

Application of Flood Marks Management System to establish rehabilitation plan of reducing natural disaster

Hyunjung HA, South Korea

Key words: Flood marks map, Flood marks management system, Disaster prevention

SUMMARY

On July 2011, Korea suffered from tremendous rain recorded 40% of annual precipitation for only 3 days, and it caused both a terrible loss of human life and property. It shows vulnerability of natural disaster prevention or emergency plan such as by floods, typhoon and inundation. Up to date, natural disaster prevention plan has been mostly compensation for the loss and rehabilitation with government aids, exchanged highly precise instrument for forecasting weather and structural method like supplying drainage system. However, because of an unusual change of climate for global warming, disaster prevention plan must need simulation of predicting inundation based on making a proper flood marks map. The point is that real-time observation system and accumulation of data should be managed continuously.

Accordingly, out of designing paper map without unity, Korean Cadastral Survey Corporation is exclusively taking responsibility for flood marks map and sends to local government through computerized management. If inundation damage breaks up in some area, control point surveying is previously performed to survey damaged area and height and true elevation of flood is observed from approved control point in flooded area. After calculating measured surveying data by software in Total Surveying System v.2, made from Korean Cadastral Survey Corporation, digital map expresses flood marks map and this will be accumulated on Flood Marks Management System in our own website. Since the flood marks database consists of various spatial information contained drainage facilities and prevention equipment, it can apply flood area estimation maps as well as flood hazard maps. As a result, this is the basic factor to establish rehabilitation plan of reducing natural disaster of local/central government.

In this paper, after introducing how to make flood marks map through Korean Cadastral Survey Corporation's own software, application using Flood Marks Management System will be informed in many ways. Finally, role in national disaster information system will be discussed in terms of developing utilization of the disaster map collection afterward.

Application of Flood Marks Management System to establish rehabilitation plan of reducing natural disaster

Hyunjung HA, South Korea

1. INTRODUCTION

Korea is not much rainy than other places, but concentrated rainfall has caused enormous damage of economical and social loss in the summer. In decades, because of global warming and abnormal climate, heavy rain appears more and more. For instance, in last summer, the amount of precipitation in six regions include of Seoul exceeded annual rainfall for only 50 days.

In order to dwindle the disaster damage, making a disaster map is going to be important as well as exertion which is restoration work or compensation after the flood. Flood marks map displays districts for damaged areas and is essential for making a hazard map, so the flood marks map is close to preventive measurement.

Korea Cadastral Survey Corporation(KCSC) established our own Flood Marks Management System to improve that whoever cannot approach flood marks map so it has been dealt without unification and to accumulate flood information open to local government, National Institute for Disaster Prevention (NIDP) and related laboratories.

In this paper, the way flood marks are acquired after flooding through 3D surveying would be announced and it would be discussed how to make a flood marks map electronically. Finally, after making a map, data and resources will be uploaded on the Flood Marks Management System and it will be also considered Flood Marks Management would be applied to several ways and tools.

2. BACK GROUND OF FLOOD MARKS MAP ESTABLISHMENT

National Institute for Disaster Prevention (NIDP) and National Emergency Management Agency (NEMA) have made flood hazard map established by Ministry of Construction & Transportation to analyze the reason of disaster or set up overall measurement for extremely flooded area from 1995 to 2000. This was so ununited and disposable that NEMA has established Flood Marks Map Design Guideline since 2006 and shows appropriate criteria.

Flood Marks Map can accumulate history of inundation damages continuously and also can make reference to set up disaster prevention plan in development plans. Besides, this could be applied as basic data for making flood hazard map to escape from disaster. After all, accumulated data could foresee how much will flooded area be and also make full use of compensation for the loss and rehabilitation. For this reason, it is important that professionals make flood marks map and manage all steps of designing maps systemically.

Korea defines designing method and operating method of flood marks map in laws and has KCSC taken full charge of making it.

2.1 Related laws for designing maps

This is guideline of designing flood marks map and all the maps should be made under the criteria. The Natural Disaster Prevention Act contains obligation of managing disaster map and designates responsible institute, KCSC.

2.1.1 Designing flood marks map

Local government should make and use several maps to reduce damage of disaster. Also it can keep history of flood or inundation safely through surveying, so it can be applied to check validity of previous disaster as the Natural Disaster Prevention Act Article 21.

2.1.2 Criteria of making hazard map

It is fundamental for disaster map to be made by flood marks map or flood area estimation map as the criteria of making hazard map. Flood marks map should be revised and made up to manage periodically whenever flood breaks up. Nevertheless, overall local government should establish maps promptly for the first time.

2.1.3 Participation of expert for making hazard maps

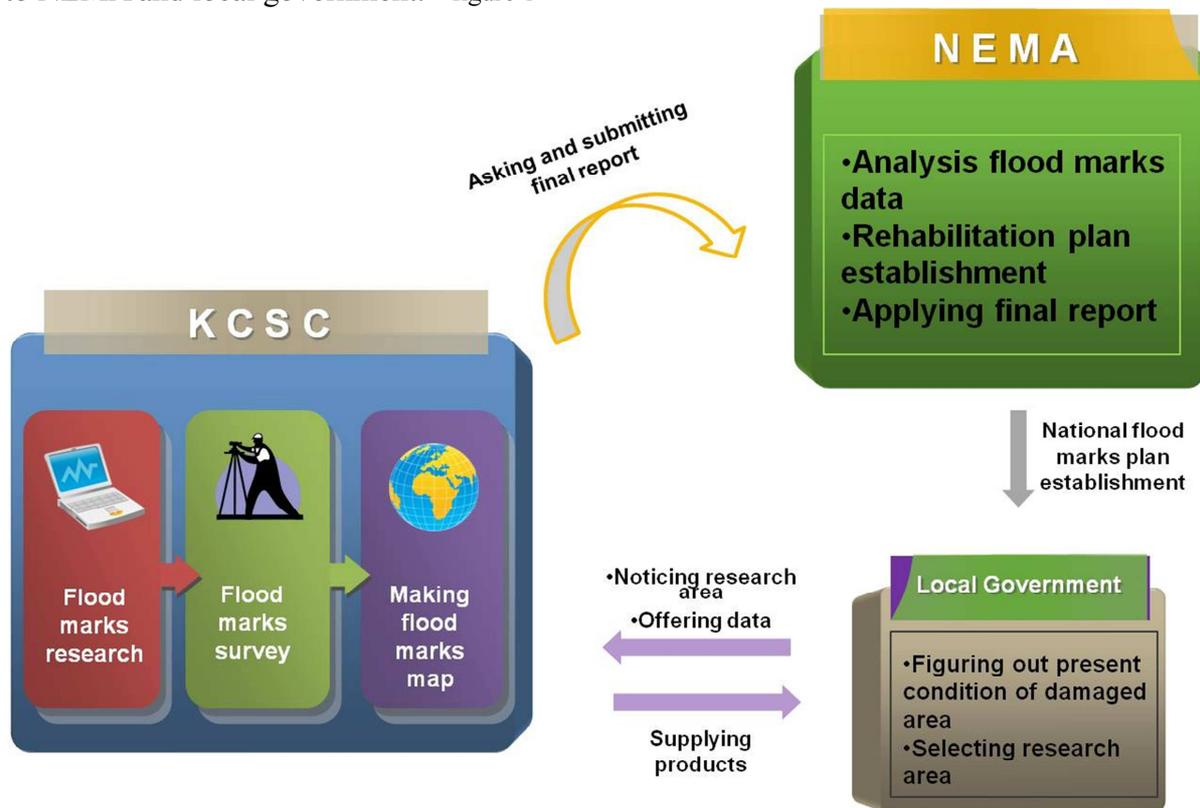
Because flood marks research and making flood marks map need to manage continuously, institute which can conduct management of flood marks map should take charge of it. Mayors responsible for making maps can appoint institute organized from Disaster Reduction Measure Association as the Natural Disaster Prevention Act Article 10.

2.2 Institute responsible for making flood marks map – KCSC

Flood marks map should not be concentrated in particular region, and it should be designed with same criteria. Above all, as heavy rain breaks up simultaneously, this map should be made by institute which has wide range of branches everywhere in Korea. KCSC is composed of main office, 12 head offices and 193 branches so that it can contact and also work with each other closely. Besides, KCSC has a lot of skilled surveyors and well-adapted program about applying flood marks map, which delivered annually 250 experts from 2007 to 2011. Moreover, KCSC has the state-of-the-art equipment such as Total Station, GPS, RTK and so on. Finally, as the Natural Disaster Prevention Act Article 119, every surveying is conducted digitally with Total Station and also both surveying data and map approval are dealt with the own web site. This system makes management of flood marks map composed easier.

The full process of offering flood marks map is below. Above all, NEMA builds rehabilitation plan establishment and makes related laws and enforcement regulations. If the flood breaks out, local government requests making a map to KCSC and notifies the research area. Before

going to the field, KCSC does the research in the office and then surveys flood marks. Using the own software to design flood marks map, a surveyor makes the map and supplies products to NEMA and local government. <figure 1>



<figure 1>. Process of offering flood marks map

3. Process of making flood marks map

3.1 Overview

Overall process of making flood marks map is below. If a flood occurs, the surveyor requests data and conducts pre-survey in the office. Direct research is the field survey after flooding and indirect research is collecting data such as media, weather forecast or flooding time. Finishing pre-research, the surveyor should conduct flood marks survey. It consists of control point survey, heights and true elevation of flood marks survey and present condition survey. Both flood marks research tables and observations are used for making a map with Total Survey System (TOSS). At last, flood marks map and other information are uploaded on Flood Marks Management System (FMS). <figure 2>

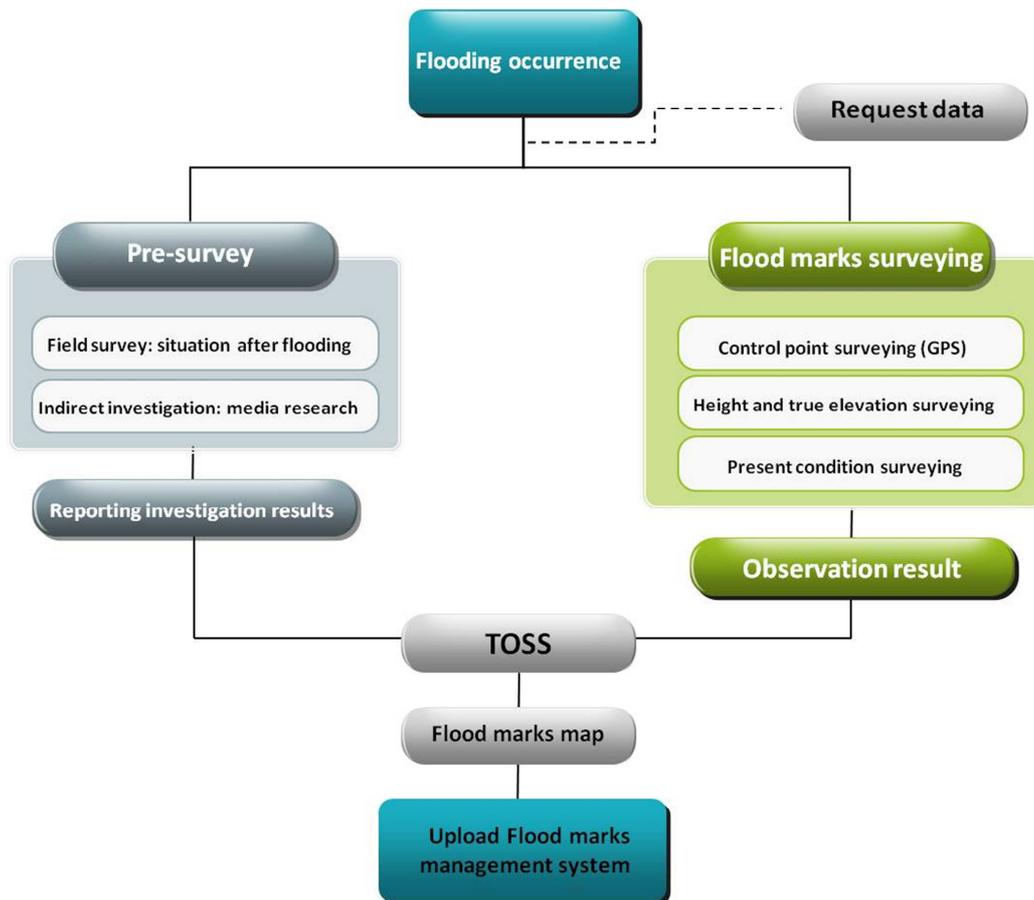


figure 2. Process of making flood marks map

3.2 Request basic data and preparing observation

3.2.1 Request basic data

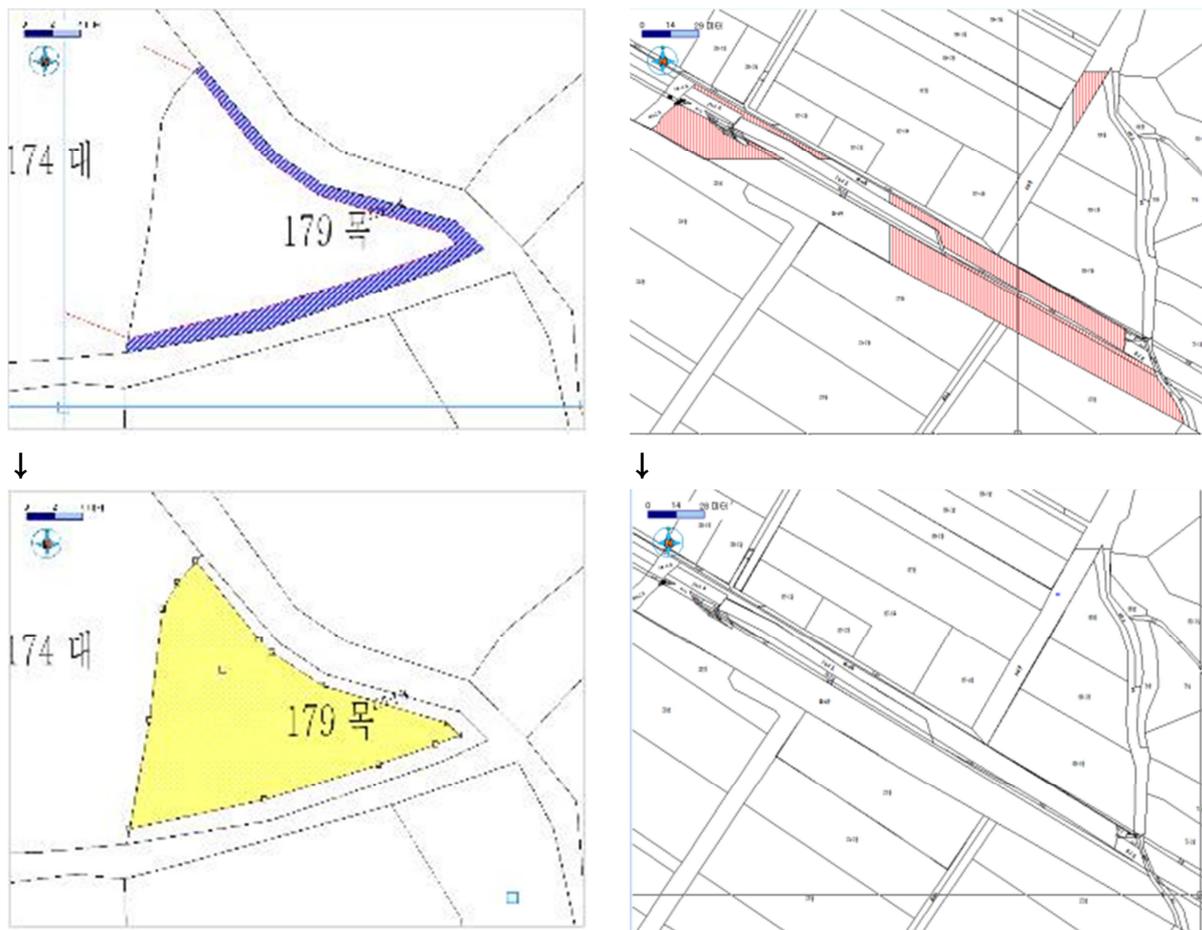
Before going to field survey, the surveyor should request basic data such as cadastral map, geographic map, continual cadastral map, division section line, prevention equipment and TIN images on the Flood Marks Management System. In case of broad area, it can be downloaded by request of demon data tool from the system next day or directly downloaded when it comes to small area.

3.2.2 Preparation of the field survey to make flood marks map

Data acquired from Flood Marks Management System and other data should be collected. In order that field surveying has to be represented on the continual cadastral map, parcel number of cadastral map and attribute data should be arranged without overlapping or emptiness. Continuous cadastral map is SHP file and consists of dbf file, shp file and shx file. Dbf file contains attribute information like FID, SHAPE, PNU and JIBUN.

Every flood marks map should be drawn on the continuous cadastral map, but it doesn't contain attribute data and also, its line needs to be corrected comparing with cadastral map. So, surveyor has to prepare corrected continuous cadastral map before going out to the field and the process of work is below.

When Total Survey System (TOSS) which is KCSC's own procedure software changes flood marks system mode and opens continuous cadastral map, the map expresses red marks. If cadastral map is also opened and attribute information merges with the continuous cadastral map, blue marks mean split and red marks mean annexation. <figure 3.a><figure 3.b> Comparing with cadastral map, the surveyor can finish preparation for the pre-survey with conducting split, annexation and registration conversion.



a. split

b. annexation

figure 3. Correcting continuous cadastral map

3.3 Field survey of flood marks

3.3.1 Offering data from local government

If flood breaks through, surveyor should ask for data to prepare the work and grasp the situation of the area. As for the data featured local characteristic, related geographic information, cadastral and geographic map and statistics such as population and land use should be asked to design flood marks map. Next, it can help figure out relationship between cause and effect that surveyor requests height, duration time and amount of flood data related with water gate. In addition, when surveyor goes field surveying, economical losses, human and facilities' victims should be researched to know specific damages.

3.3.2 Indirect research and direct research

First of all, indirect research needs weather information which is the most important data for analyzing the reason why. If heavy rain came to area, amount of rains per hour, route of typhoon and satellite pictures would be obtained from weather forecast web page. Also, through the media, surveyor could research about second hand damage such as facilities and building collision or horrible mudslide. Finally, on the NIDP website, surveyor obtains some information about present condition of drainage installation and condition of maintaining prevention equipment. This information can figure out direct or indirect causes of inundation combined with geographic factor after flood marks surveying.

Direct research will be conducted with field surveying. If surveyor takes a picture of damaged area, it could be matched between flood marks line and the picture. And through the foundation of indirection research, surveyor should ask for people living in the area about time and causes of inundation and practical circumstances of the field and should make a investigation report.

3.4 Flood marks surveying in the field

3.4.1 True elevation of flood surveying

True elevation of flood is the height from mean sea level to flood marks by connecting edge of the outline. True elevation of flood is surveyed by Total Station indirectly. And then, close the start point and finish point and finally, true elevation would be decided by average of observations except for maximum and minimum. <figure 5.(a)>

Observation parameter's criteria are below. < table 1> The criteria would be same as height of flood surveying.

Measurement unit	Minimum unit	Repeat	Tolerance limit
Cm	1cm	Average of 2 times	±30cm

<table 1>. Criteria of parameters

Total Station can acquire distance and angle from the control point to flood marks point. Surveyor observes true elevation of flood marks using Total Station, basically solved by sine law. To calculate true elevation of flood marks, true elevation of a cadastral control point adds Total Station's height and then subtracts heights from the flood marks. <figure 4>

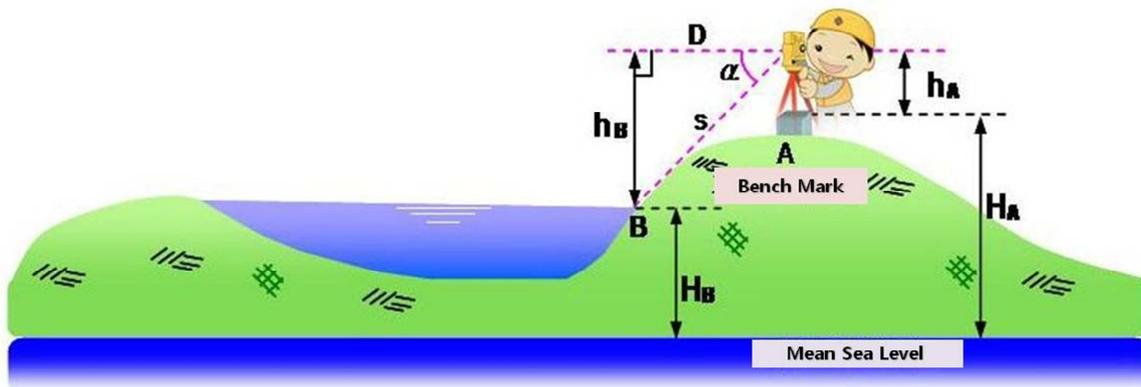


figure 4. Method of true elevation of flood marks

$$\text{True elevation of flood: } H_B = H_A + h_A - h_B$$

$$h_B = S \times \sin\alpha$$

3.4.2 Height of flood marks survey

Height of flood marks means height from land to flood marks (height of zero set). Height of flood marks is distinguished with 7 levels having an interval per every 50cm. There are two kinds of surveys for height of flood marks that one is height of flood marks survey and the other is range of equivalent height of flood marks survey. Firstly, range of the equivalent height survey is performed like making a line above the same district of a damaged area. After the survey, height of flood marks observes depth around 3-4 points in range of the equivalent height survey. <figure 5.(b)>

In principle, the height should be observed directly with ruler, but if it's impossible, it can be used by Total Station. These days, thanks to much improved technology, KCSC also acquires heights of points with Network-RTK promptly.

3.5 Design flood marks map (TOSS)

3.5.1 Making true elevation of flood marks line

Arrange an observation file at the field with height and range of equivalent height of flood marks. As the picture below, true elevation of flood marks is red dotted line and height of flood marks is blue dotted line. To make a line, true elevation of flood marks should be closed. After connecting the line, make a polygon and then average height and area would be gained. <figure 5.(c)>

3.5.2 Registration of research point

Research point means height of flood marks points within range of the equivalent heights. Additionally, if river inundates over the levee or several materials breaks, they could be registered as a research points.

Unless research point is registered, height of flood marks line couldn't be developed so before making the line, registration must be done. Research point to height of flood marks, broken embankment and river flowing backward can be inserted at text and symbol space in TOSS.

3.5.3 Making height of flood marks line and a map

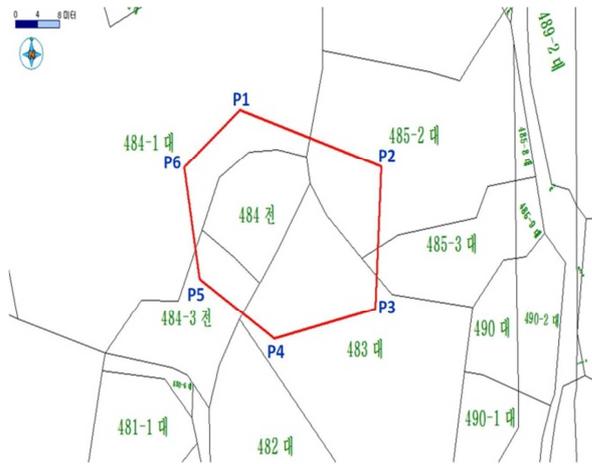
Height of flood marks line is made by closing the observed range of flood marks. It is similar with split operation that if line is far from true elevation of flood marks line, it should be crossed through true elevation of flood marks line using extension tool in TOSS. With selecting the height of flood marks polygon, the line is created automatically using the tool and also, the depth and area of the flood marks is calculated. When inserting the name of district in attribute table, color with depth of flood marks would be changed. Make a map's line in printing bound and print the flood marks cadastral map and flood marks geographic map when TIN file is input, which is downloaded from the management system.

<figure 5.(d)>

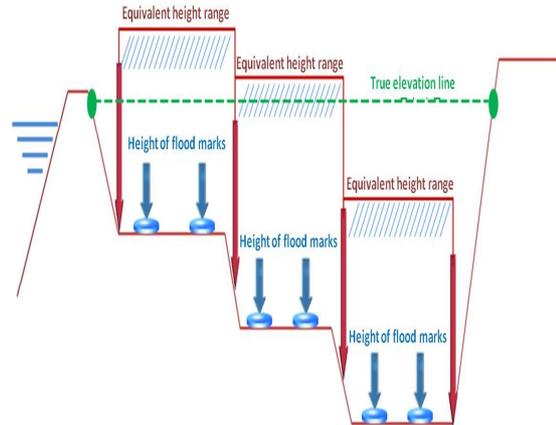
3.5.4 Making a parcel report and up-load the files

Parcel report is also made easily by pushing as CSV file in TOSS. Parcel report is necessary for supplying because it contains the amount of area about damaged field, owner's information and compensation process. Import CSV file at EXCEL and save the report inserting the cause of inundation.

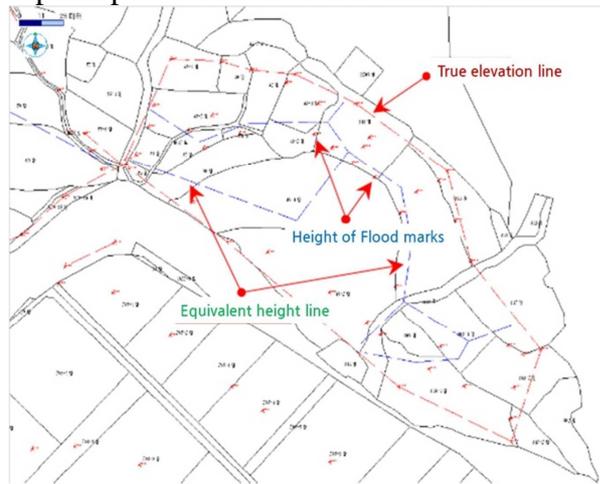
The management system should contain three files. One is ZIP file and CSV file to up-load on the system; another is CSV file which needs to make parcel report; the other is DXF file supplying the products like flood marks cadastral map. These files would be up-loaded on the Flood Marks Management System and if inundation information is selected, the information up-load tab is activated. Above all, insert [weather condition][amount of floods][disaster prevention conditions] at area information tab and enroll the district information. Finally, up-load the map and parcel report designed from TOSS.



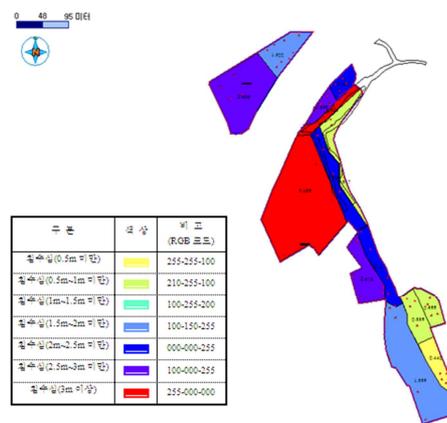
a. principle of true elevation of flood marks



b. categorization to height of flood marks



c. design flood marks map



d. flood marks cadastral map

figure 5. principle of flood marks and process of making a map

4. Flood Marks Management System

4.1 Establishment of Flood Marks Management System

KCSC wanted to correct the problem of managing data so KCSC developed the Flood Marks Management System in 2008. The Flood Marks Management System can combine related data based on web GIS and it is important that it can apply a variety of fields.

Looking into process of flood marks management work, local government requests making flood marks map through the system and then branch receives the works. When the KCSC branch requests basic data on the system, design the map using extracted data and survey data and upload the disaster prevention information on the system. <figure 6>

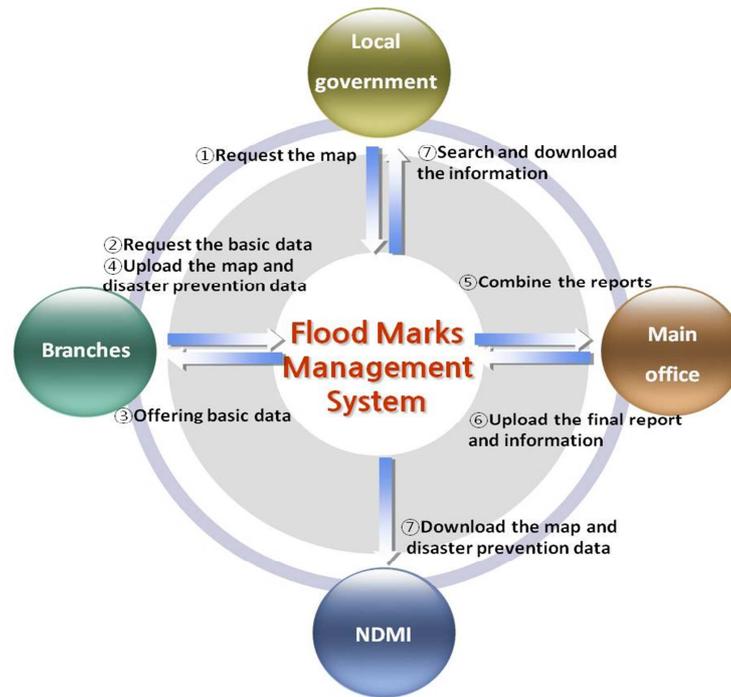


figure 6. Roll of Flood Marks Management System

4.2 Utilities of Flood Marks Management System

Flood Marks Management System has big merits, which is the map-screen tool. It can calculate distance, area and x-y coordinate using web GIS and it is easy to grasp of the situation overlapping satellite picture and flooded point. With the search tool, it is free to figure out regional flood marks, condition information, searching disaster prevention data and downloading them. In case of well-preserved area, people can search by regional and year, find the information, monitor and make a plan of prevention for areas prone to a flood.

The inundation-information tab can upload flood marks map and enroll the causes and present condition. To inquire history of inundation information for a specific area, statistics tap can show information by regional, parcel and year. In addition, the disaster-prevention tap registers and shows location of water gate and flood pumping station for protection facilities as well as shelters and embankments.

4.3 Efficient application of Flood Marks Management System

Flood Marks Management System specializes in four elements.

Firstly, it is useful to apply when people make a development project. Urban developing plan department should check if the area had had a history of inundation or not and then make a plan that buildings' and ground' height should be over the true elevation of flood surveying. Furthermore, In case of danger area of inundation, preventive measures should be made and people should try to reduce the loss. By the way, areas prone to floods should be selected as Natural Disaster Hazard Area and variety of maintenance plan and disaster prevention plan could be established.

Secondly, it could be likely to process real-time access because of the online system. That's why both data request and offering could be possible on the online, so it increases work efficiency and advances supplying real-time disaster management system. The system allows local government and disaster-related organization accessing anytime anywhere, but it will be as soon as possible that ordinary people can access the site and free to get some information as part of combination of GIS system by NEMA. After that, people could browse history of inundation damages for interest area and living district, so it can alert people to protect themselves and accelerate establishing flood area estimation map or real-time inundation hazard information. At the present, KCSC is planning to develop an application for their flood hazard map to utilize flood marks data and disaster information. KCSC is trying to offer useful and free information open to everyone.

Thirdly, Flood Marks Management System could support decision making of disaster prevention. Flood Marks Management System provides location information service and attribute table such as embankment, drainage, river facilities, water gate and flood pumping station. However, the point is that it is not superficial supplement of disaster information, but it can overlay map and damaged area and figure out accessibility offering present condition and survey data. Observing on the field, if the surveyor could survey location of rainwater pipe together, it will be helpful to learn flood area estimation and inundation research through correlation with capacity of drainage. Moreover, if the capacity is insufficient, it should be replenished or drainage's structure should be changed. Practically, KCSC carries out surveying present condition of public facilities and establishes a database, so it doesn't have differences from disaster prevention facilities survey.

Finally, it is easy to calculate compensation or insurance premium rate. The product contains flood marks cadastral map, geographic map and parcel report which is important information for the compensation work. Parcel report consists of area of parcel, owner and the official land value and also, only damaged parcel could be extracted. It would help make a budget for damage effectively.

4.4 Effects of National Disaster Management System and Integrated GIS

NEMA which takes charge of national disaster apparently needs hazard map converged with spatial data and attribute data. This is necessary for accuracy of disaster estimation or protection and also recently, increasing social requirements, it should be useful to establish disaster information system of people participating. Several efforts have been continuous, but GIS data didn't coincide between institute and local government so that the system was less efficient and needed unified management system.

In Korea, hazard map is composed of three maps that one is flood marks map which local government requests making a map to KCSC; another is flood area estimation map designed by National Oceanographic Research Institute(NORI) and NEMA, etc; the other is disaster hazard map in charge of local government. In this way, various maps are made by different institute and ways, so standard and integrated infra is scarcity.

Integrated GIS DB operation diagram is below and this was discussed already by NEMA in 2007. The fundamental concept is combining national disaster management system DB and interagency DB and constructing integrated GIS DB to connect applying data in cooperation. However, without spatial information basis and infra structure, the concept was not advanced anymore. As a result, because of increasing social response and technical improvement, integrated GIS DB is ready to construct. <figure 7>

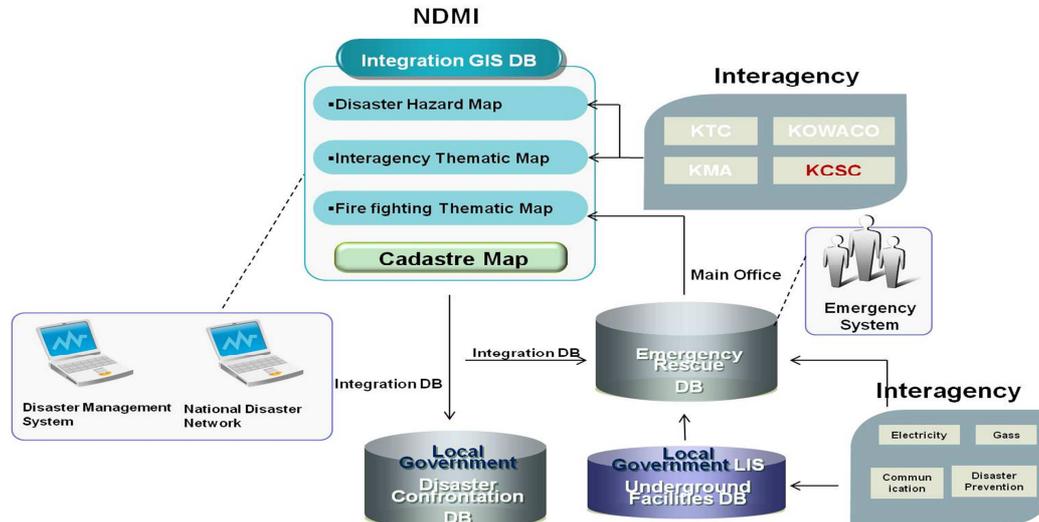


figure 7. Integrated GIS DB operation diagram

KCSC has established own infra to apply and combine with GIS system. With software with making the flood marks map, spatial infra and web GIS, it is the most important work for KCSC that not only flood marks map but also disaster hazard map could be designed. Especially, NEMA's typical thematic map is disaster hazard map and integrated GIS DB includes only flood marks map as the hazard map. This means NEMA admitted the quality of KCSC's flood marks map. At last, KCSC will be in charge of managing and combining administration information and GIS information around from national disaster administration works and will promote to develop various contents.

5. Conclusion

This paper is about flood marks map to foresee and protect the hazard of natural disaster changing constantly. To design flood marks map efficiently, KCSC is using the state-of-the-art equipment and software and KCSC makes unified map to supply local government flood marks cadastral map, geographic map and parcel report.

Flood marks map avoids existing direct requests and supplements, but through the Flood Marks Management System, it is favorable for offering GIS tools and integrated flood marks data by district and year open to every related institute. This Flood Marks Management System is developed in four merits. It could be applied for establishment of development plan and possible to process real-time access because of the online system. In addition, Flood Marks Management System could support decision-making of disaster prevention and be easy to process compensation and insurance work.

Flood Marks Management System doesn't finish just as management system, the roll of the system would be expanded to integrate the maps like flood area estimation map or flood hazard map. KCSC would do public duties to manage disaster maps efficiently and offer convenience for people as the owner of making a map in integrated GIS system.

REFERENCES

Bae, Jin Kuk, 2009, Flood Mapping for the Inland Areas using DEM

KCSC, 2008, Designing flood marks map and Enhanced measure of flood marks management

KCSC, 2011, Designing Flood Marks Map Software User's manual

KCSC, 2011, Guidelines of Designing Flood Marks Map

KCSC, 2011, Introduction of making flood marks map

Kim, Gwang Seob, 2009, Analysis of the Secular Trend of the Annual and Monthly Precipitation Amount of South Korea

NEMA, 2010, Disaster annual record

NIDP, 2000, Institutionalization of Flood Hazard Map Design and Development of Flooding Area Estimation Technique(I)

NIDP, 2010, Analysis of the Disaster Map's Present Condition and Invigoration of Its Utilization

Park, Won Chang, 2010, Methodology for the Management and Application of Flood Plain Maps using Cadastral Information

Sinn, Cheol Hyeok, 2009, Mapping the flood hazard by the application of GIS

Korea Cadastral Survey System (<http://www.kcsc.or.kr>)

Flood Marks Management System (<http://fms.kcsc.or.kr>)

National Disaster Management Institute (<http://www.nidp.go.kr>)

BIOGRAPHICAL NOTES

Hyunjung HA graduated from University of Seoul studying GIS, Remote Sensing, Surveying and Photogrammetry. She is an assistant manager in Korean Cadastral Survey Corporation. She is an engineer both cadastral survey and information processing.

CONTACTS

Hyunjung Ha
Korea Cadastral Survey Corporation
1103-10, Seojeong-dong, Pyeongtaek-si
Gyeonggi-do
Republic of Korea
Tel. +82-31-663-3030
Fax + 82-31-665-2973
Email: hhjj0628@kcsc.or.kr
Web site: www.kcsc.or.kr