

A Multi-Dimensional Cadastral Topological Data Model: Design and Implementation

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Key words: Cadastre; Land management; Topological data model; multi-dimensional; generalized map

SUMMARY

With the three-dimensional (3D) use of the land, the 3D cadastral management is extensively researched to fill the gaps of 2D cadastral management. To solve the problem of the dynamic cadastral management, the spatiotemporal cadastral data model is widely studied. 3D cadastral management should also consider 2D cadastral spatial data, so the spatiotemporal cadastral data consist of both 2D and 3D cadastral spatiotemporal data can be seen as 3D and 4D cadastral data. Considering the coexistence of 2D, 3D and 4D cadastral data, cadastral data should be multi-dimensional and the cadastral data model should apply to all dimensions.

Topology is important for representing and querying cadastral objects. The international standard ISO 19152 Land Administration Domain Model (LADM) designs a topological spatial unit to represent the spatial units. Many studies on the cadastral data management fully consider topological spatial relations between cadastral objects. Spatiotemporal topology is built for querying the history of cadastral objects, which are considered different from the topological spatial relations in most studies. Most existing spatio-temporal cadastral data models are based on the common spatiotemporal data models such as a space-time composite model, object-oriented spatiotemporal model, base state with amendments (BSA) model etc. These data models can support the spatiotemporal topologies of specific cadastral objects which are the 2D spatial unit and 3D spatial unit, but the topology of other cadastral objects such as the boundary point, boundary line and boundary face cannot be supported. This is because the topologies in these models are built separately for each dimensional cadastral object, in another word, the topologies are dimension-dependent.

To build topologies for each dimensional cadastral object, we consider a theory which can express topologies independent of dimension. We propose a multi-dimensional cadastral topological data

model (MDCTDM). It represents the topological relations of all cadastral objects simply and efficiently, because it uses a single basic element to associate cadastral objects of each dimension in the same way. Based on the generalized map, we extend the cell-tuple structure and propose an object-tuple structure for the MDCTDM. And then we design the data structure for the MDCTDM and implement it in the relational database. In this database, the topological relations of cadastral objects can be easily queried by using simple SQL statements. To verify the operations of the MDCTDM in the database, we give a case of insert operation. The case demonstrates that operation can be implemented easily by SQL statements.

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FIG Working Week 2019
Geospatial information for a smarter life and environmental resilience
Hanoi, Vietnam, April 22–26, 2019