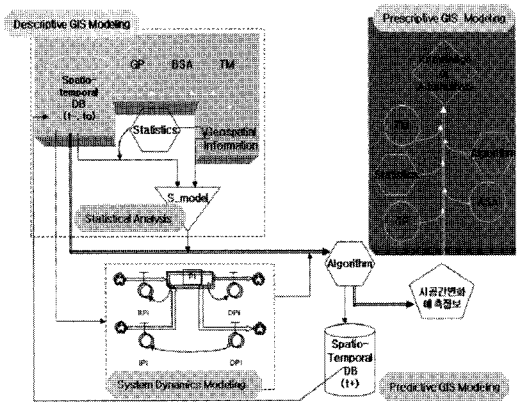

Figure 18. NSDI for Decision Support
source: Young Pyo Kim(2004)

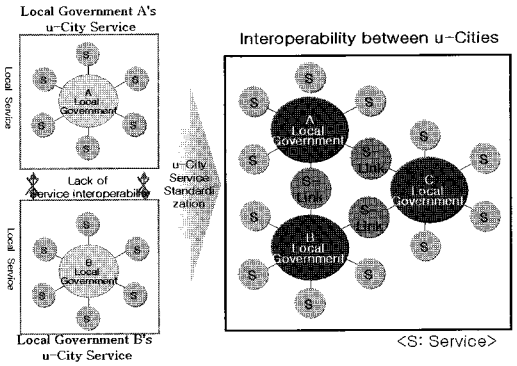

Figure 19. Interoperability for the future u-Cities and the Prescriptive NSDI

As mentioned above, a NSDI for decision support becomes much more important for the prescriptive NSDI. In this context, the proposal for KOPSS(KOrea Planning Support Systems) released in 2007[9] and the development of the pilot KOPSS need to be a part of the future NSDI in Korea. To support spatial decisions in national land planning, KOPSS needs to integrate individual systems at a national and local level.

6) NSDI for u-City

The GIS has grown in its quantity as local authorities established the urban information system for better city administration, civilian services and decision-making support services. Recently, local authorities have expressed much interest on the application of ubiquitous technology to improve citizens' safety and convenience. Construction of a u-City requires the multitude of information and telecommunication networks and digital contents; the existing information resources need to be put to use in entirety for that end. u-Korea can be defined as a collection of u-Cities and local SDI will play a critical role for the construction. Interoperability has a first priority in the prescriptive NSDI and the implementation of u-Cities (Figure 19).

7) Local SDI, substance of the Prescriptive NSDI

Integration and linkage of geospatial information is a first task to be more prescriptive in local governments. Two Phases of the integration can be conceptualized at a micro and a macro level.

In a micro-concept, the GIS integration by local governments includes the physical integration or systematic linkage of the GIS established and currently operated by local authorities as one unified system. In a macro-concept, the GIS integration by local authorities refers to the linkage of GIS-based information system and management information system (MIS) within

9) http://www.krihs.re.kr

the local authorities, and thereby comprehensively integrating the information system of related agencies and central government with that of the private sector (Figure 20).

8) Geosatistics for Geographic Knowledge

Geosatistics is also important for the intelligent NSDI. To answer GIS 5 main questions-locations, conditions, trends, patterns and models- a use of geosatistics is essential and becomes a basis for geographic knowledge and the future intelligent NSDI (Figure 21).

9) Top-down tasks for the Prescriptive NSDI

In the Kim's paper(2005), the future direction of the NGIS was summarized in terms of 6 NSDI components: data, access and metadata, standard, technology, partnership, and law/regulations and institutional policy. The top-down tasks identified in the Table 3 can be done by the central government for the prescriptive NSDI.

As indicated in the prescriptive NSDI model of Figure 22, the roles of the prescriptive NSDI will expand much more than expected. The previous NGIS projects have accomplished a lot of tasks in local and central governments. By sharing a right and holistic vision, the previous works can be linked and integrated for the better synergetic prescriptions of national importance.

By having the model realized, it might be much easier to implement u-Cities and the next-generation e-Government. Wider use of the prescriptive NSDI will vitalize game and virtual world industries and become a basis for citizen and private participation in Korea.

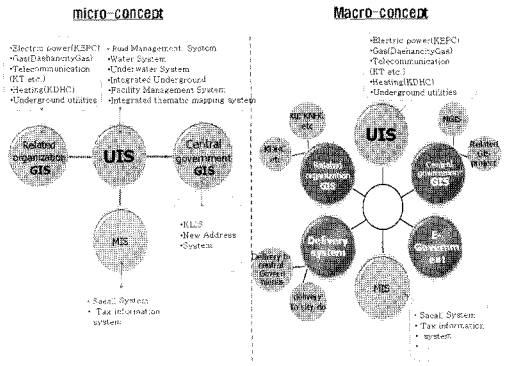

Figure 20. a micro-concept and a macro-concept of GIS integration by local authorities

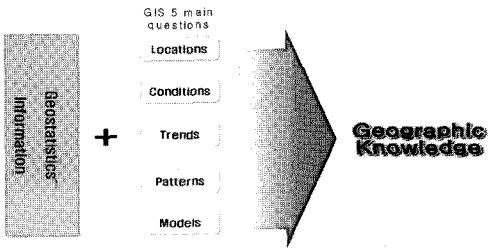

Figure 21. Geostatistics information as a basis for national geographic knowledge

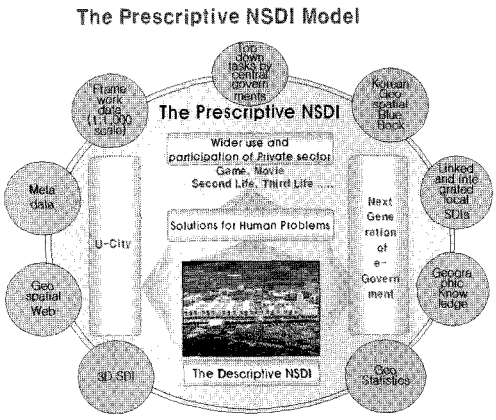

Figure 22. The Prescriptive NSDI Model

Table 3. Topdown Tasks for the Prescriptive NSDI in Central Government's Perspective

	Integration	Interoperability	Intelligence
Data	NGIS Data specifications for framework data		Data currency and intelligence with UFID
Access and metadata	Evolution of the Korean geospatial clearinghouse	More recognition of importance of metatdata and semantic interoperability	Knowledge based search for metadata
Standard	Geospatial profile for the Korean e-Government	Standard for geospatial interoperability in e-Government	Standard for intelligent service
Technology	Geospatial profile for the Korean e-Government Enterprise Architecture		
Partnership	Enhance collaborative partnership		
Law/ Regulations and institutional policy	More practical and feasible vision statement in the NGIS master plan	Adaptation of existing regulations for fitness for use of geospatial information	

source: Kim(2005)

6. Conclusion

By having more prescriptive NSDI, administrative and civil services and decisions at a central and a local level can be supported in depth and width for various domains (Figure 23).

Based on the prescriptive NSDI model, the following tasks are identified for the future Korean NGIS:

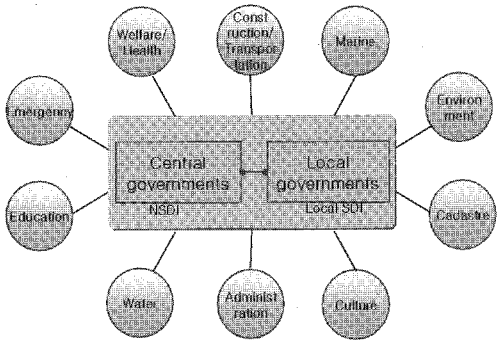

Figure 23. Integrated NSDI with local SDIs

① 1:1,000 scale and broader themes of the framework data need to be constructed.
② More detailed and informative metadata are needed for more intelligent geographic knowledge.
③ Geospatial web needs to considered as a basic platform for the future e-government and geospatial industry.
④ 3D SDI for all themes of framework data needs to be added.
⑤ Geostatistics information for national geographic knowledge needs to be converged with all themes of framework data.
⑥ Upgrading efforts toward geographic knowledge are needed.
⑦ Linked and integrated local SDIs for the prescriptive NSDI are required.
⑧ Korean Geospatial Bluebook needs to be designed and published.
⑨ Top-down tasks by the Central Government need to be included in the 4th phase of NGIS master plan.

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Received	(September 26, 2008)
Revised	(December 22, 2008)
Accepted	(December 23, 2008)