Standardizing the mathematical basis of spatial data in the construction of a pilot urban GIS database in Soc Trang province

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Abstract

Building a GIS urban database plays an important role in the process of developing smart cities. To have a complete urban database that contains a lot of information in many fields, it is necessary to collect data from many different sources. Information from many different sources must be standardized, in which spatial data must ensure the required mathematical basis. This article introduces a method of standardizing spatial data in coordinate form based on conversion parameterscasestudy in buildingplanning database of Soc Trang province. Themethod in this article brings high accuracy, economy, and supports the management of updating data into big data.

Key words: urban databse, GIS, standardizing spatial data, planning

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1. Problem statement

An urban area can be defined as a geographical space characterized by a continuous urban settlement with a high population density, is a political, administrative, economic, cultural or specialized center, and plays a role in promoting the socio-economic development of a country or a territory or a locality.

Smart urban management requires a big database including information from many different fields [1]. The main types of urban data are geographic background data, population data, economic data, social data, environmental data, technical infrastructure data, construction, planning, etc.

Geographic Information System (GIS) is a concept that refers to an organized set, including computer hardware, software, geographic data and people, designed to capture, store, update, control, analyze, and display all forms of information related to geographic locations [1].

Geographic Information System (GIS) is a useful tool in storing and managing urban databases, integrating spatial data and non-spatial data synchronously. This technology has been widely applied in many developed countries and is being deployed in many provinces and cities in Vietnam.

These applications have been widely applied in urban management with high results in innovation, improving the efficiency of management work, and are effective tools for departments, branches and localities in managing urban development according to planning.

Recognizing the effectiveness of the GIS technology, the Ministry of Construction of Viet Nam issued regulations on Guidelines for organizing the establishment of an interconnected urban database system on a GIS platform to serve the development of smart cities, stipulating the steps to be taken in the general process of organizing the establishment of an interconnected urban database system on a GIS platform [2].

GIS-based interconnected urban database system is a system designed and built to manage urban databases in the form of map layers (construction planning, technical infrastructure, housing, infrastructure works, social services, etc.) being integrated on the basis of national geographic database in the national reference system and coordinate system.

GIS enables the user to input, manage, manipulate, analyze, and display geographically referenced data using a computerized system.

One of the important tasks in the process of building an interconnected urban database system on the GIS platform is to standardize the mathematical basis of urban spatial data. This work helps urban spatial data to be linked in a unified spatial manner, all data will be displayed according to the coordinate system (VN2000).

A coordinate system is a method for identifying the location of a point on the earth. Most coordinate systems use two numbers, a coordinate, to identify the location of a point

Coordinate system plays an important role in GIS and supports in-depth analysis on database. All data from different sources input to the GIS system must have the same coordinate system, so when data from other sources needs to be converted to the common coordinate system in the GIS database.

Data conversion process depends on collected data source which coordinate system needs to be converted. In July 2000, the Government officially put the

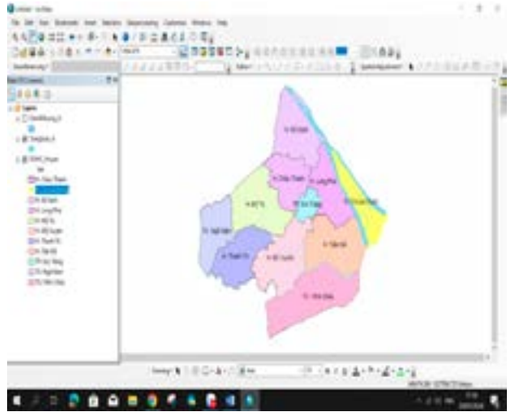

Figure 1. Administrative diagram of Soc Trang province

VN-2000 coordinate system into use [3] (according to Regulation 83/2000/QD-TTg dated July 12, 2000 of the Prime Minister on the application of the VN-2000 National Reference System and Coordinate System), replacing the Hanoi-72 (HN-72) coordinate system used before.

In this article, the research team will give the process off how to standardize the mathematical basis of spatial data collected by GPS surveying (WGS 84 coordinate system) to the VN2000 coordinate system (National Planar Coordinate System) piloted at the urban database of Soc Trang province. The results of the paper are necessary information for urban database developers, as well as managers in updating data according to regulations.

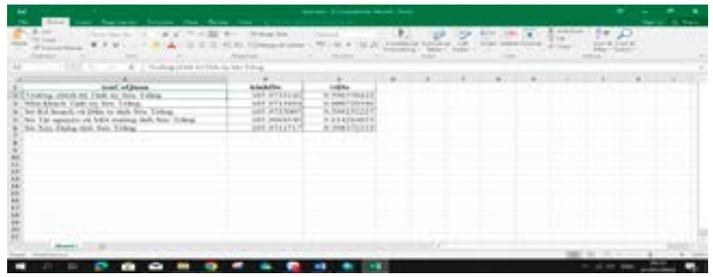

Figure 3. Standardizing GPS coordinate data in Excel software

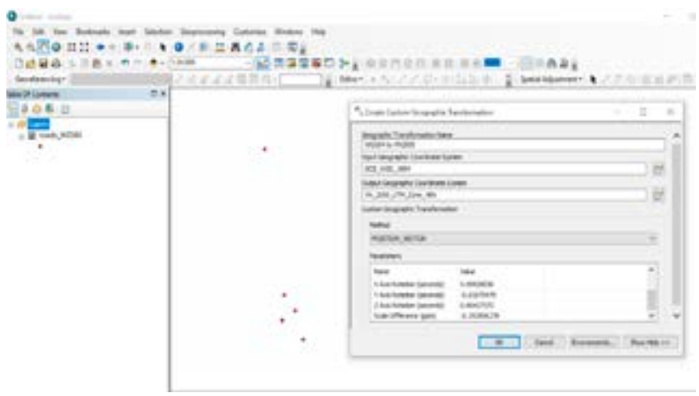

Figure 4. Declare coordinate system for GPS data in GIS environment

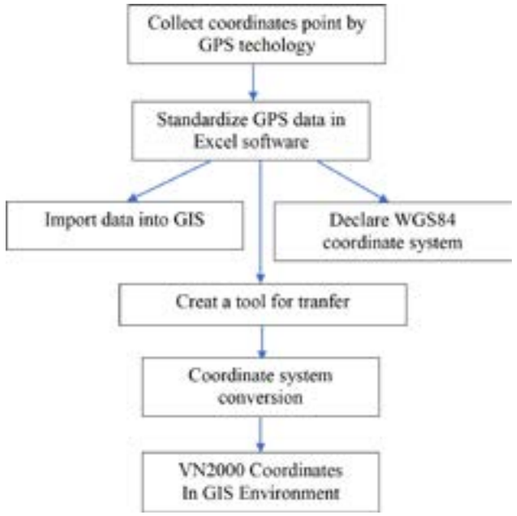

Figure 2. Mathematical base normalization process of urban data

2. Data and methods

Soc Trang is a coastal province in the Mekong Delta, located at the southern mouth of the Hau River. Soc Trang province is located at 9012' - 9056' North latitude and 105033' - 106023' East longitude. The province has an area of 3,311.80 km², ranking 43rd nationwide. The population is 1,199,653 people, ranking 34th nationwide. Administratively, Soc Trang is divided into 11 district-level administrative units, including 1 city, 02 towns and 08 districts (fig 1).

Soc Trang province planning is one of the main tasks of the government in this period, work must also follow general regulations like other provinces in Vietnam [10]. Database construction must also follow general principles in which data standardization is mandatory to synchronize data nation wide. The data standardization process complies with the regulations of the Ministry of Natural Resources and Environment on National Technical Regulations [4,9]. During the conversion process, strict compliance with regulations must be observed to avoid technical errors that affect the required results.

To build this database, the planning agency had to carry out many steps, in which database standardization plays a very important role, especially connecting with the national geographic database according to regulations.

Six points in Soc Trang province were selected using GPS technology. Coordinates collected points from

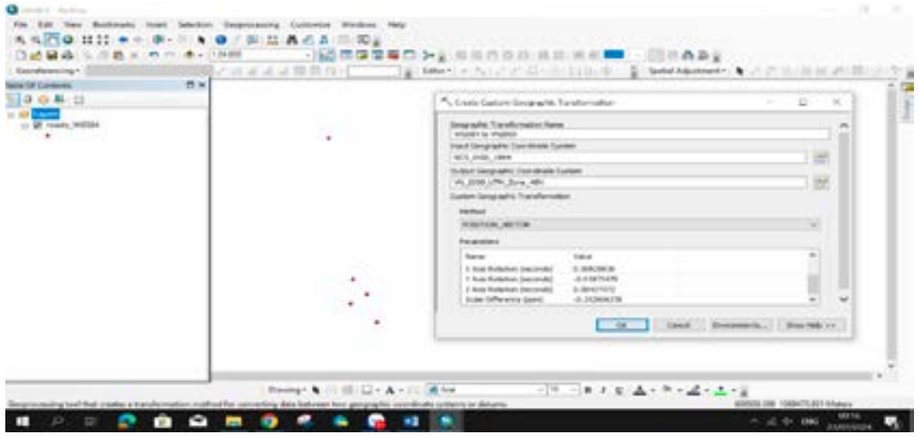

Figure 5. Building a coordinate system standardization tool

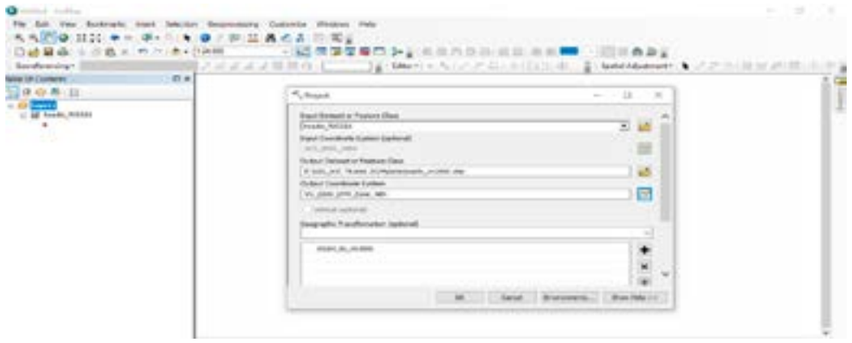

Figure 6. Converting WGS 84 coordinate system to VN2000 coordinate system

GPS technology inputed to Excel software (Figure 3).

Declaration of coordinate system of points taken from GPS technology is mandatory, in this study the coordinate system of points is WGS 84 (Figure 4).

To build coordinate transfer tool from the WGS 84 coordinate system to the VN2000 coordinate system in Arc GIS is an important technique in the process of standardizing the mathematical basis of GIS data [6]. It is necessary to rely on the information according to Decision 05/2007/QD-BTNMT dated February 27, 2007 of the Minister of Natural Resources and Environment on the use of the conversion parameter system between the International Coordinate System WGS-84 and the National Coordinate System VN-2000 the parameters:

X Axis Traslation = 191.90441429

Y Axis Traslation = 39.30318279

Z Axis Traslation = 111.45032835

X Axis Rotation = 0.00928836

Y Axis Rotation = -0.01975479

Z Axis Rotation = 0.00427372

Scale Diffrence = -0.252906278

The work of building the coordinate system conversion tool (create custom Geographic Transformation) from WGS 84 to VN2000 and seven parameters also input in this step are shown in Figure 5.

The process of building the conversion tool focuses on entering 7 conversion parameters not only the sign but also the value of the parameter. Entering these parameters must be done carefully and accurately to achieve the correct position of the objects on the earth's surface in the VN 2000 system. For planning projects in Vietnam territory, the output coordinate system is VN_2000_UTM_Zone_48N.

After completing the construction of the coordinate system conversion tool, proceed to convert the data according to the process (Figure 6).

3. Results and discussion

After performing the steps and entering the parameters as prescribed, the results are obtained (Figure 7). The red points are the points with coordinates belonging to the WGS 84 coordinate system and the blue star symbols are the points that have been converted to the VN2000 coordinate system.

These blue points have become spatial databases in the VN 2000-UTM-Zone 48N coordinate system, have been converted to shape file format, the data type is shape file feature class and the geometry type is point type. After being standardized and converted to the coordinate system, these spatial database points have been connected to the Provincial database [7]. This is a fast, cost-saving conversion method, providing effective support for urban data managers.

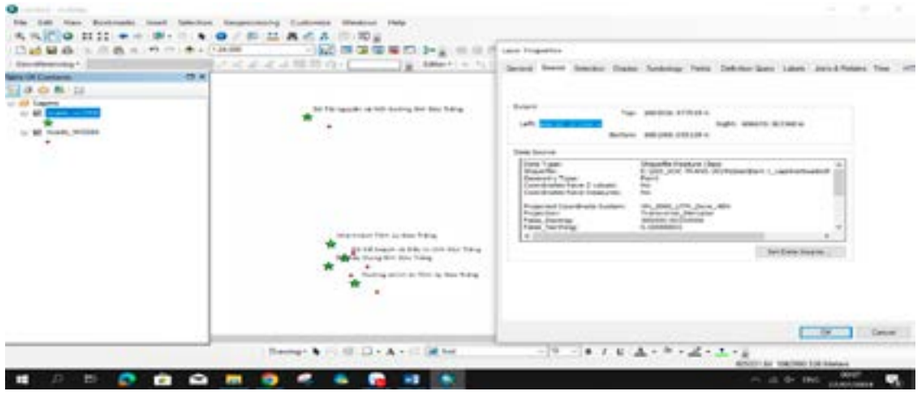

Figure 7. GPS coordinates have been converted to VN2000 coordinate system

Updating points and objects on the current situation is very necessary, it provides complete information for planners to establish or propose accurate planning options.

Objects on the earth's surface are always changing, if we do not update and put them into the same coordinate system, the current status database will always be incomplete and not the latest.

This data synchronization not only supports the planning and management work of a province but also creates connectivity for other data sets in the province and all provinces in Viet Nam.

4. Conclusion

Building an urban database is a necessary task for managers, in which the use of coordinate systems is necessary and mandatory. The VN2000 coordinate system is the common standard that the Government requires to apply to establish a mathematical basis for data [7,8].

The VN-2000 coordinate system provides a uniform and accurate coordinate system to locate locations on the surface of Vietnam. This is important in determining the location of objects in the database, especially in the process of collecting and updating data

The process and method of converting coordinate systems have also been mentioned in a number of studies. This article builds a standard process and application for urban data to support provinces in the process of updating the database quickly, accurately and economically./.

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