Time-series analysis on an 1km AVHRR data-set for change-detection in the Mediterranean (1989-2004)

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This study focuses on data exploration and knowledge mining using remote sensing data archives with high temporal resolution to study surface conditions in Mediterranean drylands, which are controlled by a complex interaction of climate, soil, vegetation, water resources, stocking rates and human impacts. Major objectives of this study were

- to modify and develop tools and algorithms to reveal changes in the seasonal and long-term characteristics of the almost exclusively vegetation-related signal archived in global environmental satellite data

- The development ensemble classification algorithms to support an automated generation of land cover maps to support the inventory of land cover changes from hypertemporal remote sensed data.

- to describe changes in surface reflectance by archetypical, dynamic, co-evolutionary
  patterns of civilisation-nature interactions, so-called syndromes (Petschel-Held et al. 1999, Lüdeke et al., 2004)

The AVHRR archive used in this study is the the Mediterranean Extended Daily One Km AVHRR Data Set (MEDOKADS) (1989 to 2004). For this data set an empirical

approach was developed to improve the intercalibration of the AVHRR/2 and /3 instruments, so that the total observation period can be used for the assessment of long-term surface changes.

For data screening the proprietary software tools TimeStats was developed, which constitutes an image processing package with advanced tools in the field of time-series analysis.

To derive meaningful conclusions from time-series analysis results were embedded and combined in the so-called syndrome
approach. The syndrome approach is based on a synoptically view of derived time-series analysis results in the assessment of surface conditions in their temporal context. Within this approach regional or local processes and
their embedding into the global context are subsumed into typical patterns. The syndrome approach considers bundles of interactive processes which
appear repeatedly and widely spread in typical combinations.

Our results demonstrate that indeed the vulnerability of drylands towards dry spells and recent episodes of droughts could be confirmed, short-term climate impacts alone are not accountable for recent degradation processes in Mediterranean drylands. The studies rather point out that biomass changes at the considered time scale are primarily caused by land-use changes due to human initiatives, with ecological and social impacts at various temporal and spatial scales. Positive NDVI developments often derive from improved land management and reclamation systems. However, on the Iberian Peninsula as in other southern Mediterranean areas, spontaneous afforestation after land abandonment and fuel accumulation due to negligence of silviculture, triggers the generation of positive biomass trends, too. With respect to the discussion about the degradation risk in the Mediterranean region this development cannot be ignored, because if the meteorological risk of forest fires further increases, also the probability of recurrent fire hazards is expected to increase.

Negative NDVI trends were found to be rather local, and in many cases they were related to an unstable state of ecosystems, caused by to expansion of irrigation beyond mid- and long-term sustainability, soil erosion, crusting and salinization, the depletion of biomass and vegetation cover, the destruction of wetlands and explosive expansion of urban agglomerates. Even initially efficient reclamation schemes may later enter a phase where undesired effects (such as soil salinizsation) become important that the overall success of the action is doubtful, for instance, by endured exploration of the natural resources beyond mid- and long-term sustainability or imprudent land management developments.

Our results suggest that the synoptical evaluation of hypertemporal AVHRR data inau-

gurates an information level that is not tangible from systems providing higher spatial and radiometrical resolution at the expense of temporal resolution. Although in particular the NDVI as indicator for vegetation cover suffers from some severe limitations it registers spatial information about short- and long-term changes in environmental conditions in their temporal contexts, despite the moderate spatial resolution of the AVHRR.

References

Petschel-Held, G. et al.: Syndromes of Global Change – A Qualitative Modelling Approach to Assist Global Environmental Management, Environmental Modeling and Assessment 4 (1999) 295–314.

Lüdeke, M. K. B.; Petschel-Held, G.; Schellnhuber, H. J. (2004): Syndromes of Global Change: The First Panoramic View. GAIA 13(1)