Preliminary Hydrological Water Resources Assessment of CEGA-ERESMA-ADAJA watershed using SWAT model

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Introduction

SWAT is a physically based, continuous time and a public domain hydrological model. During the last 20 years, SWAT model has been developed and worldwide tested in different countries to assess water resources quantity and quality. The ArcSWAT integrates SWAT interface in ArcGIS providing a friendly and useful tool in hydrological modeling. Through the use of SWAT model is also possible to assess the impact of agricultural activities on the water resources in watersheds.

The development of the SWAT model aims to provide an additional tool that can help in the decision´s making, especially in the definition of the watershed hydrological plan. Indeed, the model can be used for the evaluation of the water resources and prediction of response to climatic and soil use changes.

Objective

The purpose of this research was the set up of a SWAT model using basin parameters as a preliminary process in the hydrological modelling of the CEGA-ERESMA-ADAJA management system in the Duero's watershed (Spain).

The Site

This works was focused on the modelling set up of the CEGA-ERESMA-ADAJA sub-basin which belongs to Duero's River in Spain (Figure 1) using the ArcSWAT interface and public databases. The areas is mainly represented by agricultural land use. The sub-basin shares the influence area between the provinces of Ávila, Segovia and Valladolid.

Location: Duero´s Watershed, Spain.
Gauging stations: 28
Land use: Agriculture and forest
Area coverage: 7.852 km^2
Main soil types:
Arenosols, Luvisols, Cambisols

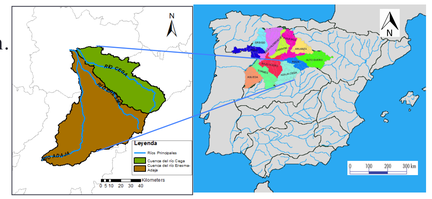


Figure 1. CEGA-ERESMA-ADAJA watershed location.

Methodology

The data used to set up of the model area reported on Table 1. The reclassification of soils, land use and slope were developed using two proposed lookup tables (soils and land use). On the other hand, the FAO slope classes were implemented for the reclassification of the slope. This process allows us to obtain a preliminary model as a strategy to reduce uncertainty in calibration and validation processes. However, the model of the CEGA-ERESMA-ADAJA watershed is still in under calibration.

The scheme of Figure 2 shows the procedure used in ArcSWAT to integrate all the available and required data into the model.

Table 1. Public data source of information

Data	Scale / Resolution	Source of information
Digital elevation model (DEM)	1:25.000 25 x 25m	Instituto geográfico Nacional, (IGN) (http://www.ign.es/)
Soils Map	≈1 km (pixel size: 813 x 813m)	Harmonized World Soil Database (HWSD) (http://webarchive.iiasa.ac.at/Research/LUC/External-World-soil-database/)
Land use Map (SIOSE)	1:25.000	Instituto geográfico Nacional, (IGN) (http://www.ign.es/)
Stream network	1:25.000	MIRAME viewer. (http://www.mirame.chduero.es/)
Provinces Map	1:25.000	MIRAME viewer. (http://www.mirame.chduero.es/)
Sub Basins Map	1:25.000	MIRAME viewer. (http://www.mirame.chduero.es/)
Climate data (between1979 to 2014)	28 gauging stations in the área limited by: South Latitude 40.4971 North Latitude 41.9758 West Longitude -5.0977 East Longitude -3.0762	Global Weather Data for SWAT (http://globalweather.tamu.edu/)

Following the scheme, the set up process allows us to bring together the data in the corresponding spatial area and consequently to define the HRUs (Hydrologic Response Units) that are used to obtain the response of the hydrological balance to changes of climate data for similar land use, soils and slope characteristics.

The spatial data for the sub-basin was delimited based on 10 km buffer of previous polygons used by Duero' s Watershed Authority (Confederación Hidrográfica del Duero, CHD) for the subsequent validation with the automatic SWAT delimitation tool.

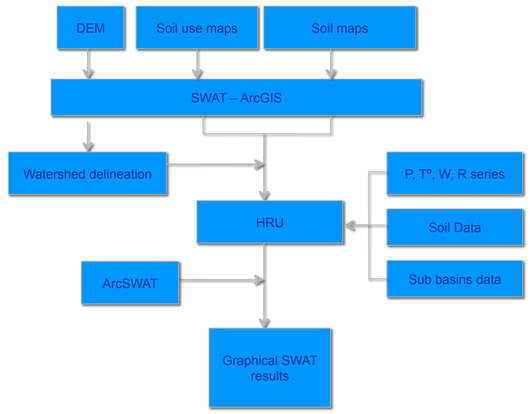


Figure 2. Methodology schema

The 10 km buffer boundary was used to set the preliminary model as a spatial reference data set into soil, land use and slope maps (Figure 3). Data have been converted to SWAT valid codes using proposed look-up tables for soils and land use. At least 1,500,000 of climate data from 1979 to 2014 have been introduced in main database of SWAT using statistics data from the basin and the external boundary. The land use map introduced into SWAT was created from the SIOSE_2005 map of Spain. More than 4,200 polygons where grouped into 78 codes using the land use look-up table. The soil map of the Harmonized World Soil Database (HWSD) was reclassified obtaining 13 soil units. The overlaping of the spatial data results into graphical HRUs map that merge information into unique hydrological units used to define a global hydrological budget of the CEGA-ERESMA-ADAJA sub-basin.

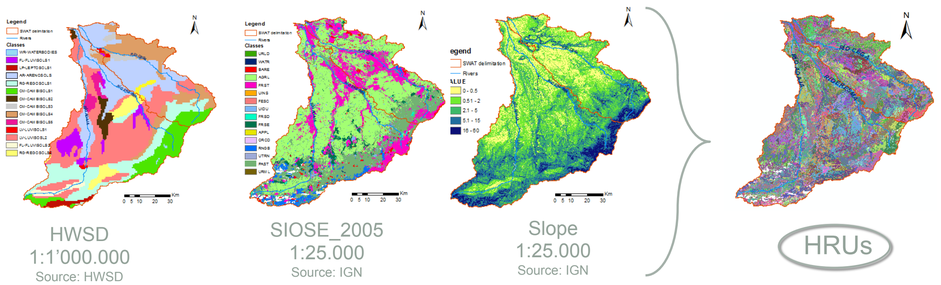
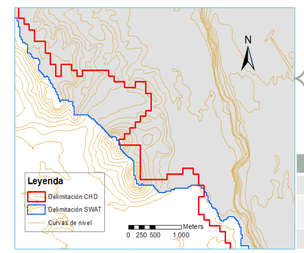


Figure 3. Spatial data set for SWAT model

Results and conclusions

The developed procedure implied the organization of parameters and data set into SWAT in ordet to obtain a well built coherent structure to convert Spanish public information to the input format of SWAT. During such a process, differences between the delimitation of watershed using the Digital Elevation Model (DEM) and the CHD's delimitation were recognized (Figure 4).



Data	CEGA	ERESMA-ADAJA
Area [km^2]	2.590,2	5262,2
Lenght of main stream network [km^2]	219,2	448,5
Nº of HRUs	218	252

Figure 4. Watershed delimitation differences

As shows by the red and blue lines of Figure 4, these differences are higher in lower slope border areas. Since the DEM delineation presents a resolution that is better than the polygon used by the CHD's, we highly recommend using the former delineation.

The global hydrological budget obtained with SWAT (Figure 5), was analysed and comparisons between precipitation and ET were carried out to understand the hydrological dynamic of the watershed

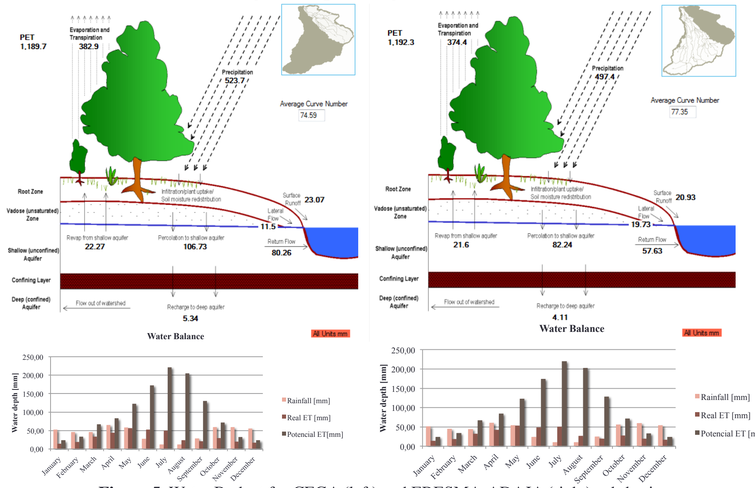


Figure 5. Water Budget for CEGA (left) and ERESMA-ADAJA (right) sub-basins.

The hydrological balance of Figure 5 shows that in the CEGA-ERESMA-ADAJA is a sub-basin the available water is limited, especially between May and October. Indeed, the graphical results privided by SWAT show that the real ET is higher than rainfall during the period that goes from June to August. This phenomenon can be explained by the contribution of the soil water content retained by the first soil layer that serve as a water buffer of potential ET during the dry period.

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