AN APPROACH TO IMPROVE DATA MODELS IN COASTAL DATABASES

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Since the 1980's, coastal data have been acquired, and, more recently, stored in GIS databases and widely disseminated. These databases describe coastal geomorphology and geology, exposure to hydrodynamic factors, human activities, and the shoreline mobility (erosion or accretion). Recently, these databases have been used for investigating vulnerability of coast to coastal hazards (erosion, marine submersion) and to climate change and to sea level rise. These new uses have shown some lacks in data models and lead to revisiting the way coastal processes and geomorphological objects are described. Through an example in Martinique (French Antilles), this abstract shows that systemic analysis of the coastal zone is useful. A method in the field of geoinformatics, namely the event bush method, shows promising capabilities to help defining important information that should be acquired and integrated within future coastal databases. Here an event-bush-inspired model is presented that is expected to evolve into a full-range event bush and thus rebuild the whole domain of knowledge about the coastal processes.

1 Introduction and motivation

Shoreline evolution in the coastal zone has received much attention due to the increasing presence of numerous assets both human and economic in these areas and because of uncertainties about the actual consequences of future sea level rise. Many factors are involved in causing shoreline changes in the coastal zone: waves, currents, winds, sea level change affecting the mobility of the sediments and causing morphological changes in the coastal zone. Because of the complex interactions between all factors involved in shoreline mobility at various time and space scales, finding out the relative importance of each process in causing sediment and shoreline mobility is still a challenge.

Recently, Gutierrez et al. (2011) proposed investigating this issue through the exploration of large coastal databases. They modeled the relations between shoreline mobility and various factors causing it by a Bayesian Network. In their study, the sea level was found the most important cause for shoreline evolution at the eastern coast of the USA. A similar study was undertaken in Europe (Yates and Le Cozannet, 2012), using the Eurosion dataset (Eurosion, 2004). The most important parameter to explain shoreline mobility there was coastal geomorphology. These quite different results pose the following question: how important is the

type of data and the data models of these two databases (with respect to the regional and local context) in explaining the difference in the results?

In fact, these coastal databases were not developed for this purpose. In Europe, the Eurosion (2004) dataset was collected by European member state institutions in charge of shoreline surveys aiming to provide authorities with homogeneous statistics and GIS data in Europe on the coastal zone. The data model of the GIS dataset was the same as in the previous 'Corine Coastal Erosion' dataset, which was released in 1990. Incidentally, this database became the only European scale complete dataset available for applying the data exploration method developed by Gutierrez et al. (2011) in Europe. One has to realize herewith that the investigations scientists can do are highly dependent on the data model used in the dataset.

Behncke and Pshenichny (2009) suggested that the event bush could serve as an intermediary method between expert elicitation and event description based on Bayesian belief networks. Event bushes are a formalism developed to describe events in the field of geosciences (Pshenichny and Kanzheleva, 2011). Though no event bushes have been created so far in the domain of coastal geomorphology and sedimentology, we attempt to present a sketch, or an event-bush-inspired plot here, that describes an extreme event affecting coastal behavior. This of course should not be regarded as event bush sensu stricto; rather, this is a conceptualization without strict rules but performed in a way that resembles the event bush by general architecture. Using this preliminary result, we query if the event bush-based way of thinking can be promising in improving the data model of coastal databases.

2 Preliminary results

An event-bush-inspired conceptualization of coastal sedimentary processes is presented in Fig. 1. It describes how the beach of Le Précheur in the Martinique island (French Antilles) was affected by the Dean cyclone on 17/08/2007, according to the observations of Barras et al. (2007) during their field survey undertaken from 02/09/2007 to 07/10/2007. The Dean cyclone was characterized by winds, heavy rains and cyclonic waves that caused erosion of several beaches but also accretion, so that the sediment losses during the storm were compensated by sediment inputs from nearby beaches and from the watershed. In particular, in Le Précheur Beach, Barras et al. (2005) found and evidence of accretion due to river solid discharge (e.g. coarse sediments near to the estuary). In Fig. 1, the primary internal event 'size of grains' is not used because high energy of cyclonic waves can transport any type of sediment whatever their size. However, this parameter would be most important if consideration of how eroded beaches recover after the cyclonic event.

From this example, we remind the obvious fact that river sediments discharge and exposure to waves are important factors for understanding how shoreline is retreating or accreting. The plot in Fig. 1 could actually apply to many beaches located near to coastal estuaries. However, these processes are poorly represented in existing large scale coastal databases. This is the case in other tropical environment, for Example in Guadeloupe (Roques et al., 2010) and in La Réunion (Aubie et al., 2001; Aubie and Oliveros 1999; Garcin et al. 2004; De La Torre, 2004), where river solid discharge cause rapid geomorphological changes because of heavy rainfall events. As another example, in Europe, the Eurosion database provides waves climates for 237 locations around Europe, at 50 to 100km from the coast (Eurosion, 2004). This is insufficient to characterize the exposure to waves and storms at the coast because the nearshore wave parameters (height, period and direction) are being modified during the wave's propagation from deep to shallow water. Moreover, some part of the coast may be protected

from some waves because of the shape of the coast. While we do not believe that including those parameters in coastal databases would be an easy task, we think that using the event bush formalism over a number of coastal sites could be useful to define the major contributors to the coastline evolution and then improve the data models used in these coastal databases.

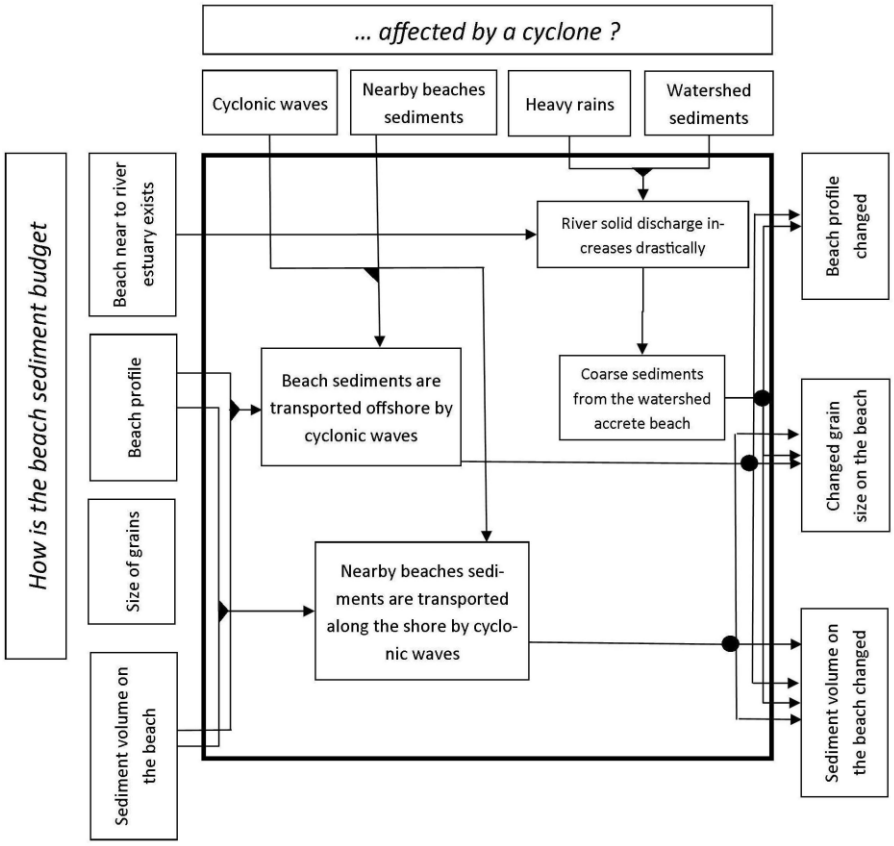

Fig. 1. A conceptualization inspired by the event bush showing sedimentary transfer processes during a cyclonic event, as described for the Précheur Beach (Martinique, French Antilles) after the Dean cyclone by Barras et al. (2007).

3 Conclusion: perspective and limitations

This preliminary investigation shows that the event bush approach can be used to describe events affecting shoreline mobility. Doing this for a number of representative events, one may identify the main processes and parameters which influence and act in the coastal changes. Comparison of this list of needed data and the coastal data model highlights the gaps. Nevertheless, while the event bushes seem to be well adapted to describe rapid events such as the effects of storm, further investigation is necessary to assess if they can help structuring the data models for slower and poorly known coastal processes such as those potentially due to sea level rise. The nearest step of the research is construction of the event bush proper for the considered environment.

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