Functional Relationships between Spatio-Temporal Vegetation Dynamics and Water Cycle


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Area of Investigation
- The Upper Ouémé Catchment (Central Benin)
  - Size approximately 19600 km²
  - The Upper Ouémé Catchment (Central Benin) Area of Investigation
  - And many more…
  - Assessment of
  - Build up of
  - Quantifying precisely
  - Set up of a
  - Creation of a
  - meteorological modelling and the nutrient cycle. (Different test plots in the forest.
  - 100 cover in the semi humid tropics.
  - Ouémé Catchement.
  - Spots.
  - Short term vegetation dynamics
  - Many of the

Scientific approach
- Multidisciplinary approach/agrocultural resource Close co-operation of biologists, agro-meteorologists and geographers (remote sensing) within the sub project, as well as scienst of other disciplines.
  - Multi temporal approach
  - Assessing the short term vegetation dynamics within a phenological cycle (observations and remote sensing in high temporal resolution) and the long term changes in land use land cover within decades (historical satellite scenes)
  - Multi spatial approach
  - Merging different spatial scales. Assessing the processes very detailed in small test plots and transfer the results on a larger area. Using satellite sensors of different resolution in time and space.
  - Gathering sound ground truth Conduction of very intensive field campaigns. Set up of more that 150 test plots for detailed studies. Close co-operation with locals. Assembling the information in a data base.
  - Developing new methods to assess the wanted information. Partly in close co-operation with the industry (Porometry, RESI, GPS-link, knowledge based classification approaches)
  - Capacity building in Benin (PHD students, training for institutions in Benin departments)

Change detection (decades)

Between 1986 and 2000 there was a quite dramatic change in land use (land cover) within the area of investigations. More than 40% of the forest and savannas have been converted into farmland and settlements (Land use/land cover classification LANDSAT Scenes). That information is very important for the set up of an land management plan and the calculation of land use.

Water balance, model tests, Kc values

To investigate the interaction between the land use/land cover and the hydrological cycle it is necessary to determine the climatic parameters of the vegetation types. Therefore a sophisticated processing chain is built up. The example shows the workflow for the evaluation of transpiration and evapotranspiration. The results are used for the water balance and as input for models and can be transferred to bigger areas using remote sensing scen es.

To increase the food security by decreasing precipitation in 150 test experiments are set up to improve the water use efficiency of different crops. This is done in a participatory approach with local farmers.

Goals of the IMPETUS subproject A3
Vegetation is a key parameter within the hydrological cycle. There is a strong interaction and feedback between the hydrological conditions and the vegetation. So the vegetation cover is a sensitive measure for changes within the hydrological cycle. The goals of the IMPETUS subproject A3 are:
- Assessing of the actual vegetation cover – input for models (climate, hydrological, settlement dynamics), creation of a sound data base for decision making
- Analysing of the vegetation dynamics in different spatio temporal scales - model input, decision making
- Investigation the processes of the land use / land cover change – set up of a model for describing and predicting land use changes -> land management plan
- Estimation of the influence of the vegetation on the hydrological cycle – model input, assessing the available fresh water
- Investigating the regeneration potential of natural forests – sustainable land management
- Improving the water use efficiency of field crops – food security

Results II: Steps towards a management plan
The results of the sub project A3 are important keystones for a general manage plan for the Upper Ouémé:
- Quantifying of the natural resources (Biomass, silvicultural resource…)
- Estimating the impact of land use / land cover changes on the local climate and hydrological cycle (climate together with A1 A2)
- Defining of areas with unique vegetation for natural reserves.
- Quantifying the land use / land changes related with development schemes (new roads, new settlement)
- Set up of a sustainable timber logging management scheme.
- Estimation of the influence of the bush fires for a better fire management.
- Improving food security by improved water use efficiency of crops

These knowledge will be integrated in a decision support system

Short term vegetation dynamics
Bush fires can change the vegetation of wide areas in a short time. The knowledge of the area and the time of the fires is important for meteorological modeling and the nutrient cycle. (derived from LANDSAT)

Temperature and humidity measured at different test plots in the forest

Evapotranspiration (local scale, high temporal resolution)
Transpiration (belowground)

Results I: Techniques and Information
Creation of new methods, instruments and information. For example:
- Creation of a database with land use information for more than 800 spots
- Set up of a land use / land cover classification for the upper Ouémé Catchement
- Quantifying precisely land use / land cover changes
- Build up of advanced classification methods for land use / land cover in the semi humid tropics
- Inventing of new instruments for measuring transpiration in cooperation with the industry.
- Detailed analysis of the different vegetation types and their determining factors (micrometeoric, radiation and soil properties)
- Precise information about the regeneration potential of different forest types
- Assessment of transpiration and evapotranspiration rates
- And many more…

0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Lysimeter

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