

## Chapter 11

# Spatial Pattern Mining for Soil Erosion Characterization

**Nazha Selmaoui-Folcher**

*University of New Caledonia, New Caledonia*

**Frédéric Flouvat**

*University of New Caledonia, New Caledonia*

**Dominique Gay**

*Orange Labs, France*

**Isabelle Rouet**

*University of New Caledonia, New Caledonia*

### ABSTRACT

*The protection and the maintenance of the exceptional environment of New Caledonia are major goals for this territory. Among environmental problems, erosion has a strong impact on terrestrial and coastal ecosystems. However, due to the volume of data and its complexity, assessment of hazard at a regional scale is time-consuming, costly and rarely updated. Therefore, understanding and predicting environmental phenomena need advanced techniques of analysis and modelization. In order to improve the understanding of the erosion phenomenon, this paper proposes a spatial approach based on co-location mining and GIS. Considering a set of Boolean spatial features, the goal of co-location mining is to find subsets of features often located together. This system provides useful and interpretable knowledge based on a new interestingness measure for co-locations and a new visualization of the discovered knowledge. The interestingness measure better reflects the importance of a co-location for the experts, and is completely integrated in the mining process. The visualization approach is a simple, concise and intuitive representation of the co-locations that takes into consideration the spatial nature of the underlying objects and the experts practice.*

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## INTRODUCTION

New Caledonia is an archipelago located in an exceptional environment. For example, a big part of the Caledonian barrier reef is referenced in the world heritage list by the UNESCO. The protection and the maintenance of this environment are a major goal in New Caledonia. Because of important mining projects on this territory, a global approach for environmental monitoring is necessary. Several national and local scientific plans finance different works about the climate change and the human effects on the environment to save.

In New Caledonia, erosion has a strong impact on terrestrial and coastal ecosystems (mountains, alluvial plains, mangroves, coral reefs). Bush fire, deforestation and/or human activities accelerate erosion in mountainous areas especially on lateritic soils. Frequent and intense precipitation events (tropical depressions, cyclones) regularly strip particles from these sensitive soils. Any eroded sediment is quickly transported to coastal plains and to the sea along the main drainage lines, with immediate and recurrent impact on human activities such as open-cast mining, farming and fishing. There is therefore a need to identify key components of erosion processes for sustainable environmental management and planning. Particularly, hazard assessment is required to plan new developments with limited erosion impacts. However, both mapping of active erosion and assessment of hazard at a regional scale is time-consuming, costly and rarely updated. The volume of data can be considerable and they are generally heterogeneous (images, physical measures, qualitative observations). Understanding and predicting environmental phenomena require advanced techniques of analysis and modelization.

The interest of data mining methods for the soil erosion problem has been highlighted in (Gay, Rouet, Mangeas, Dumas, & Selmaoui, 2007; Rouet et al., 2009). GIS raster data was used to describe and predict erosion hazard at regional scale. Nevertheless, the spatial relationship between GIS

vector layers was not considered while it could more accurately help to describe areas with erosion phenomena.

We propose in this paper a spatial approach based on spatial pattern mining and GIS to improve the knowledge of the spoiling level of a geographical area. One of the classical task in spatial pattern mining is the extraction of interesting co-locations in geo-referenced data (Koperski & Han, 1995; Shekhar & Huang, 2001; Appice, Ceci, Lanza, Lisi, & Malerba, 2003; Huang, Shekhar, & Xiong, 2004; Lisi & Malerba, 2004; Bogorny et al., 2006; Yoo & Shekhar, 2006; Ceci, Appice, & Malerba, 2007; Celik, Kang, & Shekhar, 2007; Malerba, 2008).

Considering a set of Boolean spatial features, the goal is to find subsets of features often located together. In other words, we aim to characterize relations between interesting features. However, the interpretation of the extracted patterns by domain experts is difficult. One of the major challenges in spatial data mining is to discover and deliver actionable knowledge to domain experts (Cao, 2008). Although many algorithms and techniques for spatial data mining have been proposed, it still remains an open problem to successfully provide useful and interpretable knowledge to experts. Indeed, existing interestingness measures for co-locations can lead to interpretation problems, and co-locations are presented in a textual form.

Our system provides useful and interpretable knowledge to domain experts based on a new interestingness measure for co-locations and a new visualization of the discovered knowledge. Our interestingness measure better reflects the importance of a co-location for the experts, and is totally integrated in the mining process. Note that interestingness measures can be used to quantify some specific relations and to develop environmental indicators. Our visualization approach is a simple, concise and intuitive representation of the co-locations that takes into consideration the spatial nature of the underlying objects and the experts practice. These propositions have been

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