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Developments in remote sensing, dynamic modelling and GIS applications for integrated coastal zone management

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Abstract. The International Institute for Aerospace Survey and Earth Sciences (ITC) has a research programme that should result in an integrated environmental coastal zone management system through three subprojects. The programme aims to develop methodologies and tools for assessing coastal zone changes, and for the evaluation of scenarios for coastal zone management, based on a spatio-temporal Geographical Information System (GIS) working platform which integrates remote sensing data, physical-morphodynamic and eco-hydrologic modelling, and a decision support system.

The first subproject develops methodologies for the generation of optimum Remote Sensing (RS) data sets, leading to better interpretation and complementary use of conventional and new remote sensing imagery. It also integrates RS, GIS, and modelling through hypothesis generation, parameter estimation, evaluation and validation.

The second subproject facilitates qualitative and quantitative analysis and prediction of the physical aspects of coastal landscape development under the influence of natural processes and human impacts. This subproject is based on the application of remote sensing and dynamic modelling.

The third subproject leads to a spatio-temporal working platform which supports data integration of RS and in-situ measurements, and qualitative and quantitative analysis for the prediction of coastal landscape development. Both support decision making in Integrated Coastal Zone Management.

Keywords: Decision Support System; Image Analysis; Morphodynamic modelling; Remote Sensing.

Abbreviations: RS = Remote Sensing; MBIA = Model Based Image Analysis; GIS = Geographic Information System(s); DSS = Decision Support System;

Introduction

The research programme described in this paper demonstrates the interrelationships between physical and ecological processes, using Remote Sensing (RS), modelling and GIS techniques. It integrates and improves the technologies that are available but have not yet been fully exploited. The expected results include the development of methodologies and tools to assess the hazard and risk vulnerability in the coastal zone in space and time, to define the environmental indicators and indices on which the decision-making process can be based, and to evaluate coastal zone management strategies.

Remote sensing techniques

The growing concentration of population and socio-economic activities in coastal zones increases the pressure on coastal systems, which at the same time are threatened by various natural hazards, including the generally assumed sea-level rise. In order to support the development process and to minimize the loss from possible disasters in these areas, it is necessary to monitor and to assess the ongoing coastal processes and developments and their consequences for the systems through effective and efficient (environmental) management.

Effective and efficient management depends on the availability of sufficient, proper and timely information for thorough analysis. Due to the rapid and large-scale access to multi-platform, multi-spectral, multi-resolution and multi-temporal information, RS is used for data collection in many coastal areas. In this context, there are three main elements for which RS may play a role:

- providing information on marine and coastal properties;
- providing baseline information on the coastal environment;
- detecting, mapping and measuring of e.g. sea state, pollution, sediment transport, and coastline changes.

RS techniques generate different kinds of imagery with specific characteristics and applications. Aerial photographs have a high spatial resolution and thus they are suitable for detection of phenomena in a form similar to the human eye's view. Landsat TM and SPOT satellite sensors detect objects in the (visible) light and infrared bands. They can produce natural- and false-colour images, carrying additional spectral information with high reliability on e.g. the water surface and water quality differences, vegetation types and the differences of biomass and vitality of vegetation. An overall view of the (tidal) sea surface changes is not feasible with aerial photographs. The time for image acquisition is longer than the changes in the environment. Satellite imagery

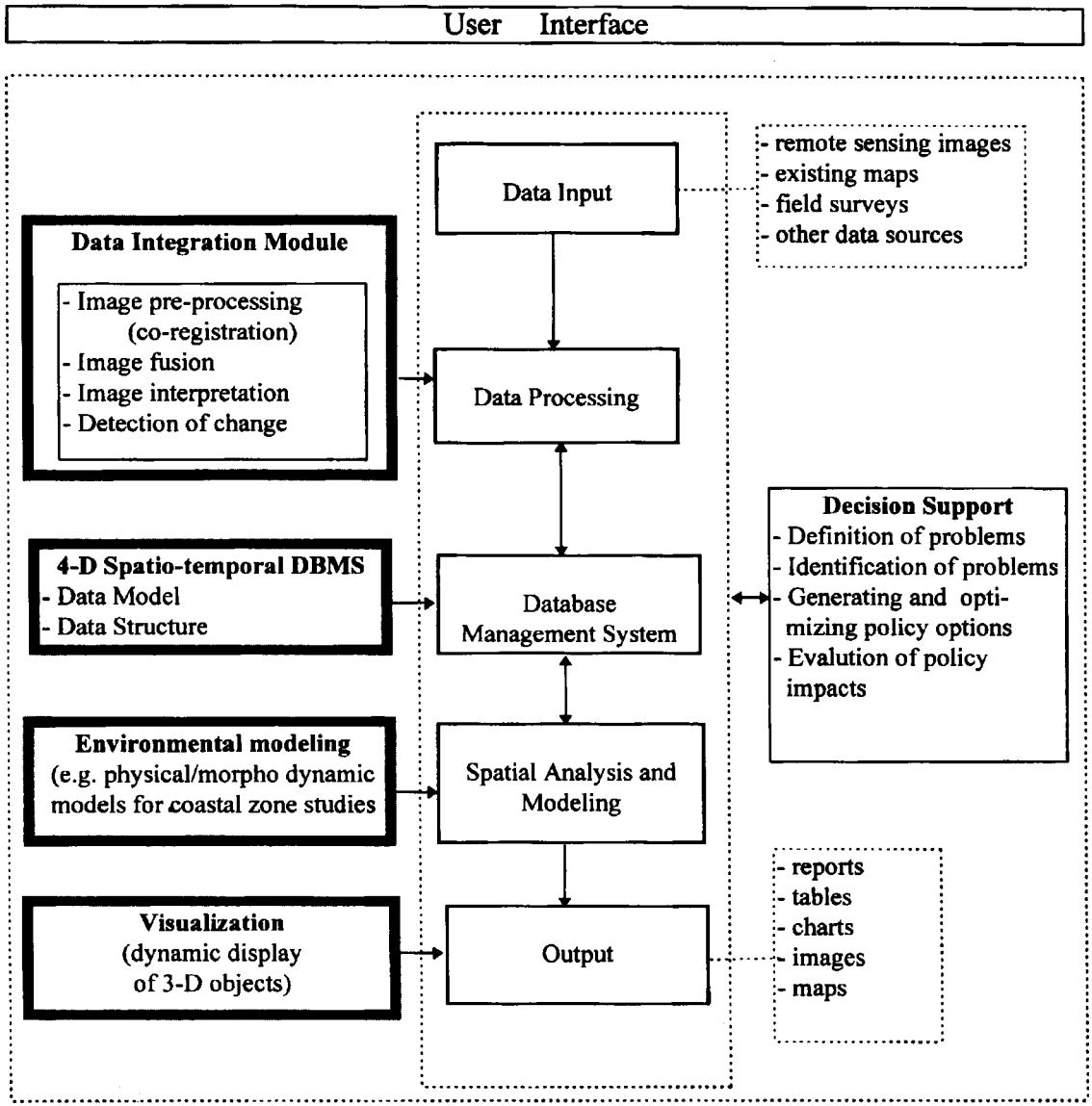

Fig. 10. Structure of the spatio-temporal GIS shell for integrated coastal zone management.