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ABSTRACT

Digital elevation model (DEM) is one of the maps is designed to emphasize the theme of terrain surface level to meet the demands of many fields in our present life. Nowadays, with the development of information technology, geographic information systems (GIS) have been widely used in resource management and the economic and social development issues, has many specialized capable softwares of analyzing space, modeling with high precision interpolation algorithm to support establishing map more quickly and accurately than the previous manual methods. By using the ArcGIS software combined with the capability of processing, interpolating space, research has successfully built a digital elevation model maps for district 8, Ho Chi Minh City at the scale of 1:25000. Results achieved helping users can grasp and evaluate objectively entirely elevation of the terrain surfaces where are flooded in the case study area through the color scale of the elevation; at the same time, shows flooded land surface areas of district 8 is very great when the tide peaked. This is a base for local government who is making and deciding a suitability and long solution to limit the regularly flooding situation in urban area.

Keywords: DEM, urban flooding, GIS

I. INTRODUCTION

Land is a very valuable resource. Map is considered an extremely important document to manage and use effectively and reasonably this resources. And, digital elevation model maps are designed to emphasize elevation of the surface matching practical demands in social-economic development. So, digital elevation model map becomes one of tools supporting to assess surface of the terrain, as a basis to decide directly planning and reasonable solutions for land management. However, establishment of terrain map exists many inadequacies, which is mainly done by manual methods, takes more time and unaccurately.

Before the boom of science and technology, GIS softwares is one of the solutions are pretty common applications with the ability to analyze space, modeling, high precision interpolation algorithm, more friendly interface with users, able to show three dimensions. GIS system leads to aid for the establishment of digital elevation model maps quickly and accurately in order to enhance the terrain effecly.

District 8, Ho Chi Minh city locates in a low terrain plain, belongs to the edge of east-southern and slump sagging lowland region of Mekong delta where is impacted directly flows of the flood from upper watershed and tide from the East Sea leading to flooding situation

In addition, objective reasons due to natural conditions are causes of subjective human leading to flooding condition as:

The drainaige system is not built in unique, maintainance, dredging unusually and urbanization makes decreasingly controlling naturally the surface of the watershed , almost land was concreted by constructing buildings, factories; citizens' knowledges of environmental protection is not good, usually wasting garbage leading to an obstruction of drainages, the status of ocupying and leveling many channels…are main reasons to cause flooding extensively. In urban area, the present problem of flooding and drainge is a serious obsession, a hard challenge to leaders and citizens when tide occurs at the same time of rainny season. Nowaday, DEM map of district 8, ho Chi Minh city is an important role in adjusting urban architecture as building contructions which are built against flooding in urban regions.

II. METHODOLOGY AND INSTRUMENTS

A. *Methodology*

The research used methods such as: surveying and investigation, statistic, analysis, synthetic, mapping and GIS application. The main methods are used:

1) Mapping methods: the important method showed acurately location of elevation points and administrative boundaries. This method was used to split layers, inherite the collection of elevation points and administrative boundaries to create input data aiming to interpolate spatial data.

2) GIS application: the research applied ArcGIS to interpolate spatial data and edit a DEM map which was carried as a basis to analyze and evaluate terrain fator amongs of orther factors for predicting and monitoring flooding areas.

B. *Instruments*

1) MicroStation V8i was used to get a system of cartographic maps that were inseted borders perfectly in order to edit a DEM map.

2) ArcGIS: was used as a main tool to build database model and establish a DEM map.

III. PROCESS

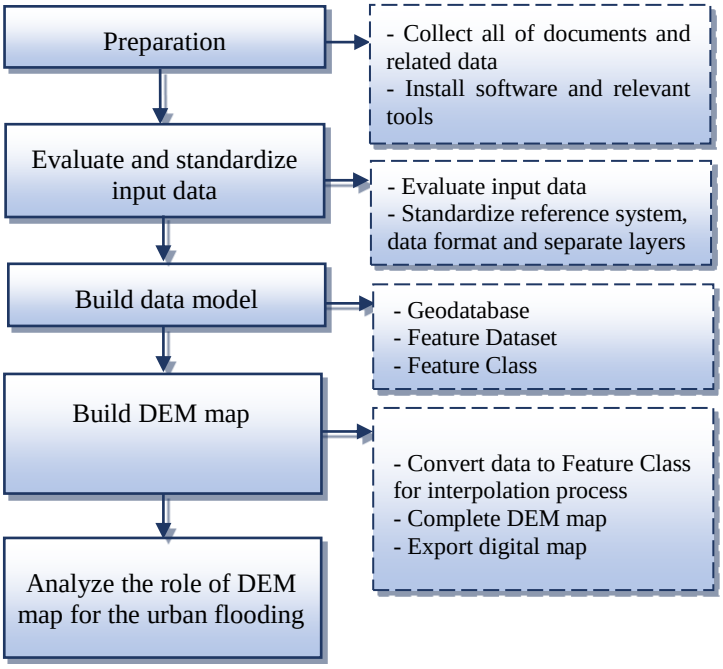

Figure 1. Implementation process

IV. RESULTS AND DISCUSSIONS

A. Evaluating and standardizing input data source

1) Evaluating map data source

The research was conducted with cartographic map system of District 8, Ho Ch Minh city in *. dgn format by combining digital image technology that has done following the regulation of Ministry of Natural Resource and Environment: VN 2000 coordination system, time zone projection of 30^0 , Meridian axes of $105^0 45'$.

Data resource was collected in vector format, consisted of 31 pieces of cartographic maps which were inseted borders at scale of 1:2000 presented in details the objects: hydraulic system, terrain, transportation, residential, plant and thematic basis. Amongs of layers, terrain consisted of elevation points and its notes were the most important data to affect directly the result of DEM map.

2) Standardizing data

Cartographic map system of District 8 was established by Ministry of Natural Resource and Environment following regulations of present standards. However, with a mount of big data of cartographic maps the research used **"congcutachlop.mbva"** tool that was run on Microstation V8i to classify map layers seperately to serve using each of layer while converting Arcgis software

The result of separately classifying cartographic map into 63 layers respectively with 63 *.dgn files decreased lightly a mount of information to present and increased speed of sellecting attributes when elevation points were processed in ArcMap.

B. Establishing data model

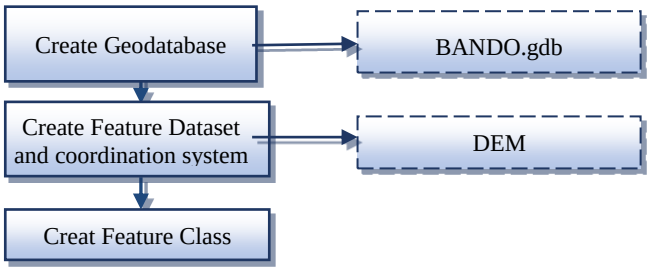

Figure 2. Establishing data model process

C. Applying ArcGIS to build a DEM map

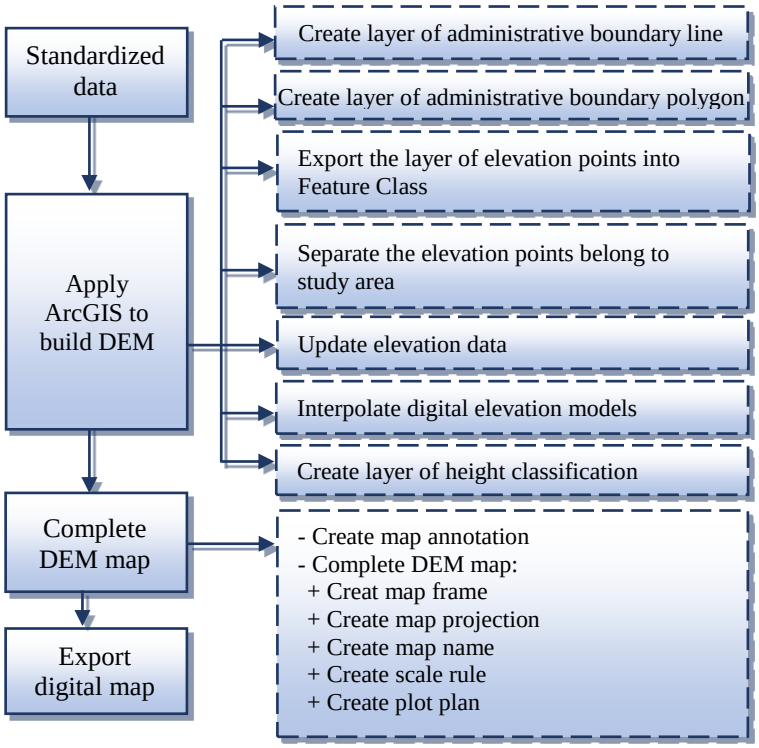

Figure 3. Establishing DEM map process

1) Converting data to Feature Class to interpolate

Creating administrative boundary layer: This was a basis to create administrative boundary layer in polygon.

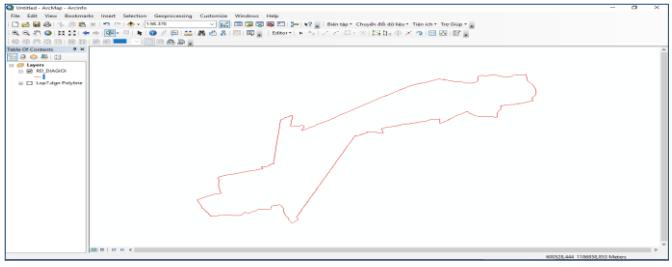

Figure 4. Administrative boundary layer

Creating administrative boundary polygon layer: this layer used the result of administrative boundary layer and Feature To Polygon tool to create polygon layer, using interpolation of

digital elevation points which are followed admistrative boundary.

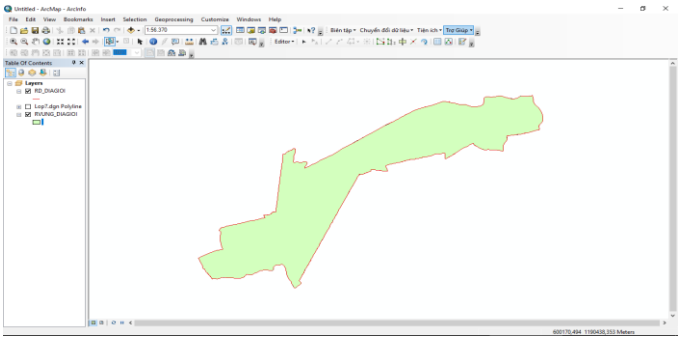

Figure 5. Administrative boundary polygon layer.

Exporting elevation points to Feature Class: the system of elevation points of cartographic map is the important data input to decide the precision of DEM layer. The result exported all of 31 spiece of cartographic map (on Microstation software) to data of Feature Class.

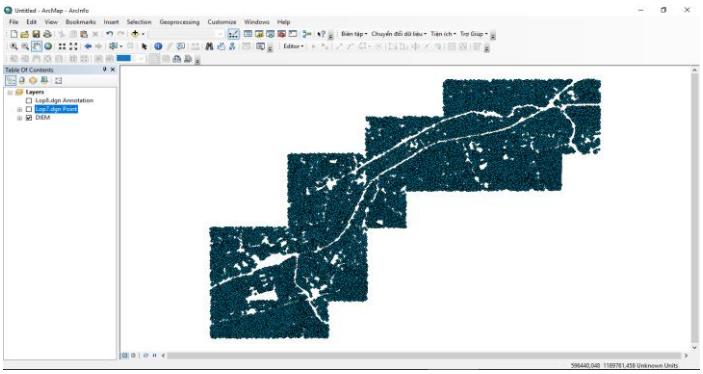

Figure 6. Elevation point layer in Feature Class

Classifying elevation points in case study area: district 8 was inseted borders by 31 piece of cartographic maps which consisted of elevation points in neighbor regions so that admited points outside of the case study area in order that the information was reduced volumne, updating time and spatial data interpolation. . The result converted sucessfully 9.854 elevation points on over the surface of terrain in the case study area.

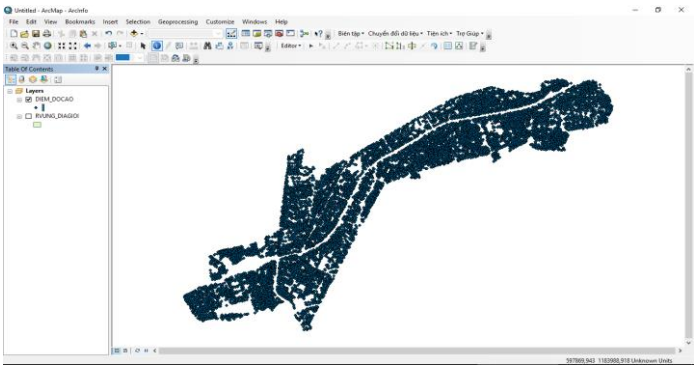

Figure 7. The result of seperating elevation points in case study area

Updating elevation data: elevation data of cartographic map is Text then it became Annotation when it was moved to Arcgis. So, it is nescessary to combine them with coordination points to get a full elevation point system with x, y and z values. Then, input data was created to interpolate DEM

*Interpolating DEM : up to objectives of estblishing map and input data, the research sellected IDW (*Inverse Distance Weighting) to interpolate DEM of the case study area.

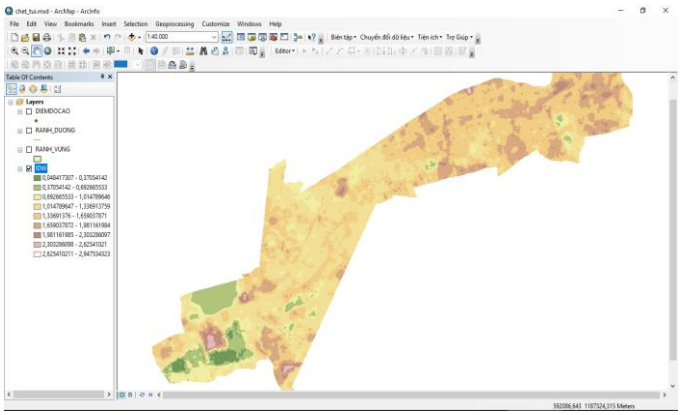

Figure 8. Result of DEM interpolation

Creating classification of DEM layer:

Table I. Statisticizing elevation point by classifying layer

Value	Elevation levels	Number of contours	Area (ha)	Scale comparing total area (%)
1	I (< 0,5m)	24.255	61,20	3,20
2	II (0,5-1m)	83.676	209,42	10,96
3	III (1-1,5m)	397.288	994,58	52,04
4	IV (1,5-2m)	241.330	604,02	31,60
5	V (2-2,5m)	15.469	39,08	2,04
6	VI (>2,5m)	878	3,05	0,16
Tổng		**762.896**	**1.911,35**	**100,00**

Source: Self-synthesis

Table 1 showed that there was a diferrences between natural area (1.9113 ha) and area in interpolation process because the surface of raster areas weren't coincided with administrative boundary by some points in the edge of rivers. However, the difference wasnot large and evalutating the surface of topography based mainly on a constantly change of elevation being from higher to lower so this diference didn't affect monitor and evaluate geomorphology of the case study area.

2) Editing and publishing perfectly a DEM map

Elevation data was mearsured directly to the content of DEM with high accuracy. The rsearch created sucessfully DEM map with scale of 1: 25.000, using UTM reference and VN-2000 coordination system and legal regulations of map and database.

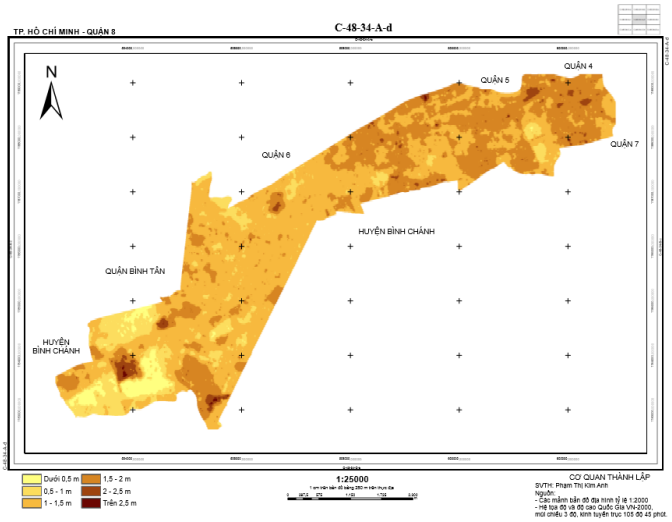

Figure 9. Interface of DEM map in the case study

3. *Analyzing the role of DEM map for flooding issue*

Elevation is one of the most important factors in flooding evaluation, prediction and monitor in urban and rural regions. Especially, in urbanizing areas, the combination of elevation factor with drainage, leaching, volumne of rainwater… must go together. The subidence is more serious when construction of infrastructure and building developed constinously. The comparation of the elevation of stages is needed to maintain to monitor the changes of elevation points on the surface. The results of investigating and measuring in the case study matched the illutration of the DEM map was 95% total elevation points of the verify. Using all kinds of satellite images to check at many resolution levels, the result showed that the flooding areas which the DEM map were still matched respectively the flooding areas in satellite images up to scale and the resolution quality.

Flooding areas were large and the locations could be defined exactly in the fieldworks. Then, the government can decide a priority for flooding points following serious levels to solve the urgent difficulties in serious flooding areas. More over, for projects against flooding in macroscope, the solutions of building irrigation works must base on DEM map as a basic index adding other factors to calculate fixing flooding situation in city planning in the future during the climate change and sea level rise condition.

V. CONCLUSION

The research used ArcGIS software to build sucessfully a DEM map in district 8, Ho Chi Minh city where usually occurs flooding by the low, hollow terrain and was subsidided up to time, cut strongly by a complex and interlacing connections of river system, is usually impacted directly by the flooding flow from the upper watershed and tide of Earstern Sea. The result of classifying elevation showed that the case study area was divided into 3 regions of very low and hollow, low and everage with 6 classes of elevation: Class I(<0,5m) with 61,20ha , class II(0,5-1m) with 209,42ha, class III (1-1,5m) with 994,58ha, class IV (1,5-2m) with 604,02ha, class V (2-2,2,5m) with 39,08ha and class VI (<2,5m) with a small scale. Besides, the result also showed that if elevation of natural surface was caculated flooding areas was very large when tide got the top. So, local goverment must think and give effective and sciencetific solutions or policy to limit and stop the flood situation in time.

In general, using DEM data from cartographic map to create DEM map is nescessary for an inner district where has an especial terrain and high speed of economic development as district 8, to reflect continuously changes elevation on the surface of land through color scale, supporting terrain evaluation , planning policies relating to resist flooding in urban areas.

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