ESTABLISHING AND EXPLOITING THE GIS DATABASE FOR THE MANAGEMENT OF URBAN WATER DRAINAGE INFRASTRUCTURE

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ABSTRACT

Flooding state often occurs in rainy season or high tide in urban areas in Vietnam recently, impeding daily life activities of the society, causing damages to people and property in flooded areas. Ho Chi Minh City is a leading economic city in the country. However the city frequently faces up with severe floods when rain storms or high tides happen. Therefore, in order to address the problem of flooding in the process of urban development today, the paper has studied the design of the framework database for the management of urban drainage infrastructure, including basic geographic data layers and thematic data layers. Based on the designed framework database, experiments were conducted for the database for District 1 of Ho Chi Minh City. From the results of the experiments, the paper explores how data mining which involves the exploitation of attribute data and spatial data mining; then, calculates, extracts and edits maps in service of drainage network infrastructure management. From the results of data mining, solutions and recommendations are drawn to improve the quality of management of drainage infrastructure in District 1, Ho Chi Minh city.

Keywords: *Drainage network infrastructure, urban, Database, Data mining.*

1. INTRODUCTION

Urbanization is essential trend in all countries. Along with the economic development, a lot of problems incurred in urban areas, especially infrastructure development did not catch up urbanization process. In urban areas, especially in special urban area such as Ho Chi Minh City, infrastructure of drainage network can not satisfy drainage requirements so water-logged phenomena usually happens, causes the much damage to property, prevent the social activities and can even endanger to the lives of people.

In order to resolve the water-logged problem in the urban development process, the establishment of GIS database about infrastructure of drainage system is extremely necessary, it helps to analyze the technical conflicting of sewer system, then overcome, evaluate the causes, propose the solutions to reduce floods; study on planning the drainage system in the future; assessment the quality of construction, defects of sewer system, the state of encroachment on canals and at the same time actively repair, replace the old degraded sewers, build the optimal operation process.

The current short comings in Ho Chi Minh city is that the drainage system on the same basin is managed by too many offices such as Department of Transportation, Flood Protection Center, District People's Committee and Urban Water Supply One Member Limited Liability Company... therefore scope of management of the offices overlaps thus storage database is dispersed, asynchronous and there is no coordination between

management units, this leads that no offices hold the comprehensive, fully updated and accurate database.

In Vietnam, for a long time ago there have been many researches and practical works on building GIS database in order to serve for any purpose but these studies did not focus on finding out how to exploit database after establishing. Huynh Van Chuong, Nguyen The Lan, 2010, research on establishing database to serve for evaluating land and land use planning. Geographic Information Technology Corporation eK (eKGIS), 2015, establish the specialized database in information and media for Ha Noi Department of Information and Communication. Truong Thi Thuy Quynh and the others, 2016, research on using ArcGIS software to create the data set and thematic maps for water supply management in Soc Trang. Only a small number of studies mentioned the exploitation of built GIS database, such as: at the Ministry of Construction, department of "Sustainable development of the environment in poor urban areas SDU", 2009, organized the local conference about assessing the current status and ability of GIS database exploitation for urban environmental planning and management; or Tran Trong Duc, 2016 exploited spatial data about the drainage infrastructure system through internet by the way of building a WebGIS system on the basis of web application ASP.NET of Microsoft, combines with opening source code products Geoserver, and OpenLayers.

In order to resolve above problems, especially water-logged phenomenon in Ho Chi Minh city, the authors studied the procedure of building the GIS database of the drainage system in District 1, Ho Chi Minh city, contemporaneously finding out how to exploit attribute data and spatial data that serve for management of the drainage network infrastructure. The data was given by Saigon Real Estate Development Joint Stock Company.

2. ESTABLISHMENT OF GIS DATABASE OF DRAINGE NETWORK FOR URBAN INFRASTRCTURE MANAGEMENT

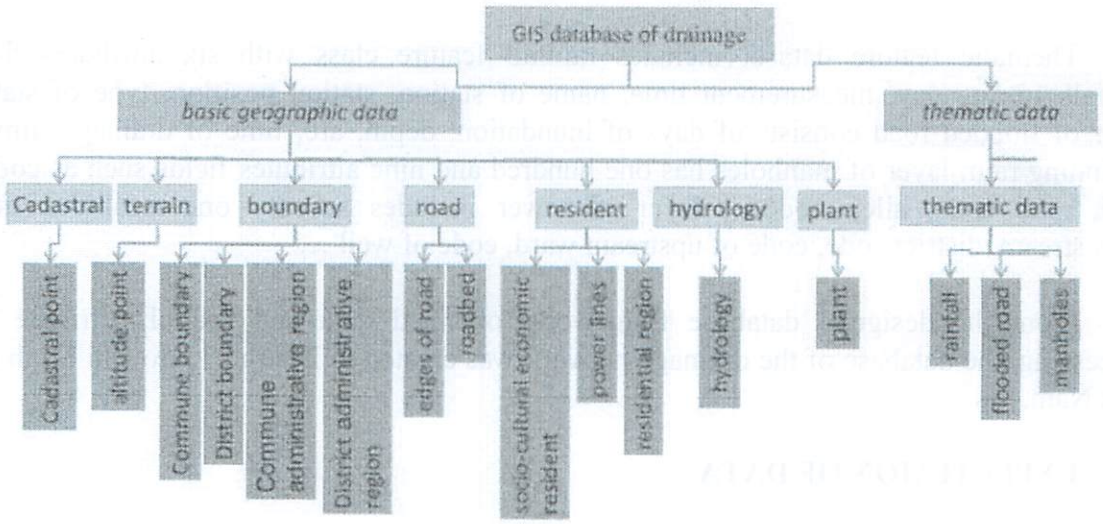

Figure 1. A spatial data framework of drainage network for the management of urban infrastructure

A database framework of drainage network for the management of urban infrastructure has been proposed, includes basic geographic data and thematic data. Basic geographic data includes: cadastral; terrain; boundary; road; resident; plants; hydrologic system. Thematic data includes: rainfall; flooded road; manholes. Base on spatial data framework as Fig 1, determining the attribute fields of each data layer as following:

Feature dataset of cadastral includes one feature class with attributes fields: name of point, kind, coordinate, type of object.

Feature dataset of terrain includes altitude point feature class with attributes fields such as: kind, altitude, type of objects.

Feature dataset of boundary includes four layers: Commune boundary feature class consists of three attribute fields: ObjectID, kind, type of object; Commune administrative region feature class includes six attribute fields: Administrative code, name of ward, administrative level, type of administrative, number of households, district; District boundary feature class consists of three attribute fields: ObjectID, Kind, type of objects; District administrative region feature class consists of five attribute fields: Administrative code, administrative level, type of administrative, number of households, district.

Feature dataset of road includes edges of road feature class is designed attribute fields: OBJECT; roadbed feature class has nine attributes fields: Kind, name of road, management level, material, width of road, status, payload, number of beats, type of objects.

Feature dataset of resident include socio-cultural economic resident feature class has five attributes fields: Kind, name of residential point, number of floors, administrative code, type of object; layer of power lines consists of five attribute fields: kind, voltage, number of wire, nature, type of objects; residential region layer has seven attributes: kind, name of residential point, number of floors, nature, height, administrative, type of objects.

Feature dataset of plant has one feature class consists of two attributes: kind, type of objects.

Feature dataset of hydrologic system also has one feature class which is designed four attribute fields: name of rivers, width, depth, bottom materials.

Thematic feature dataset includes rainfall feature class with six attributes fields: rainfall, update day, measurement time, name of station, station position, type of station; layer of flooded road consists of days of inundation, depth, are, time of drainage, time of beginning rain; layer of manholes has one hundred and nine attributes fields such as code of well, road code, alley code...; layer of sewer includes seventy one attributes fields: downstream, district code, code of upstream ward, code of well ...

From the designed database framework, obtained data and spatial, attribute data processing, the database of the drainage network was created in District 1, Ho Chi Minh city, Viet Nam.

3. EXPLOITAION OF DATA

Information that is exploited must adapt with urban infrastructure management, thus it need to exploit data according to reality of infrastructure management. The article researches how to exploit attribute data, spatial data and select new data, then perform as the derived map that is used to analyze and serve better for urban infrastructure management.

3.1 Exploitation from attribute information data

Some familiar problems in exploiting attribute data can be listed such as: check attribute information of a location defined object example exploiter can check information of each manhole along any flooded road and then zone the problematic manholes, or find out the solution of maintenance for those manholes.

The second problem is expressed as: having the attribute information of objects but no determining their location in reality, example it is necessary to define the manholes that have water outlet...

3.2 Exploiting spatial data

In Ho Chi Minh city, in reality there was a case that the medium-voltage power line falling into the puddle of water killed a person immediately, therefore the problem has been proposed that finding the flooded roads where high-voltage, medium-voltage or low-voltage wire go through and warn the electricity agencies, make them pay attention to ensure the safety of electricity networks in the rainy season.

3.3 Extracting map

Combine spatial data with attribute data to analyze, create derivative information, then edit new derivative maps for drainage network infrastructure management. However, because the completion of drainage network infrastructure database is limited, only two maps were extracted in this study:

- The map of flooded roads in District 1, Ho Chi Minh city on the fifteenth of September in 2015 was edited on the basis of information of flooded road layer and flooded day.
- The map of influences of the density of households per one meter of sewer on the flooded road on the fifteenth of September in 2015 in District 1, Ho Chi Minh city: the density of households per one meter of sewer was calculated in each ward on the basis of sewer layer and attribute field of length of sewer, layer of ward boundary and attribute field of number of households.

4. RESULTS AND DISCUSSION

With methods of exploiting data and problems were proposed in section three, in this part results of exploiting data in the study will be shown as following:

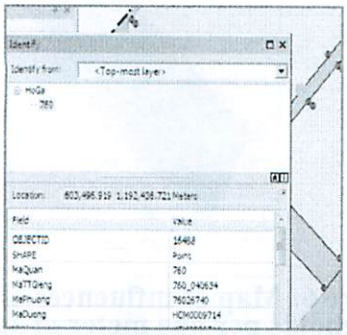

Figure 2: Check attribute information of one location defined object "manhole"

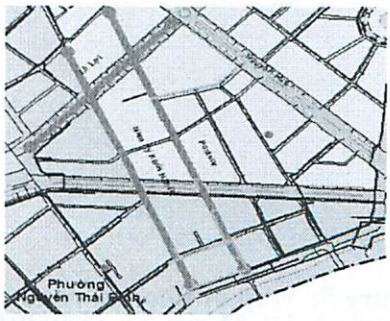

Figure 4: Finding the flooded roads where high-voltage wire pass through

Results in Figure 2 allow obtaining information about manholes such as: the manholes have the function of a well, material of valve is cast iron, material of manholes is reinforced concrete, square shape with length of edges 90cm, there is no net, one floor, there is input sewer and output sewer, belong to project of district 1... checking information of manholes demonstrate that manholes in District 1, Ho Chi Minh city all have norubbish preventing nets or filter membrance.

Figure 3 shows the attribute tables and spatial images in query process to determine spatial objects "manholes" if having attribute information "water outlet". Results demonstrated that there are 18 outlets and these outlets have no tide preventing planks, waste water was processed, Lids and pits are made of reinforced concrete and have no net of preventing. These manholes were constructed by district 1. In figure 2, we can find that water outlets were built and located on the Saigon river. While there are no outlets on Ben Nghe and Thi Nghe canals.

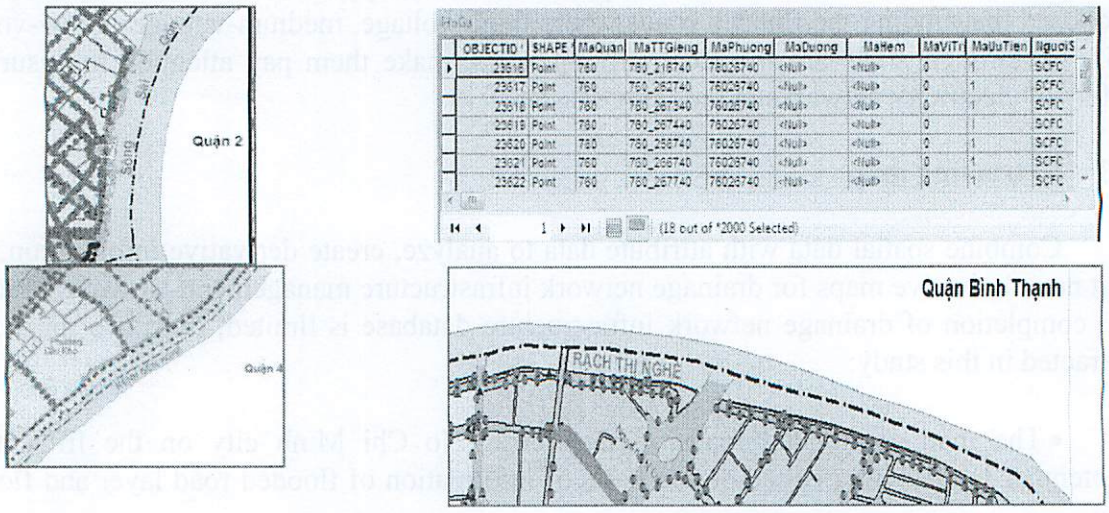

Figure 3: Query of manholes that function as "water outlet"

Figure 4 shows all flooded roads where high-voltage wires pass through, from this figure we can determine flooded routes to warn the electricity agencies who are responsible for checking, maintenance of high-voltage power lines in these routes to avoid the most risky situations.

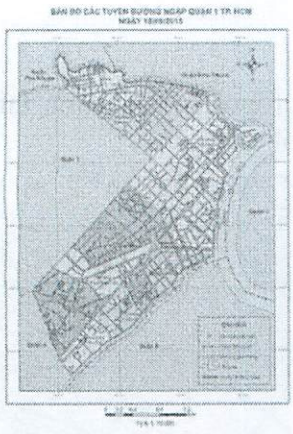

Figure 5: Map of flooded roads in Distric 1, HCM city on 15/9/2015

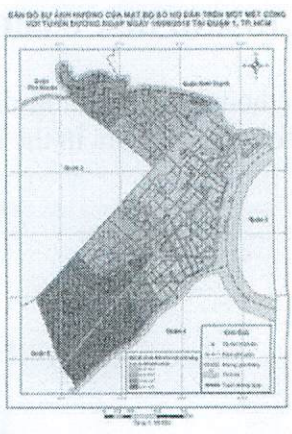

Figure 6: Map of influences of density of households per one meter of sewer on the flooded roads on 15/09/2015 in District 1, Ho Chi Minh city

Figure 5 shows map of flooded roads in district 1 Ho Chi Minh city on 15 September 2015 that was edited from the drainage network infrastructure database. This map allows to determine quickly and visually which ward the flooded routes belong to, then improve the drainage management for flooded roads.

Figure 6 shows map of influences of density of households per one meter of sewer on the flooded roads on 15 September 2015 in District 1, HCM city. Look at the map, we can see the flooded roads that belong to the ward that has low density of households per one meter of sewer, this helps eliminate doubt that density of households per one meter of sewer is the cause of waterlogged.

5. CONCLUSION

A database framework for the management of urban drainage infrastructure was proposed. On the basis of that, GIS database for the management of urban drainage infrastructure was established from the actual data. And then, the article studied the methods of analysis and exploitation of spatial information, exploitation of attribute information, method of extracting information for establishment of the derivative maps from drainage network infrastructure database in order to serve for urban infrastructure management. Results demonstrate that on the flooded routes manholes and sewers need to be checked frequently, the manholes need to be equipped rubbish preventing nets and filter membrance so that sewer is not stuck and the drainage is easier. The study also shows the methods of determination of the flooded routes where the power lines pass through, then warn electricity agencies and require them to pay attention to maintenance these wires, especially in rainy season.

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