Combination of geophysical and soil mapping methods related to reforestations in semi-arid regions

Theresa Mannschatz[1,2], Karl-Heinz Feger[2], Peter Dietrich[1]

Research funded by IPSWaT (BMBF Germany)

Abstract
This study analysis the influences of reforestation measures on soil properties and water balance in semi-arid areas such as Northeastern Brazil. For an improved hydrological modeling innovative combinations of geophysical, remote sensing and digital soil mapping methods for the assessment of needed soil parameters will be applied.

Key words
hydrological modeling, semi-arid regions, soil mapping, geophysics

RESEARCH MOTIVATION AND METHODS

Reforestation measures are often considered as effective measures to mitigate degradation and erosion of soils. Especially in semi-arid regions where the vegetation cover is grass and shrub dominated, large-scale tree plantations may have crucial impact on the water balance and thus on water availability. The here studied research area is located in NE-Brazil southern of the city Xique-Xique near the river Sao Francisco in Bahia state.

An important question is to define appropriate locations for reforestation measures based on the quantification of hydrological effects, requirements and limitations. This mainly depends on soil water availability, soil texture, drainage and river network (depends on topography), as well as soil fertility. An improved DEM derived from Aster and field measurements will be used for the description of the site topography [1].

The identification of appropriate reforestation locations will be determined in this study based on high-resolution soil property maps derived from geophysical assessments with Electromagnetic Induction (EMI) and Gamma spectrometry and traditional in-situ, laboratory soil analysis methods as well as digital soil mapping approaches [2].

The selection of the measurement areas for geophysics as well as for soil sampling points will be executed on bases of landscape segmentation approaches and appropriate sampling strategies [3, 4].

Soil maps can then be used for enhanced modeling of land-use effects on the water balance by means of a landscape water balance model such as SWAT (Soil Water

Assessment Tool). Several hydrological, climate, soil and land use model input parameters (table 1) are required.

Table 1 Main input parameters for the SWAT Model (*optional, +for calibration), most parameters also required for CoupModel

Climate	**Hydrology**	**Plant**	**Soil**
Air temperature*	Stream flow+	Plant characteristics	Bare soil temperature
Daily precipitation*	Water quality*	Pesticides*	Soil albedo (soil color)
Potential evapotranspiration (ET)	Aquifer depth	Plant cover	Bulk density
Solar radiation*	Water use*	Land use	Soil water content
Wind speed*	Management practices	Interseption	Soil texture
Location of climate stations	Watershed properties and river network	Leaf area index (LAI)	Infiltration (kf)
Relative humidity*	Location of gauge stations	Management practices	Soil depth
			Soil chemistry
Topography (DEM)			

Hydrological models are known to be sensitive to soil information quality and resolution [5]. Other model input parameters such as land use, vegetation distribution and variability over the year will be determined by analysis of satellite time series (monthly, LANDSAT 7 and ASTER) data using classification methods and NDVI for calculating evapotranspiration.

The characteristics of all land use classes will be determined based on literature, databases and will be evaluated as well as completed during field assessments. For an enhanced understanding of the hydrological and pedological processes related to the plantation of the reforestation species, the influence on water balance and physical soil properties will be firstly modeled with a 1D model such as CoupModel. The plant characteristics will be assessed during a small scale test plantation and can then be included as input parameter in the landscape model.

[1]Helmholtz Centre for Environmental Research – UFZ, Department of Monitoring and Exploration Technologies, Permoserstr. 15, 04318 Leipzig, Germany, Theresa.mannschatz@ufz.de
[2]Dresden University of Technology, Institute of Soil Science and Site Ecology, Pienner Str. 19, 01737 Tharandt, Germany

References

[1] ASTER digital elevation model. www.asterweb.jpl.nasa.gov/data_products.asp

[2] iSOIL EU funded project, 2010. Interactions between soil related sciences – Linking geophysics, soil science and digital soil mapping, http://www.isoil.info

[3] GÜNTNER, A., BRONSTERT, A., 2004. Representation of landscape variability and lateral redistribution processes for large-scale hydrological modelling in semi-arid areas. Journal of Hydrology, vol. 297, p.136-161.

[4] PARK, S. J., VAN DE GIESEN, N., 2004. Soil-landscape delineation to define spatial sampling domains for hillslope hydrology. Journal of Hydrology, vol. 295, p.28-46.

[5] YE, X., ZHANG, Q., VINEY, N. R., 2011. The effect of soil data resolution on hydrological processes modelling in a large humid watershed, Hydrological Processes, vol. 25, p.130-140.