A3

IMPETUS BENIN

Functional Relationships between Spatio-Temporal Vegetation Dynamics and Water Cycle

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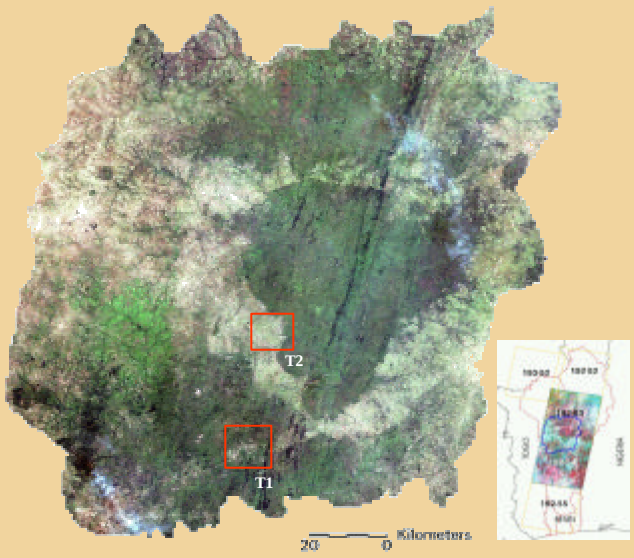
Area of Investigation

- The Upper Ouémé Catchment (Central Benin)
- Size approximately 19600 km²
- Many different land use / land types within a quite small area: From undisturbed forests over agricultural land up to urban settlements.
- Comparatively less dense populated (27 inhabitants / km²)
  - ***But***: The area is subject to ***strong immigration***. Migrants from the north (exhausted soils, diminuation of precipitation) and from the south (overpopulation) cause huge land use changes.
  - Many of the ***West-African Problems*** can be investigated in detail within the test site. For example:
    - **Deforestation** for new settlements
    - **Deforestation** caused by timber logging
    - Unproper **bush fire** management
    - **Limitated resources** of land and **land right conflicts**
    - **Overexploitation of the resource** fresh water
    - **Urbanisation**

LANDSAT mosaic of the study site (26.10.2000, channel 1,2,3)

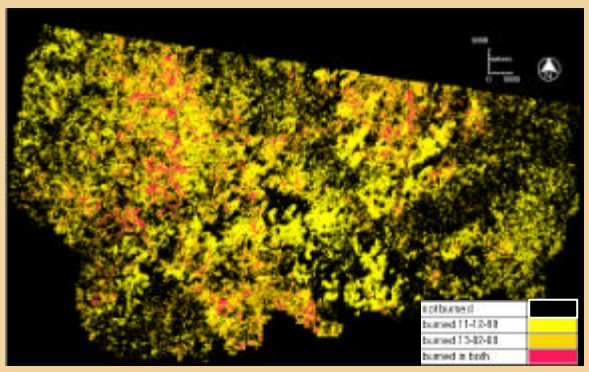


Goals of the IMPETUS subproject A3

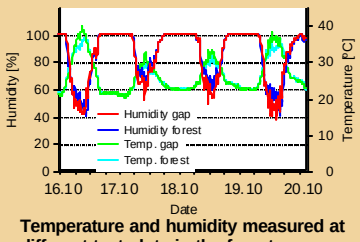
Vegetation is a key parameter within the hydrological cycle. There is a strong interaction and feedback between the hydrological conditions and the vegetation. So the vegetation cover is a sensitive measure for changes within the hydrological cycle. The goals of the IMPETUS subproject A3 are:

- **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**

Short term vegetation dynamics

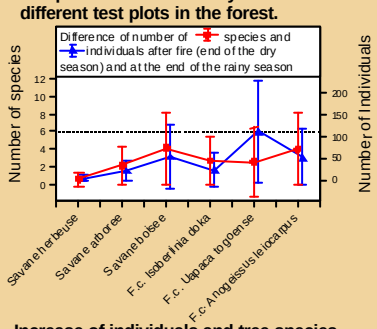


Bush fires can change the vegetation of wide areas in a short time. The knowledge of the area and the time of the fires is important for meteorological modelling and the nutrient cycle. (*Derived from LANDSAT*)



Temperature and humidity measured at different test plots in the forest.

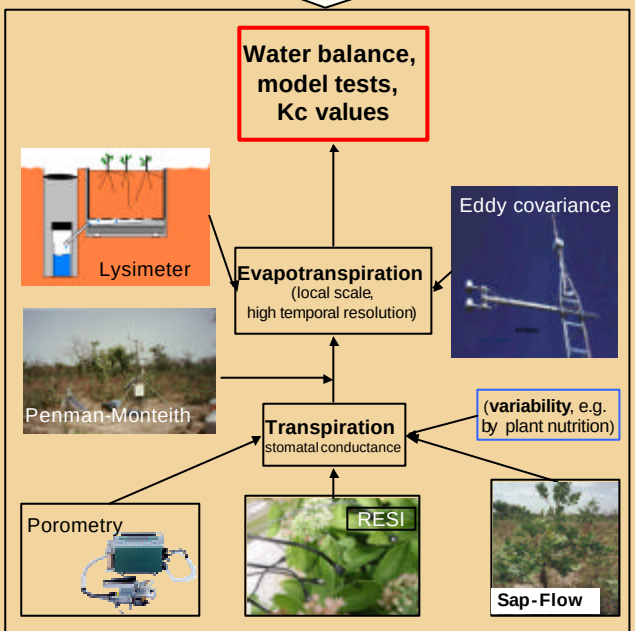
Timber logging modifies the microclimate within a forest. The microclimate is important for the upcoming of specific tree seeds. The botanists measuring the influence of timber logging on 72 test sites to get information about the climatic conditions for the regeneration potential of different forest types. This will be set into relation with the seedlings and samplings counted and distinguished into the different trees species at the test site to estimate how the forest regenerates. An vital question is the stability of the different vegetation types in regard of the size of logged areas and the transition from one vegetation type into an other caused by human influence. This results can be transferred to larger areas by analysing remote sensing scences and knowledge of logging behaviour



Increase of individuals and tree species in different vegetation units.

Scientific approach

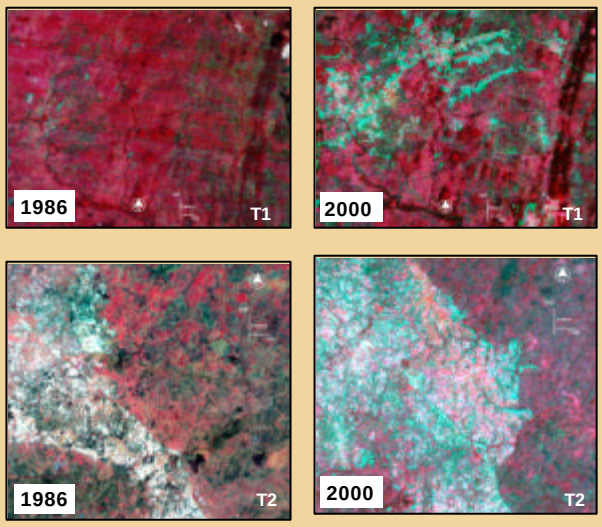
- ***Multidiscipinary approachsilvicultural resource*** Close co-operation of biologists, agro-meteorologists and geographers (remote sensing) within the sub project, as well as scientist of other disciplines.
- ***Multi temporal approach*** Assessing the short term vegetation dynamics within a phenological 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 smaller 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 detailled 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 (porometrie, RESI, GPS-link, knowledge based classification approaches)
- ***Capacity building in Benin*** (PHD students, training for institutions in Benin departments)



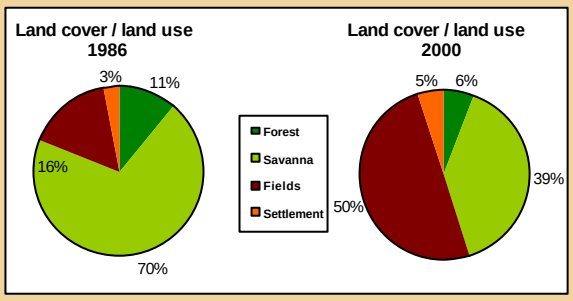
To investigate the interaction between the land use / land cover and the hydrological cycle it is necessary to determine the climatic parameters of the vegetation types. Therefore a sophisticated processing chain is built up. The example shows the workflow for the evaluation of transpiration and evapotranspiration.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

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

Change detection (decades)



The LANDSAT IMAGES show the change in land use / land cover within 14 years in the Ouémé catchment (reddish colours stand for dense vegetation). The upper pair of images is a good example how there is a change in land use / land along new build roads (arrow). The lower images show the conversion of forests to farm land



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

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 co-operation with the industry.
- Detailed ***analysis of the different vegetation*** types and their determining factors (microclimate, radiation and soil properties).
- Precise information about the ***regeneration potential*** of different forest types
- Assessment of ***transpiraton and evapotranspiration*** rates
- And many more…

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

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