Modeling Spatial Database and Application of Water Resources Dispute Monitoring in Transboundary River.

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Abstract

In recent years, the lack of freshwater resources and the national economic development's demand for energy has made many countries pay attention to the development and utilization of water resources in cross-border rivers. The transboundary, sharing and mobility of cross-border rivers inevitably lead to national interests. Therefore, this study aims (1) to construct a spatial database model of water resources disputes in river basins; the data is based on water resources disputes in Mekong River basin. (2) This research applies the designed model to monitor the conflicts on water resources on the Don Sahong Dam. The data were collected through the Text Retrieval (TR) system and web crawler technology. The obtained data were analyzed by text analysis and the data were illustrated in a form of vector maps, where disputes were from, by using Arc GIS software. Once the spatial database model for water disputes is constructed, the designed mode was applied to monitor the Don Sahong Dam disputes.The findings reveal the distribution of water organizations around the world and the spatial statistics such as the types of organizations, the frequency of government organizations, the frequency of international organizations, and the frequency of NGOs participating in the Don Sahong Dam dispute. The implications and recommendations are also included.

Keywords: International River, Spatial Database Model, Water Resources Dispute

Introduction

Due to the increasing scarcity of freshwater, the demand for water resources by river basin countries has increased, leading to problems such as the development and utilization of water resources in cross-border river basins and water distribution. Incidents of water disputes are increasing day by day. China is located in the upper reaches or even the source of almost all rivers. Among the dozens of most important cross-border rivers in China, twelve of which originate in China, and most of them are well-known rivers. Water disputes are also an issue. The uneven distribution of water in the Northwest, the disputes caused by water pollution, floods, and other disasters in the Northeast, the development plan for the mainstream of the Lancang River in the southwest region, the plan for the Yalong and Nujiang rivers, and the development plan for the main and tributary streams of the Mekong River are all of great concern to the international community. As a country in the upper reaches of cross-border rivers, China also plays a role as an investor in some hydropower development in other basin countries. It is, thus, necessary to pay more attention to and monitor the water

resources disputes caused by cross-border rivers in our surroundings. When it comes to cross-border river water disputes, researchers in China have classified the types of cross-border river water disputes from different aspects, and have carried out a comprehensive classification according to the nature of water disputes. It also provides a monitoring method for water resources disputes in cross-border river basins. The different development goals of each country in the basin, as well as geopolitics and international relations, are important causes of current water disputes.

Analysis

1. Literature review

1.1 Studies on conflicts in water resources utilization of transboundary rivers.

The causes of water resource use in cross-border rivers are the main influencing factors of the disputes. The causes of water disputes in cross-border rivers can be divided into "water conflict", "border disputes" and "water management disputes". In 1975, Nazli Choucri and Robert North proposed in their published book that the shortage of resources will be the inducement for the water war between countries; in terms of this theoretical analysis, many foreign scholars have made work and contributions (Uitto & Duda, 2002; Giordano & Wolf, 2002; Yoffe & Ward 1999; Conca, 2006; Matthews & Germain, 2007; Starr, 2002). At the beginning of the 21st century, the World Water Assessment Program (WWAP) proposed that human beings are currently experiencing a serious water crisis (Klare, 2001). Therefore, it is possible to judge the global ease of use by analyzing the current distribution and use of water resources in the disputed area. Postel (1996) believed that there were three main reasons for conflicts: consumption and degradation of resources, the shrinking pie, and population growth. The last one has led to the fact that each person can only get a smaller slice of this pie, meaning unequal distribution and possession of water resources. Xu Ting (2008) attributed the cause of water disputes to the lack of global freshwater resources, which led to the increasing demand for water resources in various countries, and the increasing water pollution, and unfair international distribution of water and energy in rivers. Li Ben (2010) proceeded from aspects of natural, social, and political factors, and believed that the total amount of water resources in the river basin was relatively insufficient. The development goals of various countries in the river basin were different, and geopolitics and international relations were an important cause of water disputes.

Chinese scholars have discussed the types of water disputes from different aspects. In terms of river types, Li Hao (2010) believed that inter-regional competition, spatial characteristics, the externalities, and the attributes of water resources are the main factors leading to cross-border water resources disputes. Resource pollution, water resources allocation, water conservancy facility construction, and river sand mining disputes are summarized as the main manifestations of cross-border water resources disputes. Wang Xiaofeng and Chen Dongjing (1999) combed the problems faced by the development and utilization of upstream and downstream international rivers and pointed out that the current focus of water resources development in cross-border river

basins is how to realize the rational distribution of water resources, navigational rights, water area delimitation, and water environment. Yu Hongcheng and Li Xikun (2003) stated that water rights and water benefit distribution disputes are the main types of current international river disputes. Hu Qinghe (2007) comprehensively classified water disputes based on the nature of water disputes and also provided monitoring content for monitoring water disputes in transboundary river basins.

1.2 Related studies on spatial database of water resources disputes in transboundary river basins.

Effective cross-border river management has inevitably relied on a large amount of basic data and information. Therefore, all countries treat relevant hydrological, environmental, and socio-economic information as important strategic data. In terms of cross-border river data management, the current basic data management of cross-border rivers abroad is relatively mature, and great attention is paid to the construction of cross-border river systems and cross-border impact monitoring. The basic development trend is, firstly, to use advanced information technology for developing data management and information system construction, including digital work (Pavlović et al., 2006). The second trend is the use of integrated technology to build a simulation system. The interactive forecasting system of the United States is currently one of the most advanced forecasting systems in the world; because of its technical advantages in database structure and data flow, the interactive function of the river forecasting system can be better used in real-time flood forecasting (Jinping & Lixian, 2002).

In China, data management is mostly concentrated on major rivers:

1) The monitoring and data management of major rivers are in the field of water resources, including reservoir power generation, data collection and analysis, flood control decision-making system, basic data management of water functions, and so on. The geographic information system (GIS) is the most widely used among many information technology and modern technology, and other technologies include some technology fusion schemes (Bo, 2009; Pengfei, 2007).

2) Cross-border river data management mainly focuses on database structure and function, data information exchange, and other technical and management aspects (Chunxi et al., 2011).

3) The studies on cross-border river data-sharing management only involve a small part of the data sharing under the framework of river basin organization and cooperation mechanism (Zhou et al., 2013). In addition, the organization of data on different platforms has not been unified.

The current studies in China on the spatial database of transboundary river basins are mainly focused on a specific basin. Zhang Chengfeng (2013) designed and implemented the spatial database system of the Songliao Basin. Xia Yong (2004) proposed to construct the water resources spatial data of the Lancang river basin, adopting the geographical factor database of the Lancang River Basin designed by Liu Zhifang (2007). Liu Gang (2007) proposed the construction of the Lancang river's spatial analysis platform to provide data guarantee for the comprehensive analysis and evaluation of the Lancang river basin.

Therefore, this paper collates and elaborates related studies on disputes among people towards water resources in cross-border rivers. Secondly, this article models a spatial database that can be applied to monitor the mentioned disputes. The researcher takes an organization and their water resources management, selecting merely the data on disputes to study its problems, builds an object-oriented spatial database model, and apply the model for monitoring the disputes occurred on the Don Sahong Dam.

2. Research findings

The construction of spatial database model for monitoring the water resources disputes in the Mekong River basin

The spatial elements of water resources dispute in the Mekong River Basin notice the organization and management of the elements through a hierarchical induction. For example, the basic geographic elements include five levels: administrative area, residential area, water system, transportation, and topography and landform. Each level includes several layers. According to the different geometric types of the data expressed, the layers are divided into points, lines, and areas. The other elements are also divided according to this hierarchical structure.

Based on the description of the hierarchical results of the spatial elements of water resources disputes, the article focuses on the spatial element layers. Because there are too many attribute structures of water resources disputes in the Mekong River Basin, this section selects three attribute structures that can represent the spatial elements of point, line, and area entities as examples: Mekong River Basin dams, Mekong River water system, and Mekong River Basin administrative regions. The administrative region of the Mekong River Basin belongs to the area data. Therefore, if the data is made into a Shap efile format (.shp) and stored in the geodatabase, three fields of Shape, Shape_Length, and Shape_Area will be automatically generated. The geometry type represented by the Shape in the area data is Polygon, which indicates the length or perimeter of the surface. The Shape_Area represents the area of the face. In the same way, in linear data, only Shape and Shape_Length represents the geometric type of linear data and the length of the line, and point data only has Shape to describe the geometric type of points, but if the point data needs to be made into a layer, it will be displayed in the software.

Operational analysis of the spatial database model in the case of the Don Sahong Dam disputes The data processing of the Don Sahong Dam dispute case data mainly includes two aspects. One is the transformation of GIS spatial data, that is, the process of GIS data visualization and the other is the standardized representation of attribute data, that is, the processing of attribute data. In the Geodatabase spatial model, the layers formed by these data can then be called and operated in Arc Map. For the formed spatial layer, we can obtain the information through spatial visualization, spatial correlation, spatial stacking, and spatial statistics. For example, through spatial visualization, we can intuitively see the distribution of water organizations around the world, to understand which watershed group and non-watershed group are concerned about the Don Sahong Dam

dispute. The water organizations in the area are widely distributed, including not only local organizations in the Mekong River Basin, but also organizations located in the United States, Switzerland, Malaysia, and other places. From the spatial statistics of the types of organizations participating in the Don Sahong Dam dispute, non-governmental organizations have the highest participation, accounting for nearly half, followed by international organizations, and government organizations. It is found that the Lao government and the Cambodian government have the highest frequency, followed by the Vietnamese government and the Thai government. Among the government agencies, the Cambodian National Mekong Committee (CNMC) is more active.

Judging from the spatial statistics of the frequency of occurrences in the news reports of international organizations, the Mekong River Commission (MRC) has the highest proportion of participation and attention of international organizations in the DonSahong dam dispute. Judging from the spatial statistics of the frequency of NGOs' appearance in news reports, several organizations that are more active in the Don Sahong Dam dispute are the International River (IR) organization headquartered in the United States and the International River (IR) organization headquartered in the United States. Switzerland's Worldwide Fund (WWF), Cambodia's local organization the NGO Forum on Cambodia, and Vietnam's environmental protection organization the Hanoi-based Green Innovation and Development Center (Green ID).

3. Discussion

Through the spatial statistical analysis of the participation and attention of water organizations in the Don Sahong Dam dispute by using the spatial database model of water resources disputes in the Mekong River Basin, the characteristics of the participation of each party in the dispute are summarized. From the perspective of the participating characteristics on the Don Sahong Dam Dispute, this article puts forward the following suggestions for China to avoid disputes in the future:

3.1 The Don Sahong Dam dispute has shown us the growing strength of non-governmental organizations in the Mekong River Basin, especially environmental protection organizations. They pay close attention to the ecological environment of the Mekong River Basin and the demands of local people. They understand public opinions through research activities and public opinion. Different forms of protest have created a lot of pressure for the development of water resources utilization activities of the river basin governments. Therefore, it is necessary for China to fully develop and cultivate domestic non-governmental organizations through non-governmental communication.

3.2 The current disputes in the Mekong River Basin are mainly since all parties cannot reach a consensus on body of knowledge of the impact of water resources utilization on the Mekong River. However, since international organizations are inter-governmental alliances, their conclusions are likely to be more objective, fair, and convincing. Therefore, China should strengthen ties with international organizations, especially in scientific research, so that China's scientific conclusions can be more authoritative and easier to be recognized by other countries and non-governmental organizations.

3.3 Although non-governmental organizations and intergovernmental international organizations have an important influence on water resources development disputes, the political will and decision-making of countries, especially those in the basin, are still the key to the success of development activities. Therefore, China should strengthen development cooperation with countries in the Lower Mekong River basin and reach a consensus with other countries from the policy level to avoid or minimize disputes.

Through the analysis and result discussion above, the spatial database model for water resources disputes does not only organize and manage the water dispute data in a unified manner but also provide an entry point for the coordination of the relationship between the parties in the dispute through the spatial analysis of the water dispute data. That is to say, the spatial database model of water resources dispute can be comprehended in terms of the reasonable organization and management of related dispute data, and improve the efficiency of dispute data retrieval and query. It helps display relevant information through spatial visualization, providing a new kind of dispute data acquisition. Also, the spatial database model of water resources disputes does not only provide support for the spatial knowledge mining to obtain more valuable information but also serve China's decision-making and policies in terms of water disputes.

Conclusions

This paper focuses on the construction of the spatial database model of water resources disputes in cross-border rivers. Through the construction of data sources, data processing, and data model, the spatial data and attribute data of water disputes in cross-border rivers are in the object-oriented spatial database based on Arc SDE software. The main work and content of this present study include the following aspects: summarize the types and characteristics of water dispute data, design the process framework of spatial database model, and process the collected data. The Don Sahong Dam dispute was used as an application to test and verify the spatial database model. The feasibility and scientific findings of the model are discussed. The research innovations of the article mainly include the following two points:

The study is based on previous studies on water resources disputes and spatial database modeling. The theoretical research on spatial database modeling of river water resources disputes has a certain innovative significance. This article innovatively applies the object-oriented spatial data model to the spatial database modeling of cross-border river water dispute monitoring, and comprehends the unified organization and management of the spatial data and attribute data of water disputes.

However, the current research still has some shortcomings. First, there is insufficient data on water disputes. The basis for the construction of the spatial database model of water resources disputes in cross-border rivers is the collection of water dispute data. However, due to the limitations of time, resource conditions, and data access rights, the current water dispute data available are limited. Access is more severely restricted by rights and language. Secondly, limited by time, energy, and existing research resources, the article lacks a deeper discussion on the research and design of the metadata of the spatial database of water disputes.

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