Earth Observation for Quantifying Eco-hydrological Fluxes

1. Introduction

1.1 Objectives

The main objective of the research is to effectively utilize earth observation methods and time-series analysis to quantify the hydrological fluxes and environmental variables in the semi-arid Konya closed basin spatio-temporally and with good accuracy. It is further aimed to quantitatively analyze ecohydrological relations/ changes at regional and local scale in time. The research questions under consideration are:

1) Can we improve the accuracy in quantifying the hydrological fluxes (evapotranspiration) integrating the remote sensing and field based surface energy balance techniques (SEBS and Bowen ratio)?
2) Integrating RS, field and time-series methods effectively, can we reveal the inter-relations among hydrology and environmental variables quantitatively to understand feedback mechanisms at the regional and local scale?
3) Can we effectively estimate the ecological water demand of the downstream using earth observation techniques?

1.2 Study Area

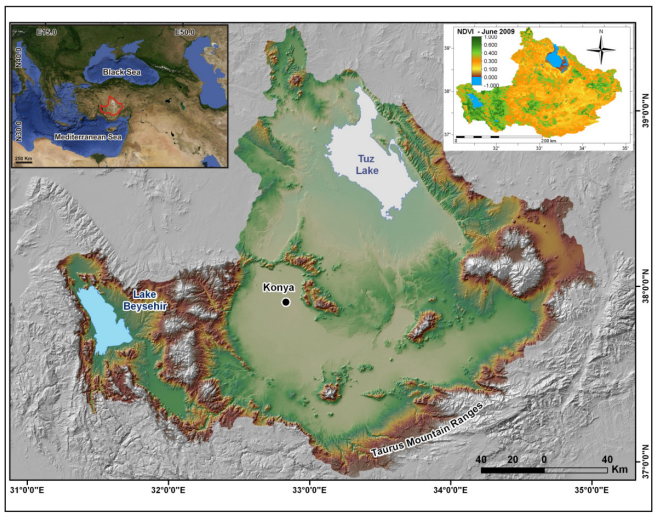

Fig 1. The geographic location, digital elevation model (DEM) and vegetation (NDVI) of the Konya Closed Basin, Turkey

1.3 Summary info on the study area

Location	:	37-39° N - 31-35° E
Elevation	:	900 – 3.534 m.a.s.l.
Surface area	:	54.000 km²
Climate	:	Arid to semi-arid P= ~350 mm/year E= ~1200mm/year (PanA)
Landcover	:	Strong contrast between intensively irrigated agricultural lands and the sparse steppe areas (Fig 1, NDVI map).
Water resources	:	There are two large lakes present in the closed basin: the hyper-saline Tuz Lake in the downstream and the freshwater Lake Beysehir in the upstream part. Groundwater is the main source of drinking and irrigation.

2. Improving the accuracy of ET in semi-arid regions

2.1 Overview

Remote sensing based surface energy balance models (for example, SEBS by Su, 2002) can quantify the spatial distribution of evapotranspiration (ET) unlike the ground techniques (Fig 2.).

However, according to comparison with the field evaporative fraction (EF) data from Bowen ratio stations, SEBS model overestimated ET under the dry & sparsely vegetated conditions of semi-arid regions (Fig 3.), which is a general problem for single source energy balance models.

Proposed solution:

Integrate the output of SEBS model (Fig 2.) with the empirical equation relating the ground measurements of evaporative fraction (Bowen ratio station, Fig 4.) with EO data of soil moisture, temperature gradient and NDVI (Fig 5).

The resultant ET map better reflect the contrast b/w the irrigated lands and the surrounding dry landscape (Fig 6.)

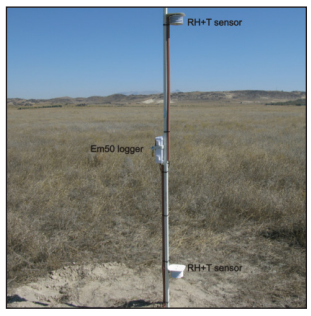

Fig. 4 Bowen ratio station

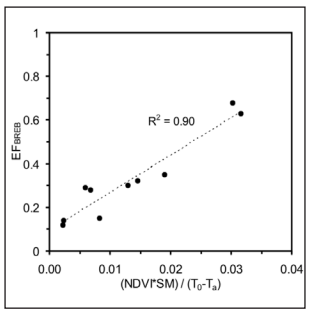

Fig. 5 Relation of EF with SM, NDVI and T0-Ta

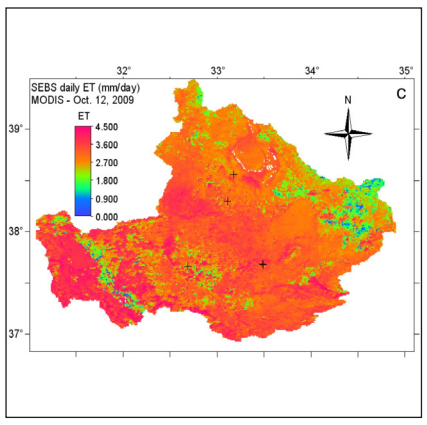

Fig. 2 Daily ET map by SEBS model

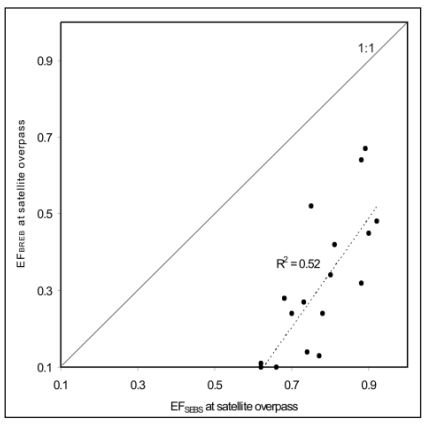

Fig. 3 Comparing EF by SEBS vs. Bowen ratio

Data

- SEBS input: Modis VIS+NIR+TIR bands, MOD15A2 (LAI), air temp., wind speed, surface pressure, sun hours, down-welling radiation from MSG (LSA-SAF facility)
- Bowen ratio ground measurements
- Soil moisture data from AMSR-E observations (Owe, de Jeu et al., 2008)
- NDVI from MODIS

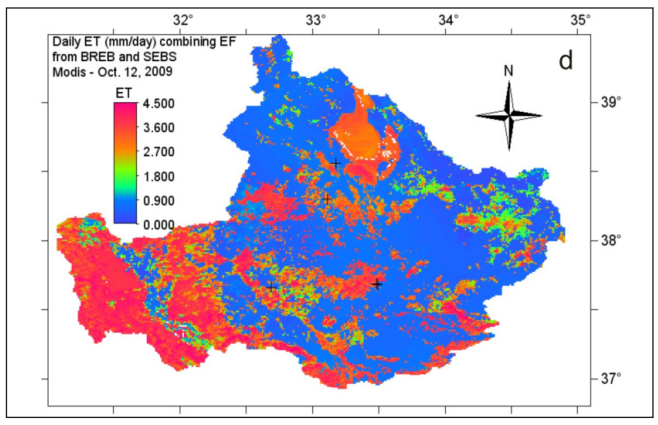

Fig. 6 Improved daily ET map

3. Eco-hydrological dynamics using earth observation and time-series

3.1 Overview

Long term eco-hydrological dynamics in the Konya closed basin will be analyzed integrating different source EO data (MODIS, AVHRR, MSG) and applying HANTS algorithm for time-series analysis. A conceptual diagram of the basin is shown in Fig. 7 and some initial examples are presented:

- yearly changes in vegetation (NDVI product of MODIS) for different sub-units of basin (Fig. 8)
- year changes in soil moisture (AMSR-E data from VU Amsterdam) for different sub-units of basin (Fig. 9)
- seasonal change in daily ET (Fig. 10)

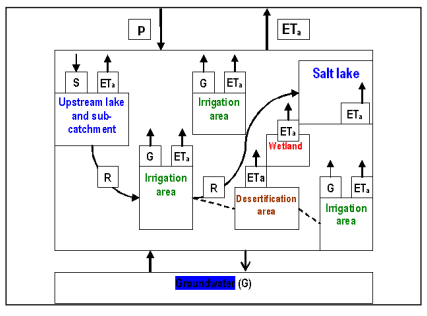

Fig. 7 A conceptual diagram of the basin (P: Precipitation, ETa: Evapotranspiration, S: Snow, R: runoff, G: groundwater in/outflow)

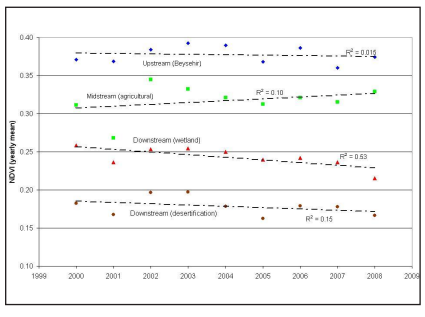

Fig. 8 Yearly changes in NDVI (average of MODIS 16-day composites b/w April-October)

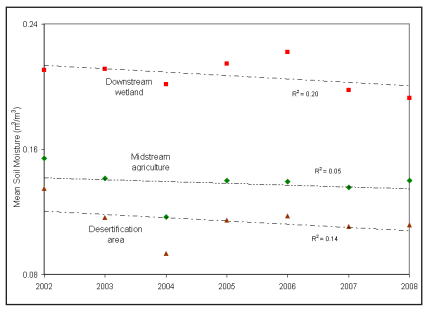

Fig. 9 Yearly changes in soil moisture (average of AMSR-E data b/w June-October)

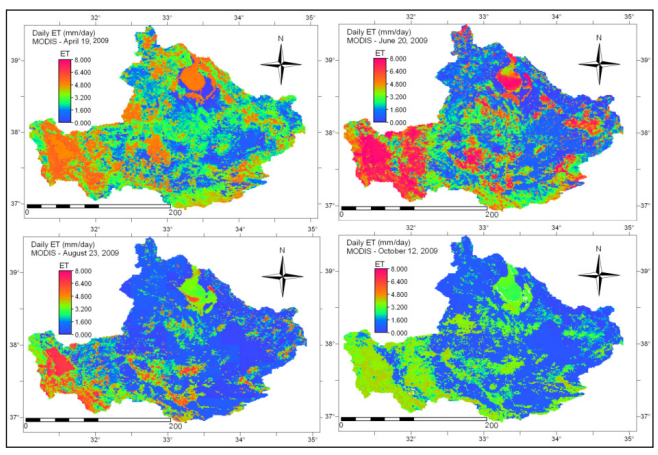

Fig. 10 Seasonal change in daily ET

References:

Owe, M., R. de Jeu, et al. (2008). "Multisensor historical climatology of satellite-derived global land surface moisture." Journal of Geophysical Research-Earth Surface 113(F1): 17.

Su, Z. (2002). "The Surface Energy Balance System (SEBS) for estimation of turbulent heat fluxes." Hydrology and Earth System Sciences 6(1): 85-99.

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