

## Chapter 4

# A Systematic Approach for Managing the Risk Related to Semantic Interoperability between Geospatial Datacubes

**Tarek Sboui**

*Université Laval and NSERC, Canada*

**Mehrdad Salehi**

*Université Laval and NSERC, Canada*

**Yvan Bédard**

*Université Laval and NSERC, Canada*

### ABSTRACT

*Geospatial datacubes are the database backend of novel types of spatiotemporal decision-support systems employed in large organizations. These datacubes extend the datacube concept underlying the field of Business Intelligence (BI) into the realm of geospatial decision-support and geographic knowledge discovery. The interoperability between geospatial datacubes facilitates the reuse of their content. Such interoperability, however, faces risks of data misinterpretation related to the heterogeneity of geospatial datacubes. Although the interoperability of transactional databases has been the subject of several research works, no research dealing with the interoperability of geospatial datacubes exists. In this paper, the authors support the semantic interoperability between geospatial datacubes and propose a categorization of semantic heterogeneity problems that may occur in geospatial datacubes. Additionally, the authors propose an approach to deal with the related risks of data misinterpretation, which consists of evaluating the fitness-for-use of datacubes models, and a general framework that facilitates making appropriate decisions about such risks. The framework is based on a hierarchical top-down structure going from the most general level to the most detailed level, showing the usefulness of the proposed approach in environmental applications.*

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## **INTRODUCTION**

In order to derive the maximum profit from the power of the geospatial data and the efficiency of the datacube structure in the decision making process, geospatial datacubes have been introduced. Geospatial datacubes integrate spatial data with the datacube structure and are recognized as one of the most promising decision-support systems (Rafanelli, 2003). In some situations, we need the interoperation between geospatial datacubes. The situations where such needs arise are: (1) a simultaneous and rapid navigation through different geospatial datacubes, (2) a rapid insertion of data in a datacube from another one, and (3) an interactive and rapid analysis of phenomena changes by comparing the content of different geospatial datacubes (Sboui et al., 2007).

With the emergence of software agents, semantic interoperability has been viewed as the technical analogue to human communication (Brodeur, 2004; Kuhn, 2005; Sboui et al., 2007). According to this view, each agent tries to interpret the exchanged data as it has been originally intended by another one. However, due to the uncoordinated use of data (i.e., semantic heterogeneity), agents may faulty interpret data or be uncertain about its intended meaning. That is, there is a risk of misinterpreting the exchanged data.

The risks of data misinterpretation are even more pronounced when interoperating geospatial datacubes developed for strategic decision purposes. In fact, strategic decisions made on the basis of inappropriate interpretations of data may lead decision analysts to have inappropriate judgment and to make unwarranted inferences about some aspects of the problem to be solved, and thus to make faulty decisions.

This article aims to support the semantic interoperability between geospatial datacubes. It proposes a risk management approach that allows identifying and assess the related risks of data misinterpretation in a systematic manner based on the quality of datacubes models (i.e.,

metadata and schema). In the next section, we discuss the risks of data misinterpretation in the interoperability involving geospatial datacubes. Then, we propose a categorization of the semantic heterogeneity that may occur during such interoperability. Then, we propose an approach to identify and evaluate such risks. After that, we propose a method that aims at supporting an intervener (human or software agent) to respond to these risks. Then, we provide an example of application, and we show the usefulness of the proposed approach in environmental applications. Finally, we conclude this paper.

## **RISK OF DATA MISINTERPRETATION RELATED TO SEMANTIC INTEROPERABILITY BETWEEN GEOSPATIAL DATACUBES**

This section discusses the risks of data misinterpretation related to semantic interoperability in general and the one involving geospatial datacubes in particular.

### **Interoperability between Geospatial Datacubes**

A datacube is composed of a set of measures aggregated according to a set of dimensions with different levels of granularity. Both dimensions and measures of a geospatial datacube may contain geospatial components (Bédard et al., 2001). Interoperating geospatial datacubes may involve one or the combination of the following actions on their components: 1) integrating measures which may refer to adding a new measure to a datacube from another one based on common dimensions and members, or creating a new common measure based on existing measures of different datacubes, 2) integrating dimensions which may refer to creating a new dimension based on the dimensions of different datacubes, adding one or several dimensions of one datacube to another, or

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