as Rector. Former Rector Professor Martien Molenaar was decorated with Royal Honours as Officer in the Order of Orange - Nassau (Officier in de Orde van Oranje-Nassau). The decoration was awarded by the Mayor of Enschede, Peter den Oudsten, during the 59th Dies Natalis of ITC on 17 December 2009.

The Supervisory Board of the International Institute for Geo-Information Science and Earth Observation (ITC) has, following the approval of the Executive Board of the University of Twente, appointed Prof. Dr. Ir. Tom (A.) Veldkamp (46) to be rector/dean of ITC. He will succeed Prof. Dr. Ir. Martien Molenaar, who is stepping down as rector on 1 January 2010.

Tom Veldkamp has a PhD in agricultural and environmental sciences from the Wageningen University and Research Centre (WUR). He is currently professor of land dynamics, head of the WUR Landscape Centre and interim scientific director of the Centre for Geo-Information and Remote Sensing (Environmental Science Group, WUR).

As of 1-1-2010 ITC is embedded in the University of Twente as the sixth faculty.

On 13 November 2009 the United Nations University (UNU), represented by its rector Professor Conrad Osterwalder, and ITC, represented by its rector Professor Martien Molenaar, extended the current agreement appointing ITC as an Associated Institution until 2014.

The agreement was extended due to the progress achieved between UNU and ITC in the successful implementation of the capacity building programmes in the fields of disaster geo-information management and land administration, as mentioned in the initial agreement. Both ITC and UNU want to further develop this relationship for the mutual benefit of both organisations.

With the extension of this agreement joint programme activities will be developed on disaster management and land administration which are designed to serve institutions with a task in disaster reduction and land administration with emphasis on sustainable development.

Department of Physical Geography, Utrecht University

Representative: Prof. Steven de Jong
Report written by: Steven M. de Jong, Victor Jetten, Hans van der Kwast & Elisabeth Addink

1. Introduction
The Faculty of Geosciences of Utrecht University in The Netherlands is a successful research and educational organisation (www.geo.uu.nl). The Faculty has four departments: Physical Geography, Earth Sciences, Human Geography & Planning and Innovation & Environmental Sciences. The remote sensing, GIS and geostatistical research and educational activities are mainly housed in the Department of Physical Geography. Below we present some examples of completed and ongoing PhD studies and of some staff projects.

2. PhD theses work at Utrecht University:
In 2009 one remote sensing related PhD thesis was successfully completed and defended. This PhD project was: ‘Quantification of Top Soil Moisture Patterns: evaluation of field methods, process-based modelling, remote sensing and an integrated approach’ by Hans van der Kwast. Hans left Utrecht University and is now working for VITO in Mol, Belgium. The project was a successful co-operation between UU, ITC Alterra and the University of Rabat in Morocco. A summary is given below.

A key variable both in agricultural land use and in degradation processes such as erosion and desertification is the spatial and temporal distribution of soil moisture. Knowing rainfall alone is not enough, the different soil types in the area have more or less water holding capacity and redistribution of rainfall takes place at the edge of the plateau through runoff. Since 1998 the consortium have cooperated in various research projects, all focussing on water scarcity, groundwater recharge, runoff and erosion, and large scale soil moisture predictions. The study area has a size of 55 km^2, and is located in the community of Sehoul about 20 km east of Rabat (Morocco). Apart from rainfed and irrigated agriculture there is also a large cork Oak forest.

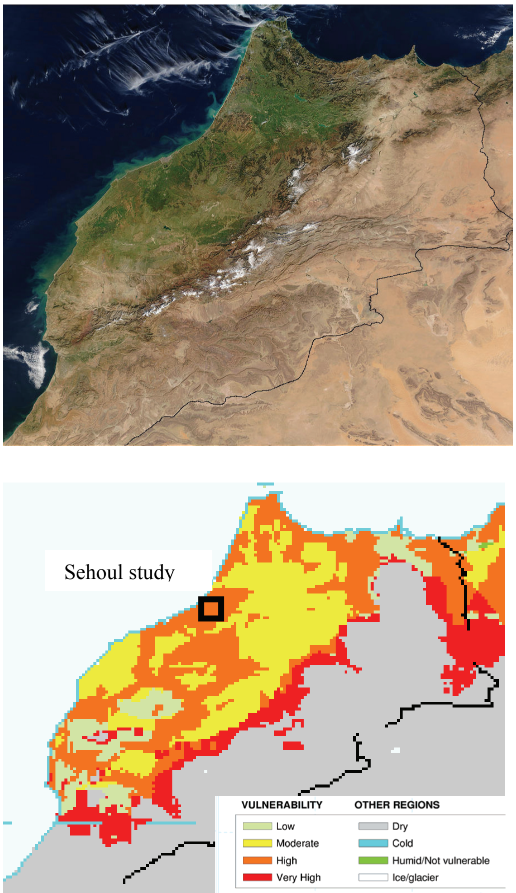

Figure 1. A MODIS image of Morocco (left) and the country of Morocco on the Global Desertification Vulnerability Map (USDA-NCRS, 1996). The Sehoul research area is situated in a high risk zone

In the past the edges of the plateau were protected from erosion by a mixed grass shrubland cover. However, historically the French colonisers took over the best soils on the plateau and forced the Moroccan farmers to occupy the edges of the plateau, causing overgrazing, intensification of the land use and consequently land degradation and erosion (see figure 2). Today large parts consist of sparsely covered unpalatable shrubs. Soil moisture modelling as part of operational environmental models are important tools for decision makers. These models need a combination of all available up-to-date data, from satellites and field measurements, for predictions of environmental variables at short time scales, i.e. hours to days after a rainfall event. These timescales are important for many natural hazard predictions as flooding and drought.

Figure 2. Examples of land degradation: degraded shrubland (left), gully erosion (right).

An important source of information for soil moisture is satellite images. Remote sensing provides information on vegetation cover and on the health status of vegetation by using information of red and infrared wavelengths, which is an indirect indication of soil moisture status. Moreover soil moisture can be determined more directly through solving the energy balance of the earth surface. This study therefore focuses on a coupling of energy balance modelling with soil moisture modelling to predict soil moisture patterns changes in time for a medium scale. A data assimilation approach is used whereby the soil moisture model that functions with an hourly time-step, is corrected by the energy balance model at the time of the overpass of the satellite. We investigate if this approach can improve soil moisture predictions.

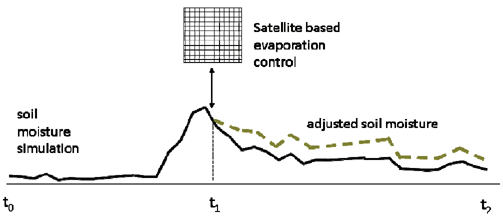

Figure 3. Methodology: a water balance model predicts soil moisture changes in time, the satellite image provides spatial information that can adjust and improve the model predictions at the day of overpass and afterwards.

Soil moisture prediction in the area is done in two steps. First the Surface Energy Balance System (SEBS) is used to estimate the evapotranspiration flux based on remote sensing data. Since there are only a few days with usable satellite images, the spatial patterns of evapotranspiration can be estimated but only for a few given sites. Moreover evaporation is one of the most important factors of the water balance but will not give directly the soil moisture. The second step is to employ a GIS based water balance model that can predict the soil moisture in time. The soil moisture prediction are checked against the satellite image and used to improve the spatial model predictions (see figure 3). Using remote sensing information to map the evaporation is based on the principle that a wet soil has a different spectral signature than a dry soil. Incoming solar radiation on a soil surface is used to heat up the soil, and evaporate any water present in the soil. On a dry soil the incoming radiation will be used to heat up the soil and evaporation is assumed zero. Since a dry soil has a high reflection and is very light in an image, while a wet soil is darker, differences in reflection can be translated to differences in evaporation. Using the potential evaporation rate, calculated from latitude and solar position, the image can be transformed into a map of a relative evaporation rates in the area. One of the advantages of the method is that it can be done with many different type of sensors, from the high resolution ASTER (10 m resolution) to the coarse resolution MODIS (250 to 1000 m resolution).

Second, a 3 layer spatial soil water balance model is constructed to predict the soil moisture for the top layer. Each layer is 15 cm in depth. On this scale it is assumed that all rainwater infiltrates and seeps slowly downward towards the groundwater. The model predicts the evaporation at the soil surface based on meteorological variables measured at one station in the area. The solar radiation, dryness and temperature of the air and wind speed determine the atmospheric demand for moisture. The actual evaporation depends on this demand and on the speed with which the soil can transmit water to the atmosphere. This is predicted on an hourly basis by the model. Summarizing the model predicts evaporation based on atmospheric information from only one meteorological station (one "point") but uses maps of soil properties and land use properties to make a spatial map of available soil moisture.

The soil moisture model was calibrated against measured TDR moisture values for a period of about 50 days (see figure 4). This was repeated for the rainy season of the year after. Results were good for the experimental locations. However, in order to succeed in calibration, the hydraulic conductivity of the soil types had to be increased to exceptionally high values. The reason for this is that several factors determine the water movement in the soil and the uncertainty of all these factors was combined in the conductivity, which is easiest to adapt.

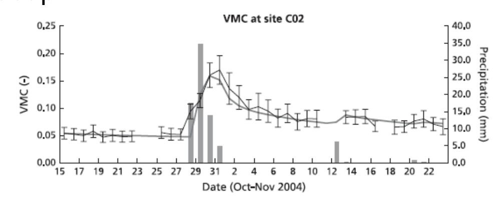

Figure 4. Measured (dots + uncertainty) versus modelled (lines) top soil volumetric moisture content (VMC) for field sites Cereal 02 at the start of the growing season, from 15 Oct to 23 Nov 2004. Vertical grey bars are daily rainfall.

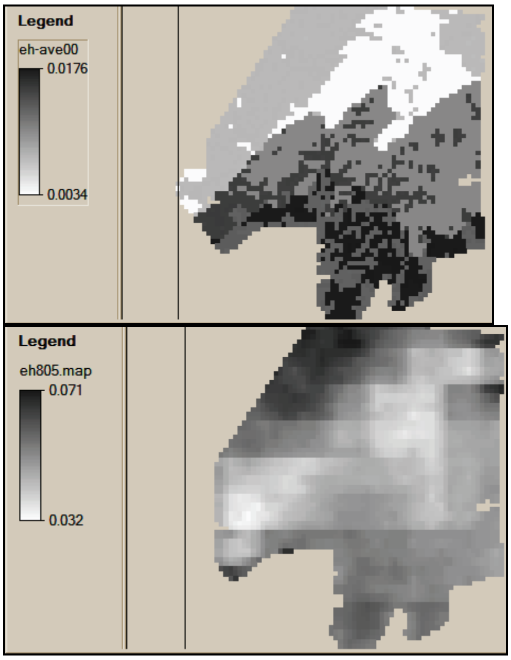

Figure 5. Example of the moisture map produced by the soil moisture model (upper) and by the energy balance method based on a MODIS image (lower)

Figure 5 shows the soil moisture content as simulated by the two approaches (soil model above, SEBS below) at a time of satellite overpass. Unfortunately no reliable high resolution cloud free images were available. Therefore the test was done with MODIS images which have a low resolution and consequently an unclear pattern. At this point only general observations can be made.

The first obvious result is that the units are different: the calibrated soil moisture model has a much drier top soil (about 5-10 times) than can be achieved with the satellite image. It should be mentioned that both methods have a large uncertainty which can be combined in various ways. The images in figure 5 do not have the have the same legend so that the pattern display is optimized. In both cases the north east part of the area is driest, and a similar variation in pattern can be seen in the south, indicating that some of the land use is captured, but there the similarity ends. The pattern on the left hand shows that model prediction seems very detailed, but the details do not change in time because the pattern is fixed by the soil and land use patterns imposed (from with the input variables are derived). Thus it may be that throughout the growing season this does not give accurate predictions and does not simulate real changes, in spite of the fact that the mode is calibrated for four locations. The image on the right hand side shows a real momentary soil moisture but unfortunately the resolution offers no practical results at this scale. Also the image derived evaporation seems more than is likely in reality: the lowest soil moisture from the image is higher than the highest soil moisture from the water balance model, and since the model is calibrated, the image cannot reproduce the measurements properly.

The objective of this research is to investigate the possibilities of using satellite data to improve soil moisture prediction by a spatial water balance model. The results are technically promising, both methods have there advantages and disadvantages. The water balance model produces better absolute values but has very rigid patterns, the satellite based method seems to produce better patterns but the absolute predictions are questionable. The results might be better in the sense that a better pattern comparison could be done, if high resolution images would be available regularly, but cloud free images are difficult to obtain, limiting the possibilities of this approach. The final conclusion at this point is that the spatial prediction of soil moisture for practical purposes remains difficult.

Further reading:

Van der Kwast, J., 2009, Quantification of Top Soil Moisture Patterns: evaluation of field methods, proces-based modelling, remote sensing and an integrated approach. Netherlands Geographical Studies 381, KNAG Utrecht. Full text available at www.uu.nl/igitur

Appendix 1: Full contact details of NL members in EARSeL

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