Monitoring of riverine wetland dynamics with MODIS images

Intermediate results of a monitoring system development.

Background and methods

Riverine wetlands in the semiarid/arid areas follow an annual cycle of inundation and desiccation. The ecosystems are adjusted to these changes. Usually, there is a conflict in these areas over the scarce water resources: food production needs irrigation water, which is often provided on the expense of the water available for wetlands. According to the availa-bility of water, three basic land-cover categories can occur in wetlands: water cover, vegetation cover and soil/dry land. These extre-mes have well differentiable spectral responses, represented by different locations in the feature space of a multi-band satellite image. Depending on the micro-relief and the water stage, many mixed pixels might occur on a RS image. Categori-cal classification of the images may hide the fine differences. The changes of the land cover are mostly gradual in time (although flooding can occur relatively fast), which are best represented by change vectors calculated from consecutive images (Figure 1). The length and direction of the change vector indicate magnitude and type of change. Time series of the change vectors follow specific patterns (trajectories) based on the region's flooding pattern and ecosystem (Figure 6).

The monitoring method being developed, quanti-fies this process. After a spatial and spectral co-registration of the images, a morphological and statistical analysis is performed on the calculated change vectors. The objective is to recognize processes in the dynamic system of a riverine wetland, which do not follow the regular pattern. It is assumed that a more sensitive method can be worked out based on the change vectors then what is possible based on the comparison of categorical maps. Comparing the parameters of consequent annual trajectories provides further information on the interannual changes. The project also aims at the selection of a proper representation of the results for environmental experts and managers of wetlands.

MODIS images for the monitoring of the Shadegan Marsh

A semi-automated approach is being developed and tested in the Shadegan Marsh, Iran (Figures 2 and 3) to monitor changes in the dynamic wetlands of semiarid and arid regions, using MODIS images. In the rainy season of wet years, the whole area of the marsh is covered for sufficient time for the development of marsh vegetation, which died out in the dry season. In dry years, the water is sometimes not enough for a full coverage of the marsh area, so most of it remains without vegetation (Figure 4).

Practical problems occurred in using the MODIS images: the geometric and spectral quality of several bands made it difficult to implement the above described ideas, which are sensitive to the proper co-registration of the images. Finally, three bands were selected for the testing: red, NIR and MIR (0.62-0.67mμm, 0.841-0.876mμm, 1.628-1.652mμm). Figure 6 shows representative change trajectories of some characteristic land cover types (see also Figure 5). Trends and random changes can be discovered in the trajectories. The random changes are partly due to the errors in the spatial and spectral co-registration of the images (e.g. Figure 6), but still characteristic differences can be seen between the shapes and locations of the trajectories.

The further steps of the research have two main objectives: to improve the co-registration of the images and to work out the morphological and statistical description of the change trajectories.

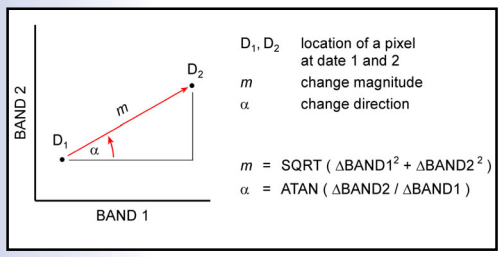

Figure 1: Principle of change vector and its calculation.

Figure 2: Location of the Shadegan Marsh in southwest Iran.

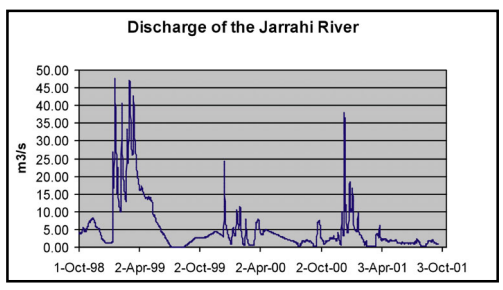

Figure 4: Hydrograph of the river, which is the main water resource of the Shadegan Marsh. The hydrological year of 1998-99 was wet, whilst the following two years were very dry. The year of 2001-02, which period is represented by the MODIS images, was wet again (no data is available).

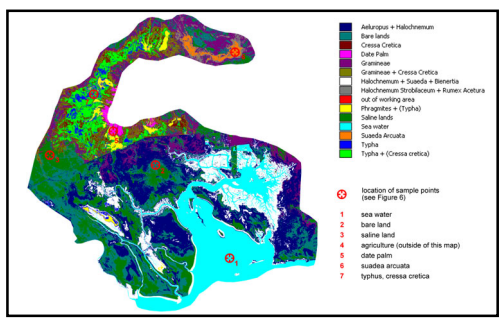

Figure 5: Vegetation of the Shadegan Marsh. Data sources: Landsat ETM images (January, March and May 2000) and detailed fieldwork. (Remote Sensing Centre of the Ministry of Jihad-e-Agriculture, Iran)

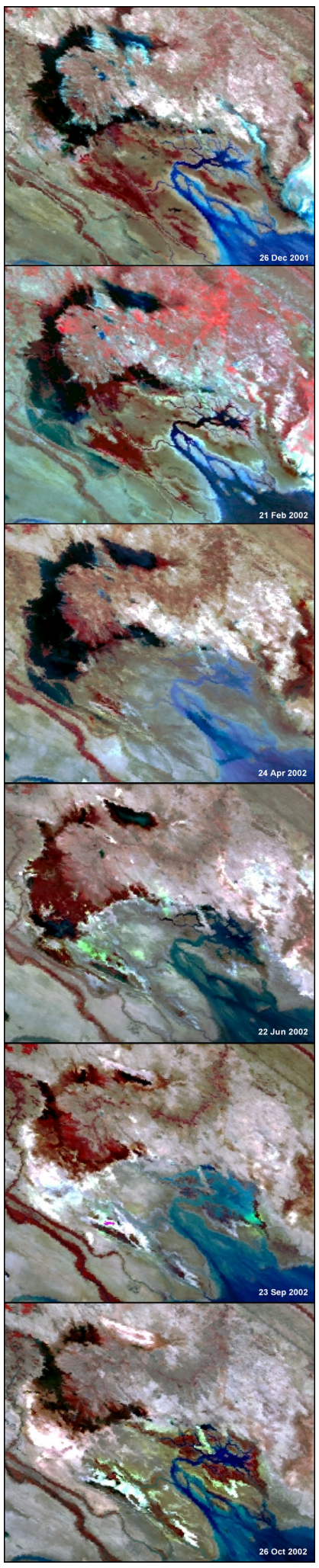

Figure 3: Time series of MODIS images: False colour composite (NIR, red, green in RGB respectively).

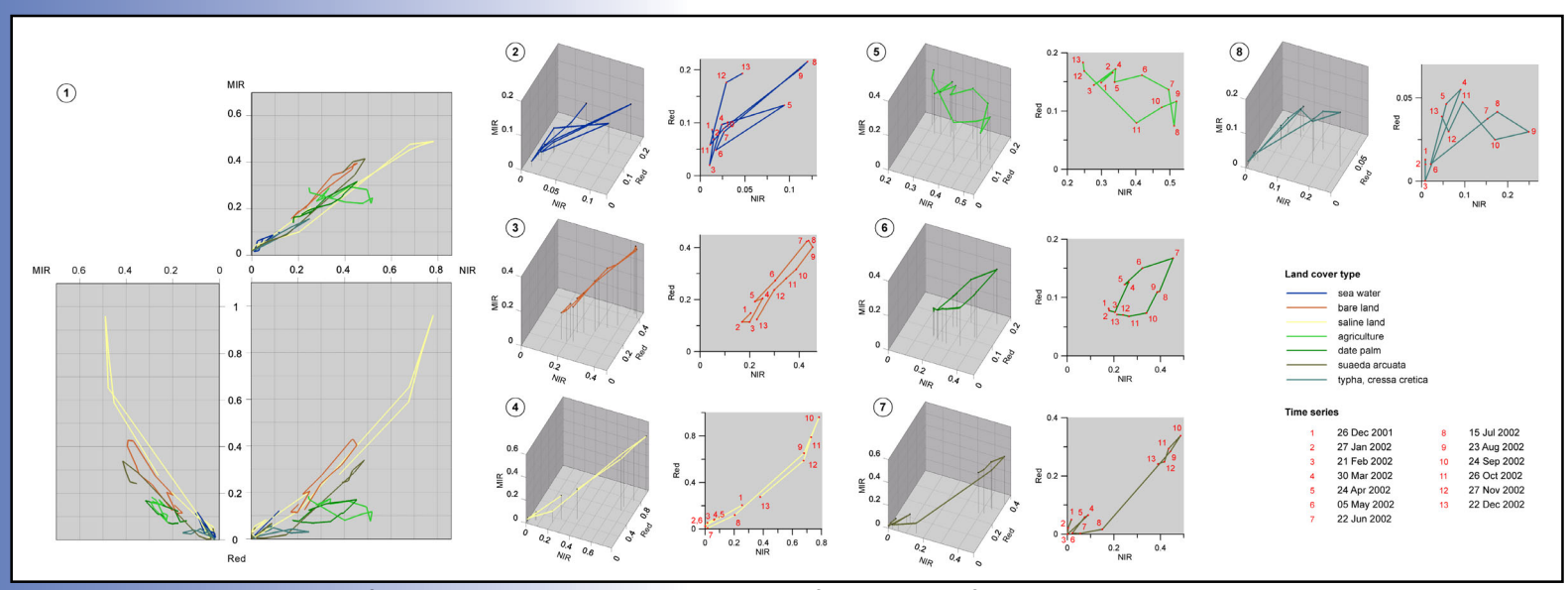

Figure 6: Change trajectories of characteristic land cover types in the feature space of red, NIR, MIR bands.

For more information:

Zoltán Vekerdy
ITC, P.O.Box 6 7500 AA Enschede, the Netherlands
Tel: +31 (0)53 4874363 fax: +31 (0)53 4874336
http://www.itc.nl/personal/vekerdy

Dorit Gross
Technical University of Dresden (TU-Dresden) Institute of Cartography, 01062 Dresden, Germany
Tel: +49 (0)351 46334809 Fax: +49 (0)351 46337028

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