A STUDY ON THE DEVELOPMENT OF TECHNOLOGIES FOR THE MAINTENANCE AND MANAGEMENT OF RIVERS IN CONNECTION WITH RIMGIS (River Information Management (GIS) in KOREA)

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ABSTRACT

This study has focused on the development of maintenance and management technologies by using related data through the analysis of changes for river beds, while managing such dynamically fluctuating data for river beds by using LiDAR and high-resolution images. The development of such technologies is for the improvement of utility for the field of river maintenance and management, and the advancement of maintenance works for rivers. By using a detailed topographic map for rivers, which has been made with LiDAR and high-resolution images, it has been possible to informationalize the data for river beds and banks before putting such information in RIMGIS DB. Also, the monitoring technology required for the establishment of the river maintenance and management system in connection with RIMGIS, while minimizing the impact of the changes for river beds. By supplementing the functions and data-structure of RIMGIS containing the topographic information and the maintenance and management information regarding rivers, it has been possible to maintain and manage rivers in real time. Also, it has been possible to provide the information for river beds and sections in a river to secure the cross-sectional area of flow according to the changes for river beds. Through such a process, the technology to supplement RIMGIS has been developed to maintain the functions of a river. By utilizing such maintenance and management technologies as basic technologies, it will be possible to maximize the utility of the field of river maintenance and management under the River Information Management Geographic Information System (RIMGIS) in regard to the national river management data requiring constant improvement of functions and execution of maintenance and management works by considering the 2-dimensional line-based information with lack of accuracy and variety and a low level of utility.

1. Introduction

It needs a systematic management technology of information like collection, analysis, provision of data related to underwater riverbed variation of river to forecast national flood and reduce flood disaster. While the data for maintenance & administration of river are available only from the basic plan for river improvement and the river books, these data are established on a ten-year cycle so that there should be a limit to progress of works using the latest data like flood forecast and it needs to collect data and provide the analyzed data using advanced technologies. Also it is required technical development to manage the data of riverbed varying dynamically and provide the related data through analysis of the riverbed variation. There has been increasing sociological interest related to flood caused by growing damages due to abnormal climate and flood in these days and it is required to manage and provide data corresponding to social requirements. Through establishment of river management system using precise and the latest data such as LiDAR and high resolution images, it is able to contribute to establishment of policy and improvement of national reliability of river-related works. For the technology for maintenance & administration of river connected

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with national river management data, it informationized dynamically varying riverbed & bank data of river using LiDAR and precise topographic maps of river made in the form of high resolution images to be built into RIMGIS DB and developed the technology monitoring riverbed variation by establishment of river maintenance & maintenance connected with RIMGIS and study of monitoring technology to minimize the effect on riverbed variation.

2. Methodology

For riverbed data of river, this study examined the related data such as sedimentation of draft sand varying dynamically with time, erosion of riverbed, high water bed as well as riverbed variation due to crossing structure and also the data related to dynamic changes of river in RIMGIS. Also it monitored the time series varying situations of riverbed using LiDAR or high resolution images and developed a monitoring technology of riverbed variation to support the policy information such as dredge amount and the timing. After collecting the related data based on the DB establishment process of dynamic change of river shown in the Table 1 below, the DB of dynamic change information was established.

Table 1 DB Establishment Process of Dynamic Change Information of River

| Division	Contents
Data Collection	▪ River Management Geographic Information System(RIMGIS): ▪ Basic River Plan, River Facilities Maintenance Book, River Status Book, Basic Information ▪ Primitive Data LiDAR, Aerial Images, Water Zone Survey, DEM Data
Data Analysis	▪ Understanding of River Variation Related Data Items & the Details, Space Information, Attributes Information
Item Selection	▪ Selection of River Variation Data Related Items
DB Design	▪ Application & Design of Codes According to RIMGIS & Computerization Guidelines
DB Establishment	▪ Select Test Beds & Establish According to DB Design Table
DB Inspection	▪ Verification & Test of Standards and Data Details about the Established DB

In the data collection stage, it researched the basic river plan as a project carried out in the country regarding dynamic changes and the data related to geographical features to set up the necessary range for DB establishment and decide the details to be established for the DB establishment of dynamic changes of river and researched the matters related to dynamic changes of the related systems like RIMGIS. The Table 2 below shows the data related to dynamic changes of river.

Table 2. Analytical Data of Riverbed Variation

River	Surveying Station (No.)	Distance(m)		Past Riverbed (El.m)	Present Riverbed (El.m)	HEC-6 (El.m)				Adoption	Remarks
		Section	Accumulated Value			5 years later	10 years later	15 years later	20 years later		
The UpperNam River	230	200	109,210	48.29	48.48	48.35	48.25	48.06	48.01	48.25	
	231	160	109,370	49.83	50.33	49.91	49.72	49.67	49.65	49.72	
	232	200	109,570	51.07	49.86	49.87	49.79	49.63	49.56	49.79	
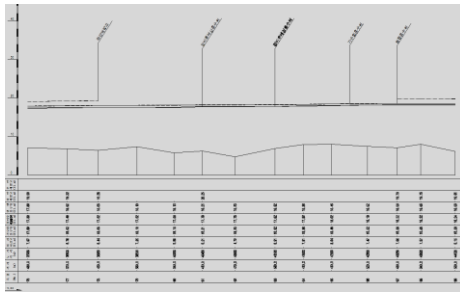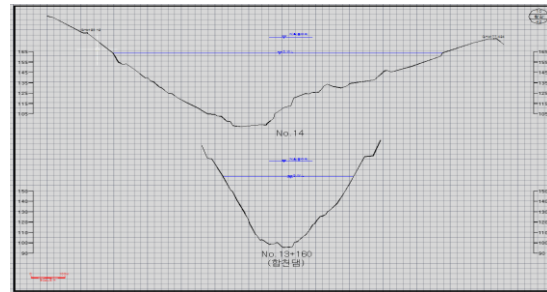
Vertical Sectional View   **Cross Sectional View**

Figure 1. Vertical Sectional View and Cross Sectional View

It analyzed the related matters about the data collected for the study and selected as the target data after analyzed the data items for DB establishment of this study through understanding of the information related to riverbed variation out of the basic river plan report providing riverbed variation information through RIMGIS and the product regarding vertical & cross sectional information. For the DB establishment of riverbed variation, it designed DB to control the related data for the DB establishment of riverside variation of the target model area in Nakdong River based on the already established basic river plan report and the current state of river topographic inquiry surveying data so to establish the DB of additional information.

Table 3. RIMGIS Space Layer Lits

Layer_ID	Layer_name	Type	Code Value
			ID Code
RB_PS_1230	Altitude Reference	Point	RB1230
RB_TP_1240	Numerical Altitude Data	Letter	RB1240
RB_PS_2100	Location of Stone Marker	Point	RB2100
RB_TP_2200	Name of Stone Marker	Letter	RB2200
RB_LM_3100	Present River	Line	RB3100
RB_LM_3200	River Center Line	Line	RB3200

Table 4. RIMGIS Attributes Information List

Table_ID	Characteristics	Table_name
RM_PROJECT	M	Project Basic Information
RM_RMP	M	Basic River Plan Information
RB_BASIN	M	Basin Information
RB_RMP_DIM	M	River Plan Data
RC_RIV_CONDITION	M	River General Condition
RC_LANDMARK_STONE	M	Survey Control Point

For the attributes information of river management, this study abstracted the related information from the related matters, basic plans, data from advanced river topographic survey for the management of riverbed variation related materials following the RIMGIS guidelines of river management books to manage river information and carried out the design of data structure. For the data structure to control riverbed variation related information, this study provided FK(Foreign Key) in each table to manage riverbed variation related data so that it would be able to inquire the information mutually connected with crossing information, riverbed variation analysis information, vertical information, DEM and topographical data focusing on the structure of basic river information as the master table of the existing RIMGIS.
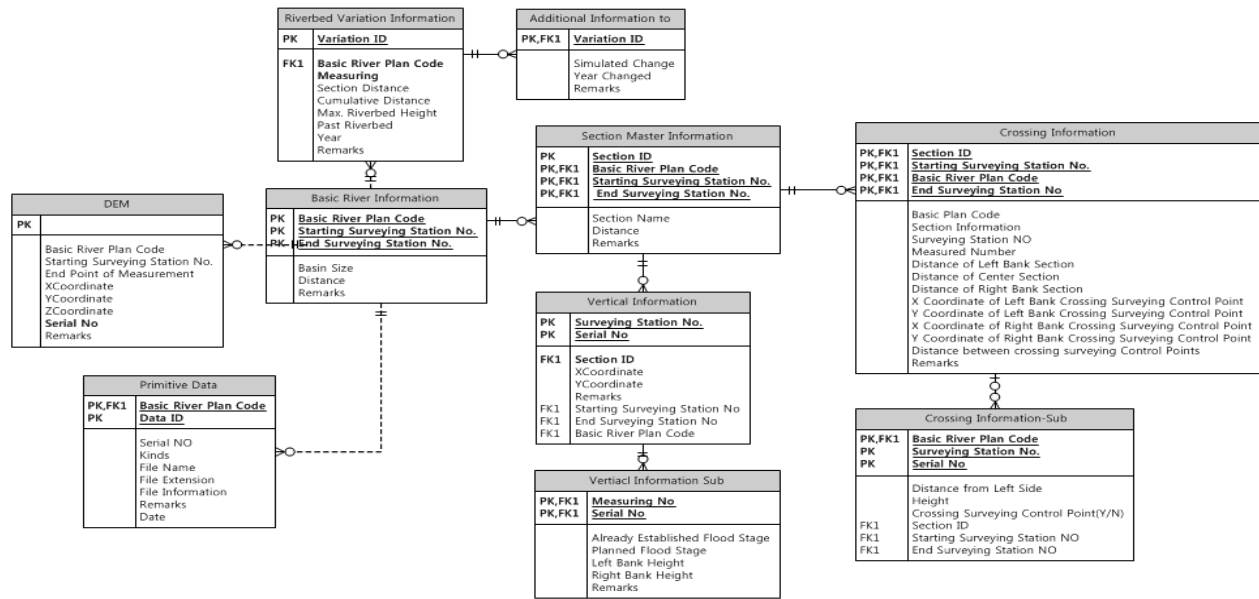

Figure 2. ERD(Entity Relationship Diagram) for Management of Riverbed Variation Related Data

Through analysis of data, processing of duplicated data related to riverbed variation have been carried out as bellows. .

- Order of priority has been given to the duplicated data in order of the latest data establishment.

- For order of priority, the order of river records management system, WAMIS, RIMGIS was used as the data selection criteria when attributes information contradicted each other.

- The data eliminated duplicated ones were used for the DB establishment. Also some errors in the notation were found, which had been corrected for the DB establishment.

- For DB establishment, it classified DB table decided through design of data structure and also by riverbed variation to which each table belonged and the basic table to establish the information.

The detailed matters of DB establishment made in this study are as shown in the Table 7 below.

Table 5. Establishment of Riverbed Variation Related Information

Division	Target Data	Contents	Number of Issues	Remarks
1	Basic River Plan Report	Vertical Section Drawing	2	Nakdong River
2		Riverbed Variation	39	

3	RIMGIS	Crossing Information	23	
4		Basic River Information	1	
5	Primitive Data	LIDAR	1	
6		DEM	20,000	

The riverbed variation monitoring related technology was developed on the basis of the established riverbed variation DB information and the riverbed variation monitoring in this study is different from those methods used in the existing study such as the one using the result of river cross-sectional survey and the one monitoring riverbed variation by draft sand survey. This study carried out river topographical survey by efficient and economical methods such as LiDAR, sonar and based on the achievement gained by the advanced methods, presented measures monitoring riverbed variation as a part of the river maintenance & administration system. Figure 4 shows the flow chart of system procedures of riverbed variation monitoring technology connected with advanced river topographical survey.
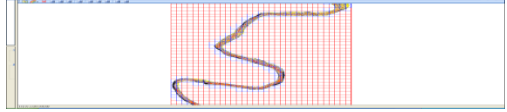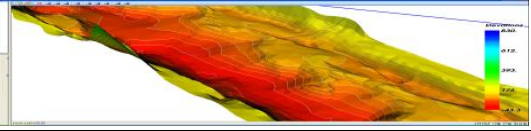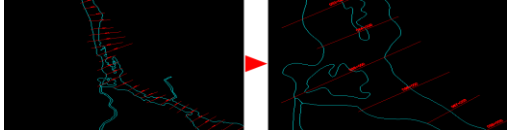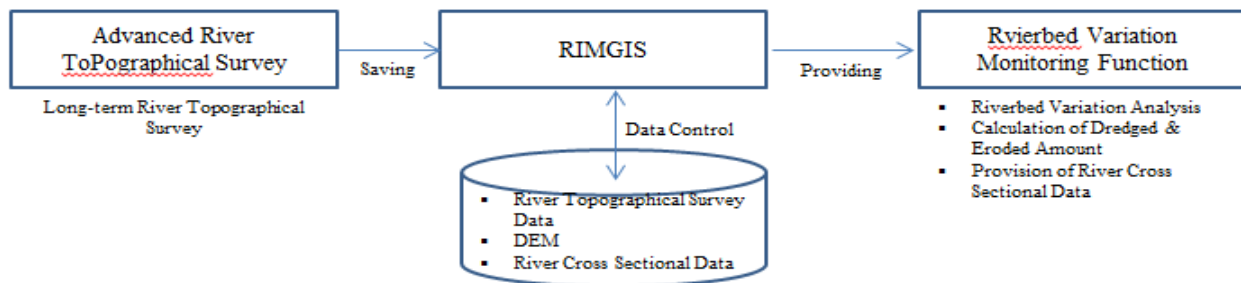

Figure 3. Riverbed Variation Monitoring System

The riverbed variation monitoring technology in this study develops the program with functions of saving, control, providing of river topographical survey data based on RIMGIS and at the same time, the river topographical survey data save the data at the base point like establishment of basic river plan as well as the survey data being occurred when river related works are carried out. The river topographical survey data are composed of topographical data, river cross sectional data, crossing surveying station data and this study developed those programs for river administrators, which they start the monitoring program realized in RIMGIS and can obtain the information of riverbed variation situations at a specific location in a desired river to understand the riverbed variation situation, and the riverbed variation amount analysis program by which a river and the location to be analyzed is selected and the amount of dredge, erosion for a certain period from a base point is analyzed, and the program providing topographical input data to utilize river topographical data in hydraulic & hydrologic interpretation program(Hec-RAS, etc.) used for river flood discharge analysis. Table 8 shows major functions of riverbed variation monitoring technology developed in this study.

Table 6. Major Functions of Riverbed Variation Monitoring

Division	Contents
Inquiry of Riverbed Variation Status	
Calculation of Riverbed Variation Amount	
Extraction of Topographical Cross section of Riverbed	

4. Conclusions

Through DB establishment & application of national river topographical data, followings, it is able to present measures applicable in the establishment of dynamic change data to RIMGIS, which will be able to use as the basic data. Also for the R&D of the monitoring technology of river's dynamic variation data, it presented measures for support to administrative works and development of monitoring technology of river's dynamic change data through examination of river maintenance & administration and research & analysis of riverbed variation monitoring. It is able to establish the maintenance and administration system to provide the riverbed data changing dynamically with time to the works of poly making, design and maintenance & administration of river through the river maintenance & administration technology connected with the national river management data and also possible to establish the dynamic change data of RIMGIS through the analysis of dynamic riverbed variation and the related data. Also it is possible to forecast flood through the river maintenance & administration technology connected with the national river management data as well as information management like collection, analysis and the provision of the data related to riverbed variation to reduce flood damage, and able to keep the consistency of correctiveness as it uses the advance technology. There has been increasing social requirement of it due to recent abnormal climates and flood and it is able to manage and provide the data so to cope with this.

References
1. K-Water. 2002. The Development of River Information Management GIS.
2. K-Water. 2002. The System Schema of development of River Information Management GIS.
3. Hanriver flood management Center of Ministry of Land. 2007. .The study of advanced utilization of River Information Management GIS.