EVAPOTRANSPIRATION MONITORING OVER THE ALPILLES-CRAU-CAMARGUE AREA FROM REMOTE SENSING DATA

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1. INTRODUCTION

Evapotranspiration is a predominant terms of the water cycle. Around 2/3rd of precipitation water is released back to the atmosphere by evapotranspiration. Many hydrological and agricultural applications request evapotranspiration as an input or to be computed using adequate models. In general, continuous monitoring and spatial coverage is required.

Remote sensing offers the possibility to map evapotranspiration. The last decade has seen the consolidation of evapotranspiration concepts that allow robust estimation of evapotranspiration, either based on morning surface temperature rise, or on bounding evapotranspiration estimates by their values on dry and wet areas.

In the frame of three large French and European research programs, -1) the French Resyst Observatory (ORE) in the Camargue area (Rhône Delta), -2) the European Alpilles ReSeDA experiment, and -3) the European WATERMED project, evapotranspiration was monitored by combining in-situ meteorological and micrometeorological data together with remote sensing images acquired at various spatial resolutions. Our objectives were -1) to design procedures for providing evapotranspiration maps, -2) to evaluate estimation of evapotranspiration against field measurements, -3) to provide information on evapotranspiration for the various ecosystems of the area under study (no information existed already for some of them). More recently, we extend our objective to a continuous mapping of evapotranspiration by designing procedures for interpolating in time evapotranspiration estimations between remote sensing observations. The overall objective of the study was then to acquire evapotranspiration knowledge over the various ecosystems in the lower Rhône valley in France (Camargue, Crau, Alpilles-Durance) in order to improve crop production and water use monitoring and the modelling of the Camargue hydrological system, particularly water and salinity levels in marshes and ponds.

2. DATA AND METHODS

Continuous monitoring of energy balance was performed over several agricultural surfaces for one year during the Alpilles-ReSeDA program (wheat, sunflower, alfalfa). In the frame of Resyst, continuous in situ energy balance monitoring was performed over a sansouire surface (hallophyte ecosystem) for which no evapotranspiration reference was previously available. Intensive periods with energy balance systems set on several surfaces (rice, grassland, wheat) were organized at the time of some high resolution remote sensing acquisitions.

Surface energy balance models (SEBAL [1] and S-SEBI [2]) were implemented for computing evapotranspiration, using remote sensing data as direct inputs. Several sources of data were used: NOAA-AVHRR data from 1997 to 2002 (1km resolution); ASTER data (90 m); INFRAMETRICS and FLIR IRT airborne camera (20 m and 3.5 m). The Implementations of the two models with this various remote sensing data have been presented by Jacob et al. (2002) [3], Gomez et al. (2005) [4], Sobrino et al. (2007) [5] and Courault et al. (2008) [6].

Time interpolation of remote sensing estimates of evapotranspiration was done in two steps: -1) an extrapolation of instantaneous estimates to daily estimates based on the conservation of the evaporative fraction and on an adequate derivation of the daily net radiation, -2) an interpolation of the daily evapotranspiration between days with remote sensing data acquisition based on a combination of the estimation with reference evapotranspiration computed from ground meteorological station data.

3. RESULTS

Several results were obtained.

1. In situ monitoring over the various crops provided evapotranspiration data in agreement with the many previous data on such ecosystems; the monitoring of the sansouire hallophyte ecosystem provided new information showing a very low evapotranspiration level
2. NOAA-AVHRR continuous monitoring for several years displayed the variability of annual evapotranspiration depending on ecosystems, ranging from a low 350 mm/year in the Crau steppic dry area to 600 mm/year in an agricultural area (flooded rice + wheat) while the average annual precipitation was 560 mm.
3. High resolution evapotranspiration maps were in agreement with in situ data showing the validity of the surface energy balance models (root mean square errors ranged between 30 and 70 W m^{-2}).
4. Comparison between AVHRR estimates and high resolution estimates were also in agreement showing that in the investigated situations errors due to scaling were not too large

Our results make it possible to propose the implementation of a procedure to monitor evapotranspiration at various scales from remote sensing data.

4. REFERENCES

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