Using public-domain datasets to model the Küçük Menderes basin, Turkey

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Abstract Distributed hydrological models used to investigate basin water resources generally require large numbers of data which are not always available. However, data from satellites and global datasets of elevation, land cover and climate are available from the Internet. The paper describes the application of a distributed hydrological model using only data from satellite and the Internet and discusses the results.

Key words digital elevation model (DEM); distributed hydrological model; land classification; public-domain datasets; SLURP; TOPAZ; Turkey; water management; water resources

INTRODUCTION

The Küçük Menderes Basin, Turkey, has an area of about 3617 km^2 and flows from east to west into the Aegean Sea. Extensive irrigation projects are planned for the basin (Alpaslan, 1999) and it was of interest to model the implications of a proposed dam and reservoir. However, local climate and streamflow data were not available and it was decided to model the basin using only data available from satellite and from the Internet.

METHOD

The SLURP distributed hydrological model (Kite, 2000) uses digital elevation, land cover and climate data to simulate and route streamflow through a basin. For the Küçük Menderes basin we used the 1 km resolution US Geological Survey GTOPO30 digital elevation model (DEM) from the Internet to define the basin, sub-basins, elevations and distances. The DEM was analysed using the US Department of Agriculture/University of Saskatchewan's TOPAZ model (Garbrecht & Martz, 1997) with the SLURPAZ interface (Lacroix & Martz, 1997).

The land cover classification was derived from 1 km resolution US National Oceanic and Atmospheric Administration satellite images from the Advanced Very High Resolution Radiometer sensor, accessed from the Internet. The temporal variation in land cover was derived in a time series analysis of near infra-red (NIR) data; the spatial variation of land cover was defined from normalized difference vegetation indices and the DEM provided the physical setting. Land cover types were then derived using an unsupervized classification (Fig. 1).

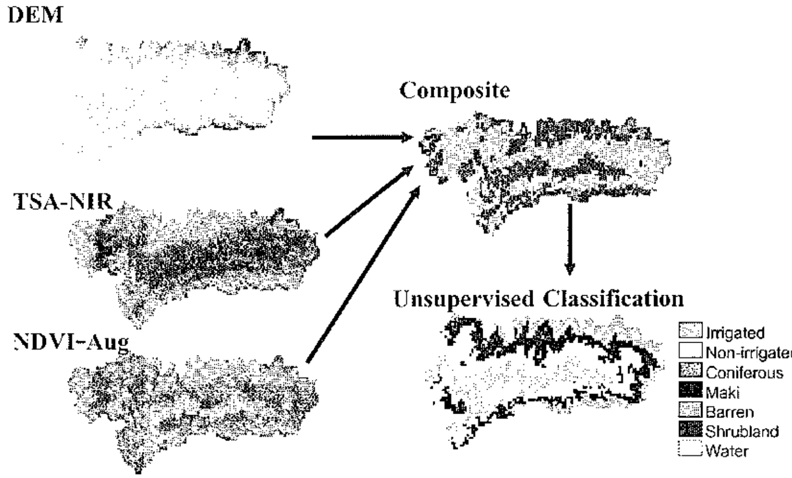

Fig. 1 Derivation of land cover map.

The climate data required (precipitation, temperature, humidity and radiation) were obtained from the US National Climate Data Center's Global Surface Summary of the Day, off the Internet.

RESULTS

The simulated streamflows from SLURP were aggregated to monthly values and compared with observed monthly streamflow from EIE (the Turkish electricity company), Fig. 2. The model fit is generally good, especially for the first two years of simulation. The overestimation of flow during June–October each year is because the model does not include diversions for existing irrigation schemes.

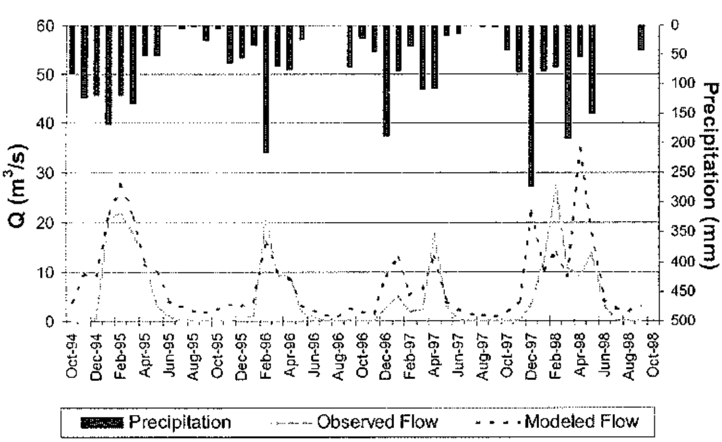

Fig. 2 Mean monthly recorded (EIE station) and simulated (SLURP) flows, and monthly precipitation.

In 1998 the simulated flows have peaks at different times from the observed flows. From the precipitation (top of Fig. 2), we can see that the model correctly simulates high flows after high precipitation while the recorded hydrograph does not. Perhaps the climate stations used do not adequately represent the basin precipitation conditions, or an alternative explanation is that there are errors in the EIE data (1996–1998) since it had not been quality controlled at the time of this comparison.

A reservoir is being constructed to supply 1.6×10^8 $m^3 year^{-1}$ of water for an 18 200 ha irrigation scheme in the basin (Alpaslan, 1999). To simulate inflows to the reservoir, we first assumed that the reservoir would start from empty (Alpaslan, 1999). The model shows (Fig. 3) that there would only be enough water to satisfy the irrigation demand (grey) for the first few months of every year with these inputs (black). In no year could the total irrigation demand be satisfied. Then, we assumed that the reservoir had been filled to its "normal water level" (Alpaslan, 1999). In this case, with the reservoir 48.8 m higher than in the first option, we were able to satisfy the irrigation demand.

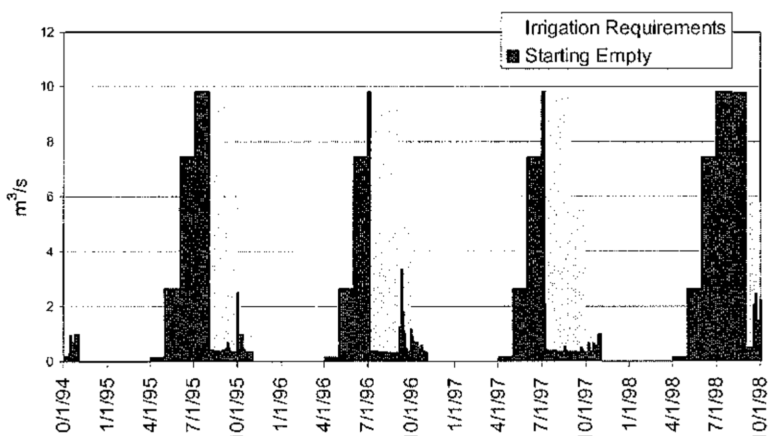

Fig. 3 Water demand (grey) and water supply (black) for the irrigation scheme assuming an empty reservoir on 1 October 1998.

CONCLUSIONS

We have shown that we can apply a distributed hydrological model to a basin using only data from the Internet without calibration. The implications for modelling are that we can do the same for other basins and that we can do the modelling from anywhere with Internet access. This will be useful for quick and cost effective evaluations of management alternatives.

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