



Satellite time series analysis of vegetation dynamics for water resources management in semi-arid regions

Robert Behling, Sigrid Roessner, and Saskia Foerster

Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences, Potsdam, Germany

One of the consequences of global climate change is the more frequent occurrence of extreme weather conditions. Semi-arid regions are especially vulnerable since evapotranspiration significantly exceeds precipitation for most of the year and rainfall occurrence is dominantly sporadic and highly variable in amount and spatial extent. Consequently, these regions suffer from droughts of increasing duration and severity, occasionally interrupted by strong rainfall events generating high surface runoff and in part highly destructive floods. In semi-arid regions water retention capability is often further reduced by changes of the original vegetation cover due to conversion into farmland and intensification of land use. The result is widespread land degradation by a decrease in permanent vegetation cover and an increase in soil erosion. Under such conditions sustainable water resources management is of key importance, however, reliable long-term observations describing the water cycle and the resulting water budget are missing for many regions of the world. This situation requires new approaches in improving seasonal forecast for relevant water resources parameters as well as spatiotemporally explicit understanding the of influence of water and land use management on the long-term development of water availability and land surface conditions.

The German collaborative research project 'Seasonal water resources management in semi-arid regions: Transfer of regionalized global information to practice' (SaWaM) aims at the development of methods allowing the use of global data for deriving information needed for regional water resources management in semi-arid regions by integrating meteorological, hydrological and ecosystem sciences and supported by satellite remote sensing analysis. The performance, practical applicability and transferability of the developed methods are assessed in several semi-arid regions including Brazil, Iran and Sudan. Here, we present our work on the analysis of the seasonal and long-term vegetation dynamics at different spatial and temporal scales using satellite time series data of different spatial and temporal resolution (MODIS and Sentinel-2). Our goal is linking the derived vegetation dynamics to changes in meteorological conditions, water availability and land use. In this context we put emphasis on the spatiotemporal analysis of bioproductivity related to different land use types and climatic conditions to identify and characterize hotspots of water usage in form of irrigated agriculture as a basis for further evaluation of the underlying water management practices.

We perform time series analysis of satellite-derived vegetation indices (VI) using various statistical aggregates, such as maximum, mean and temporal duration related to variable time periods (hydrological year, dry and wet season, growing patterns) as well as additive time series

decomposition. Thus, we analyze long-term trends, seasonal deviations from long-term average conditions, and break points in the time series related to land use and water management changes. Moreover, we compare the derived spatiotemporal VI dynamics against the dynamics of hydrometeorological conditions (e.g. precipitation, evapotranspiration, temperature) as well as land use patterns in order to evaluate the impact of hydrometeorological drought conditions on different land use types and water management practices. In conclusion, we present prototypes for information products supporting decision making of the local experts in the target regions.