

2015 SWAT international Conference



Assessment of solid load and siltation potential of dams reservoirs in the High Atlas of Marrakech (Moorcco) using SWAT Model

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Contextualization

Facing the uncontrolled exploitation of natural resources resulting in the deterioration of land in the N'FIS watershed



assessment and mapping of water erosion of soil is performed to allow the spatial parameters



make proposals for its development to fight against erosion



SWAT

Why is GIS useful in soil erosion study?

- **Environmental issues are always spatial orientated.**
- **Many computer models have been developed to predict soil erosion. The database of information required by these tools is relatively complex.**
- **GIS can handle those spatial data very easily and efficiently.**

Facteurs d'Erosion

- **The erosion factors influence the intensity of the process of detachment , transport and deposition , lead to specific forms of erosion. We can mention five:**

Vegetation

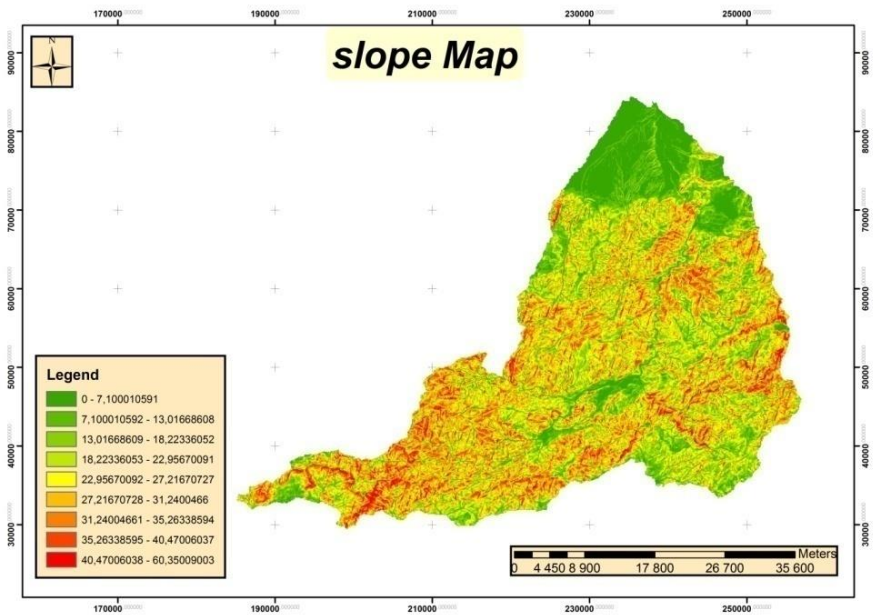
Rainoff

Topography

Soils

**Cultural
technics**

Study Area



Localisation: The north side of the central high atlas

Altitude: -the average elevation: 2074m

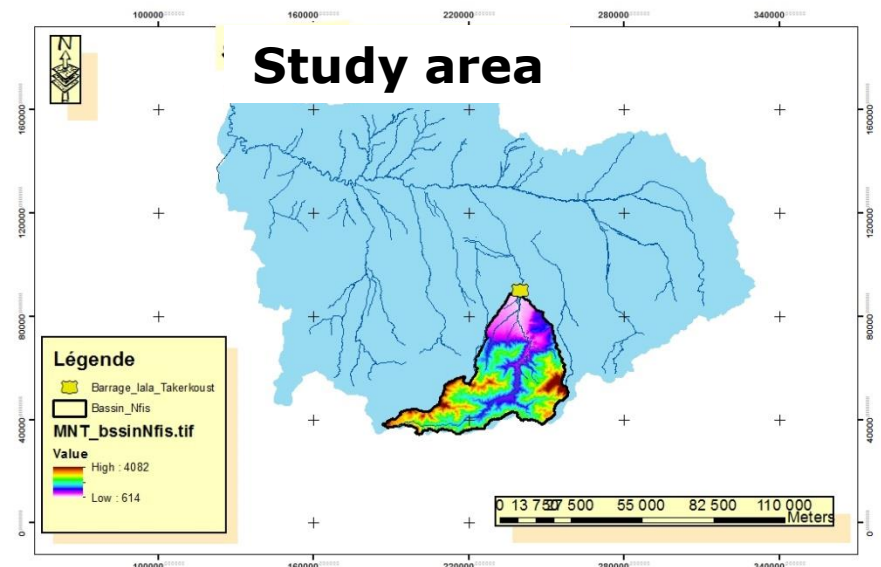
- Median : 2080m

- The most frequent elevation: between 1600 and 2000 m

Climat: semiarid , high spatiotemporal heterogeneity . The temperature at the opposite precipitation is quite regular . The measurements show an average annual temperature of 18.6 ° C

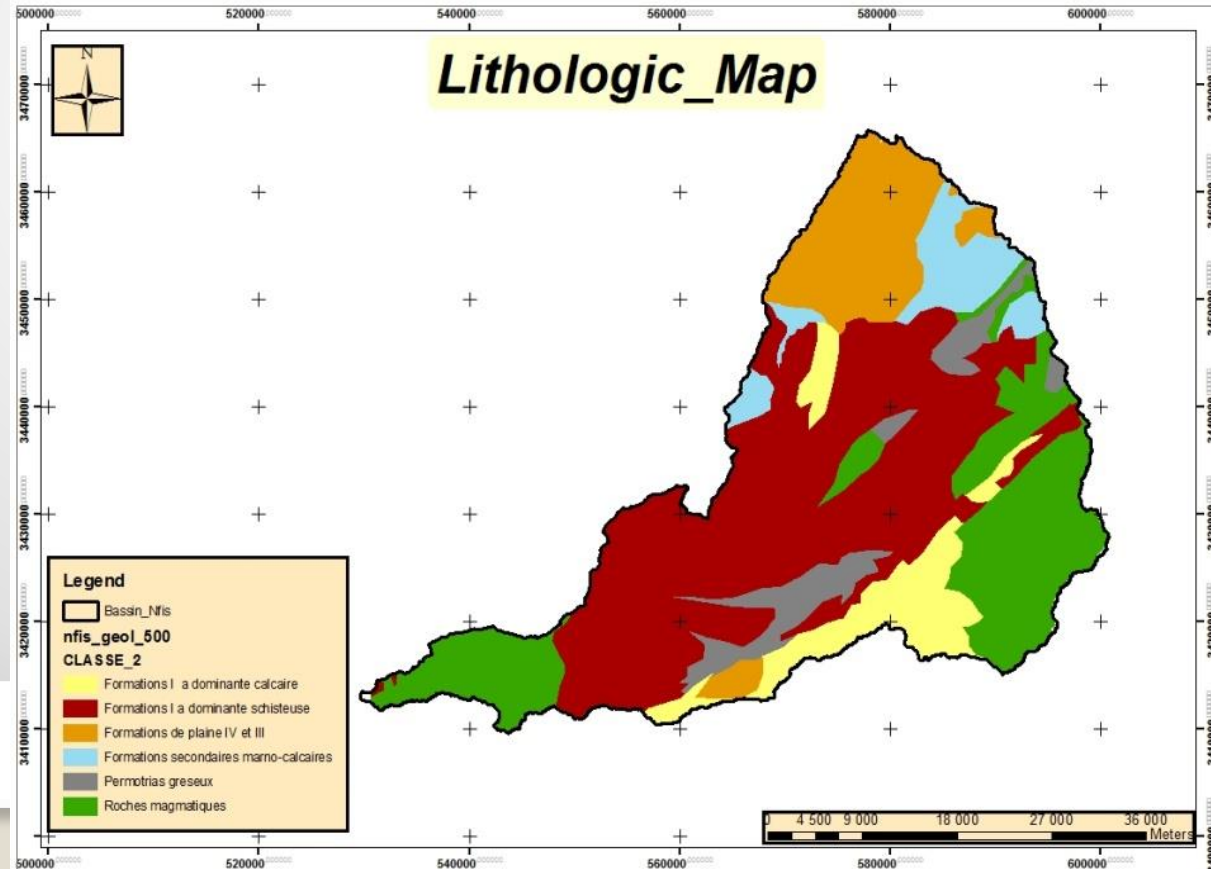
The morphology of the N'fis watershed is diverse by the effect of multiple tectonic movements and erosion affecting this geological structure , one can observe :

- From the peaks and ridges
- Trays dissected hills
- Depressions Narrow and deep valleys
- Alluvial terraces staggered levels or nested
- A brutal contrast between the horizontal planes of the high places and slopes .



Study Area

The distribution of soil at the N'Fis basin depends mainly on the nature of the source rock ,topography , and vegetation type , The soil units type sandy and clay soils form two different sets oriented NE -SW both types are developed on primary shale on land eruptive and limestone . To the north of the basin, a great depression of Permo-Triassic land, Jurassic and Cretaceous consist of sandstones, marl or clay licks and limestone



Problem and Objective

- * It is the seat of a large number of dams and lakes that depend heavily on the ability of watershed erosion.*
- * This is a recent string with slopes of significant value and producing large quantities of solids.*



**Quatify the soil erosion
process**

Methodology

RUSLE Universal Soil Loss Equation

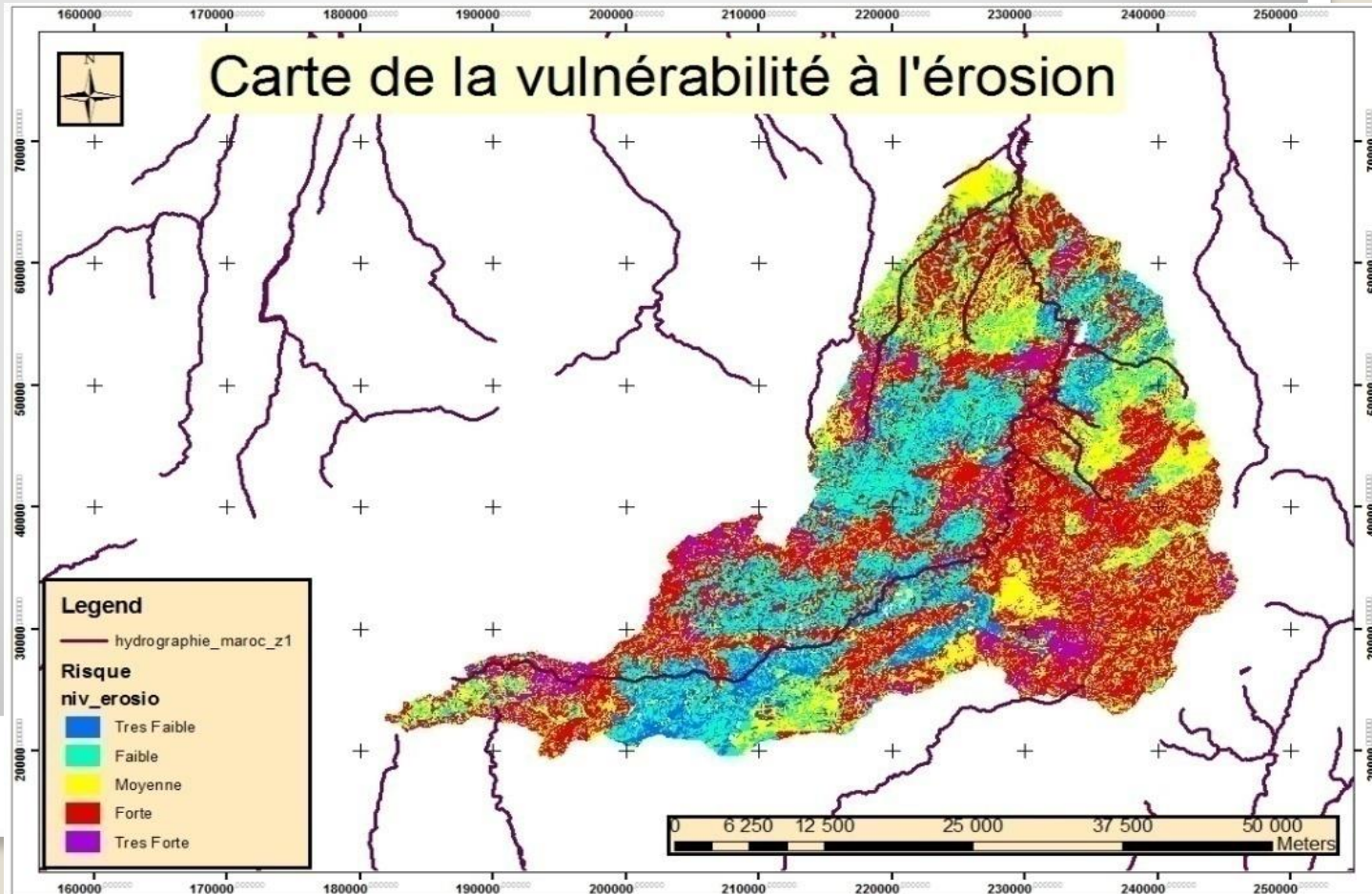
- ✪ Wischmeier, W.H. and D.D. Smith. 1978. Predicting rainfall erosion losses. USDA Agriculture Handbook 537, U.S. Department of Agriculture.

- **A** is the computed soil loss (tons/acre/year)
- **R** is the rainfall-runoff erosivity factor
- **K** is the soil erodiility factor
- **L** is the slope length factor
- **S** is the slope steepness factor
- **C** is the cover-management factor
- **P** is the supporting practices factor

$$\mathbf{A = R K L S C P}$$

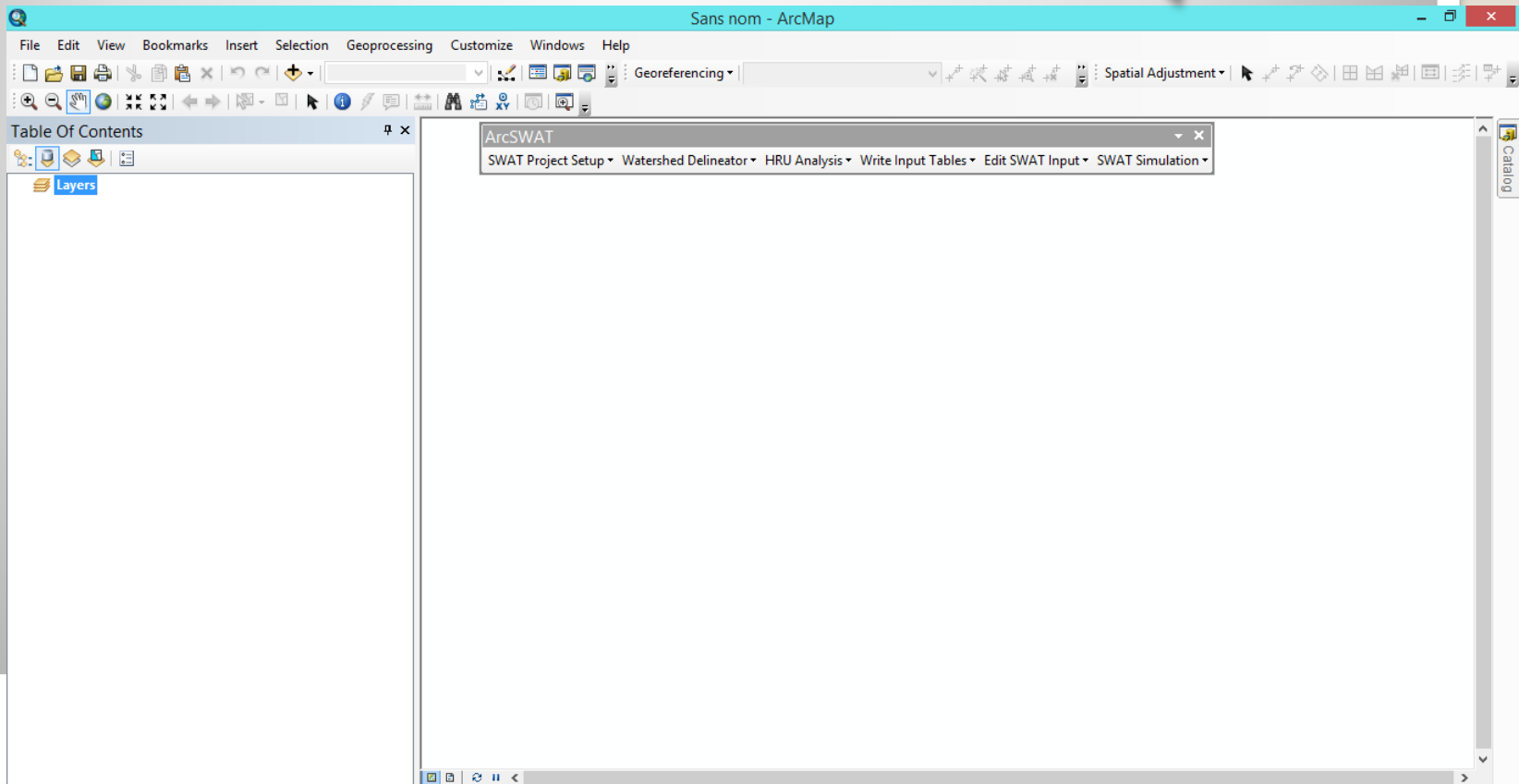
Results

The loss of soil values vary between 0 and 123 t / ha / year , depending of the watershed area. The average soil loss is estimated at 60t / ha / year, which is considered high and exceeds the acceptable threshold of soil loss of 3t / ha / year estimated for areas that presents similar conditions to those of the watershed of N'FIS

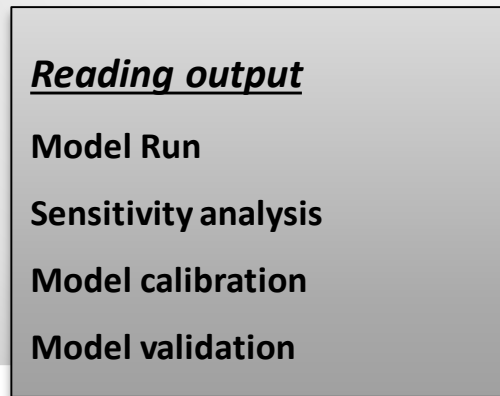
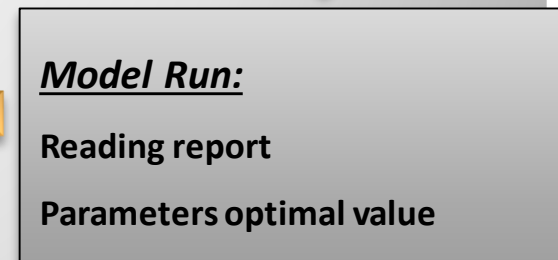
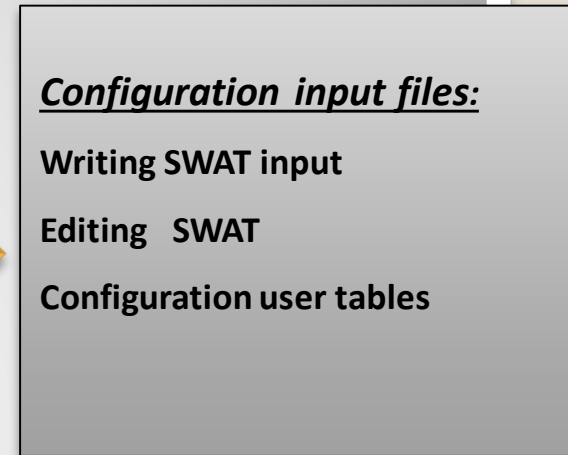
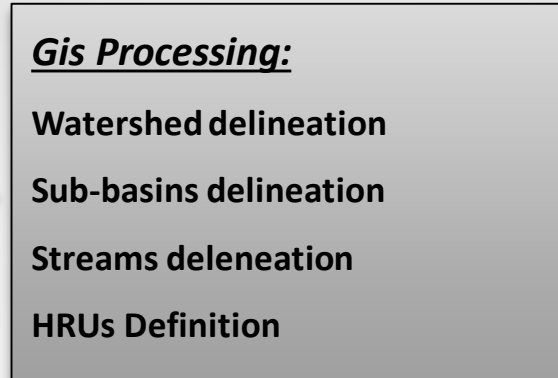
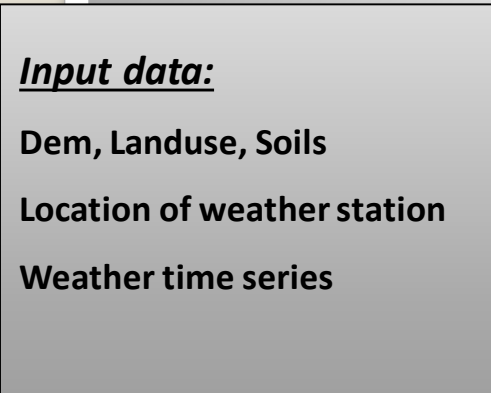


Methodology

In this study, we had used the ArcSWAT graphical user interface to manipulate and execute the major functions of SWAT model from the ArcGIS tool



Methodology



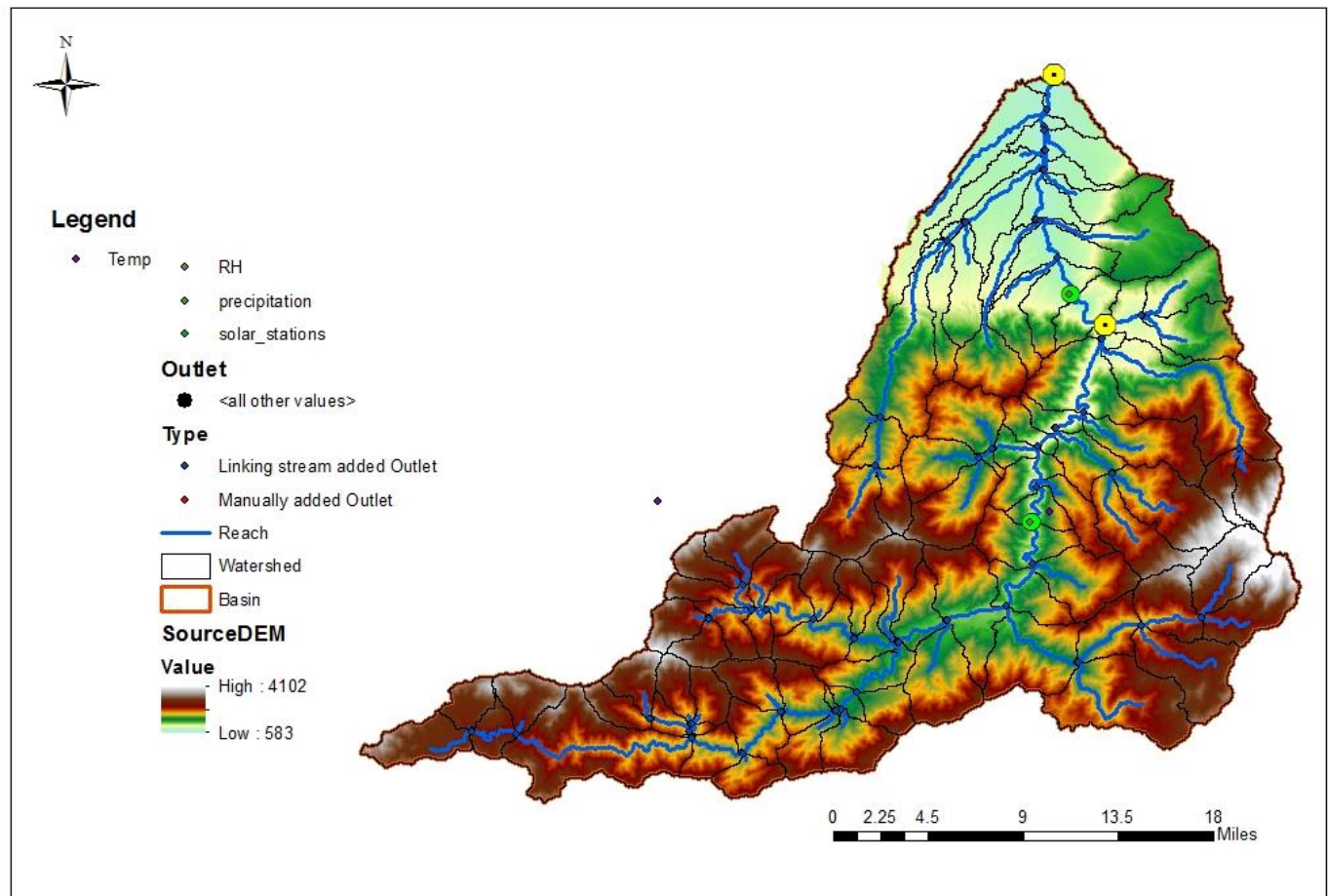
Creation of the Database

The Implementation of the SWAT model requires the creation of a database containing morphological description (topography), physical description (pedology and land use) and climate (precipitation, temperature, etc.) of the basin. These layers of information must also be associated with a set of attributes describing the properties of each layer.

- The recovery of digital model representing the relief of the studied area
- The digitalization of the soil and geological map of the studied area;
- The processing of satellite images through the process of supervised classification for extracting land use map;
- Recovery and structuring in adequate files of data on the climate at the meteorological stations studied;
- The processing of these climate files
- Collecting and structuring data concerning the soils analysis

Digital elevation model

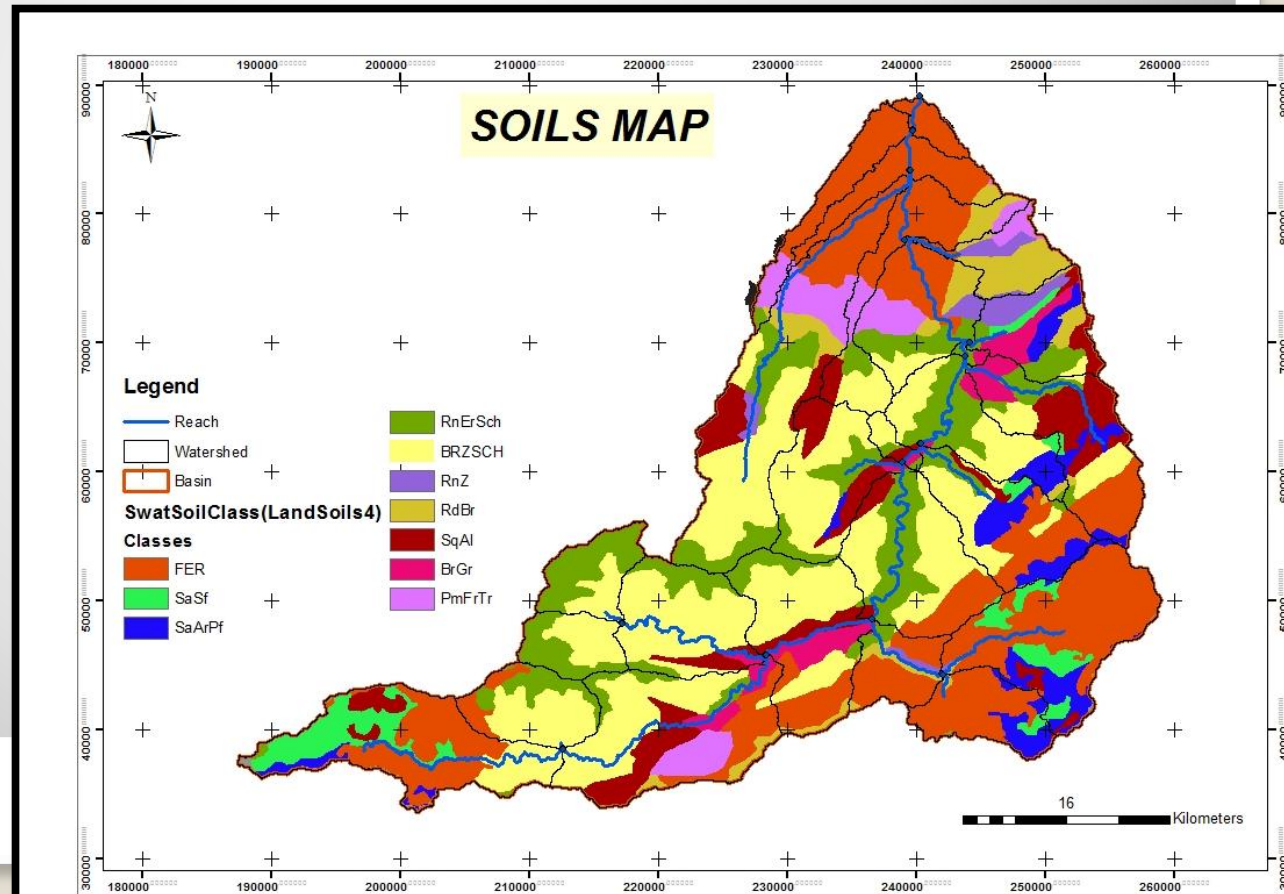
DEM 30m



Soils map

The soil units consist of type sandy and clay soils types are developed on primary shale on land eruptive and limestone . The main soils are listed :

- developed soils of ranker types
- The soil calcimagnesian rendzinas kind(brown limestone or lime)



Soils Analysis

The screenshot displays the ArcGIS Desktop interface with the 'User Soils Edit' dialog box open. The dialog box is titled 'User Soils Edit' and contains a list of soil types on the left and parameter input fields on the right. The 'PmFrTr' soil type is selected in the list. The parameters are organized into two sections: 'Soil Component Parameters' and 'Soil Layer Parameters'. The 'Soil Component Parameters' section includes fields for SNAM, NLAYERS, HYDGRP, SOL_ZMX (mm), ANION_EXCL (fraction), SOL_CRK (m3/m3), and TEXTURE. The 'Soil Layer Parameters' section includes fields for Soil Layer, SOL_Z (mm), SOL_BD (g/cm3), SOL_ALWC (mm/mm), SOL_CBN (% wt.), SOL_K (mm/hr), CLAY (% wt.), SILT (% wt.), SAND (% wt.), ROCK (% wt.), SOL_ALB (fraction), USLE_K, SOL_EC (dS/m), SOL_CAL (%), and SOL_PH. The 'Add New' button is disabled, while 'Cancel Edits', 'Save Edits', 'Delete', and 'Exit' are active.

User Soils Edit

Select Database to Edit

- User Soils
- Land Cover/Plant Growth
- Fertilizers
- Pesticides
- Tillage
- Urban
- User Weather Stations
- Septic WQ

Write Input Tables | Edit SWAT Input | SWAT Simulation

processing Customize Windows Help

Soil Component Parameters

SNAM	NLAYERS	HYDGRP
PmFrTr	2	B
SOL_ZMX (mm)	ANION_EXCL (fraction)	SOL_CRK (m3/m3)
60	0.5	0.5
TEXTURE		
SIL-SIL		

Soil Layer Parameters

Soil Layer: 1	SOL_Z (mm)	SOL_BD (g/cm3)
	30	1.84463396226415
SOL_ALWC (mm/mm)	SOL_CBN (% wt.)	SOL_K (mm/hr)
0.100455692210173	0.557142857142857	3.39302520747928E-4
CLAY (% wt.)	SILT (% wt.)	SAND (% wt.)
7.57097791798107	17.6656151419558	74.7634069400631
ROCK (% wt.)	SOL_ALB (fraction)	USLE_K
0	0.01	0.44345576287313
SOL_EC (dS/m)	SOL_CAL (%)	SOL_PH
73.5	0	0

Add New

Cancel Edits

Save Edits

Delete

Exit

Search

Local Search

ALL Maps Data Tools Images

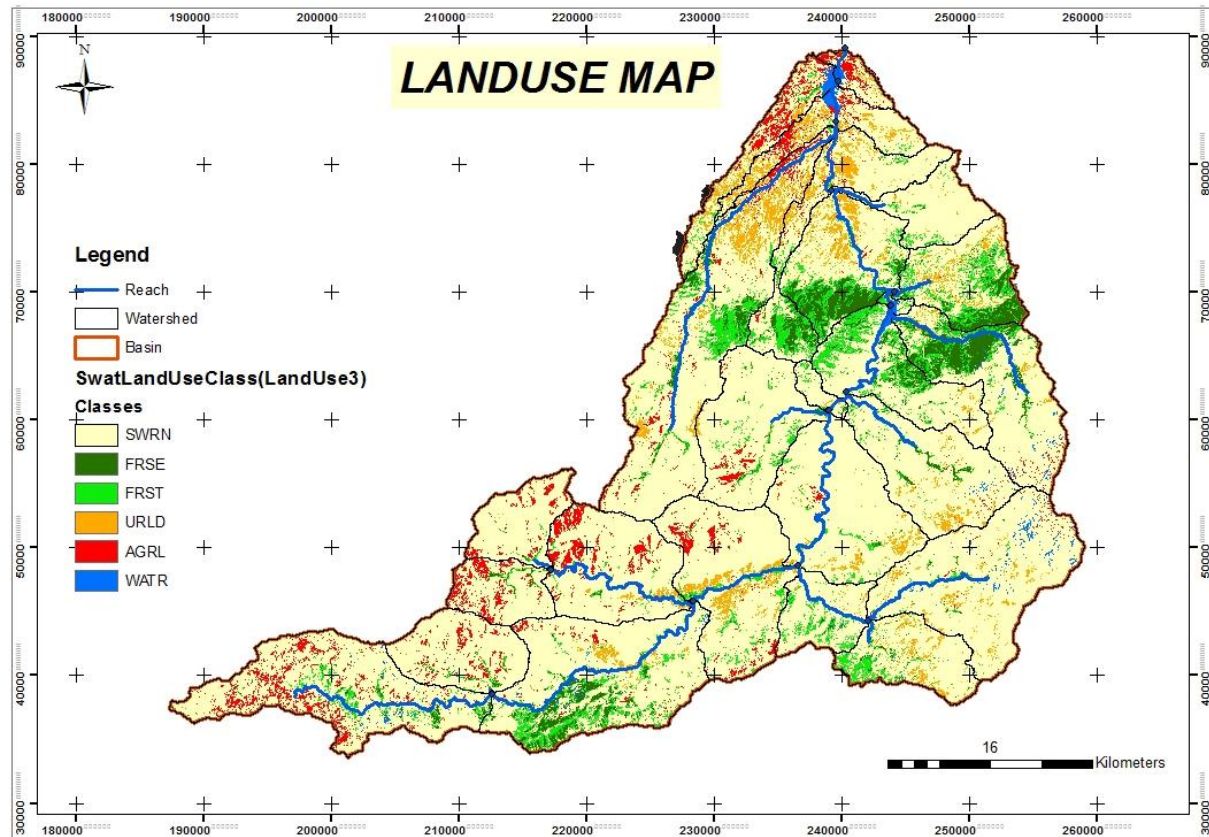
Any Extent

78.10 106.40 Inches

11:10 AM 6/24/2015

Landuse

Watershed N'fis distinguished by a diverse natural vegetation and includes two forest formations that take almost all of the basin area and are located mainly upstream it is the drill Goundafa and Aghbar. From the point of view of earth rotation, the cultural practice of the population reveals a predominance of cereal and a small part for arboriculture but remains insignificant.



Climat

- ❖ Precipitation *FROM* (ABHT)
- ❖ Temperature
- +
- ❖ Solar radiation
- +
- ❖ Relative humidity *FROM* (CFSR global weather)

Simulation

- Warm up 2 years
- Daily output 2000 to 2009

Setup and Run SWAT Model Simulation

Period of Simulation

Starting Date : Ending Date :

Min Date = 1/1/1998 Max Date = 12/31/2009

Rainfall Sub-Daily Timestep

Timestep: Minutes

Rainfall Distribution

Skewed normal

Mixed exponential

SWAT.exe Version

32-bit, debug 32-bit, release

64-bit, debug 64-bit, release

Custom (swatUser.exe)

Printout Settings

Daily Yearly Print Log Flow Print Pesticide Output

Monthly NYSKIP : Print Hourly Output Print Soil Storage

Print Soil Nutrient Route Headwaters Print Binary Output

Print Water Quality Output Print Snow Output Print Vel./Depth Output

Print MGT Output Print WTR Output Print Calendar Dates

Limit HRU Output

Set CPU Affinity

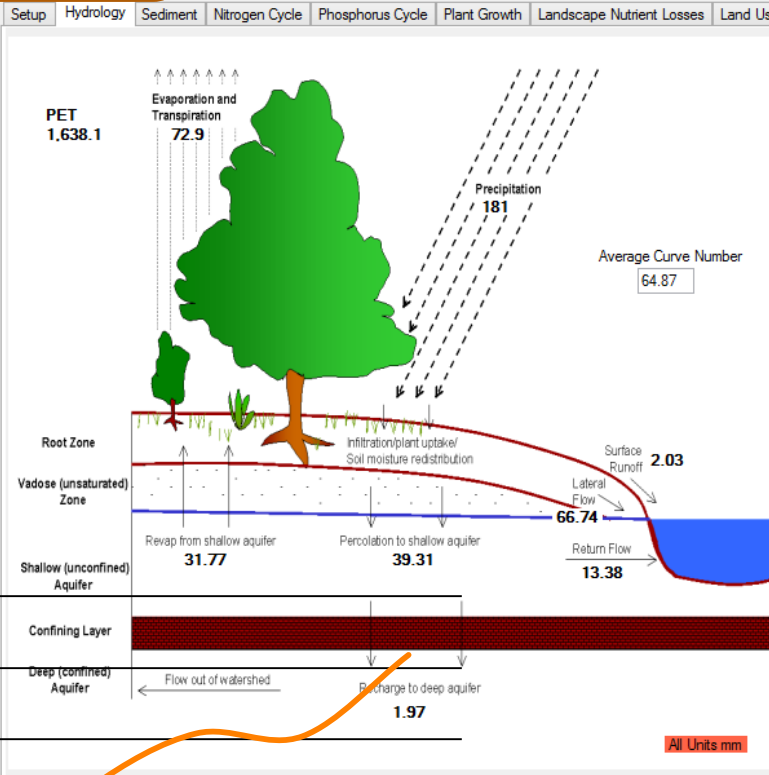
CPU ID:

Setup SWAT Run Run SWAT Cancel

Hydrologic Balance

ET 40% of precipitation

High permeability



Realistic hydrology is the foundation of any model. Pay particular attention to evapotranspiration, baseflow and surface runoff ratios. Baseflow/streamflow ratios for the US are provided by the USGS, data are accessible via the button below. The ranges specified here are general guidelines only, and may not apply to your simulation.

Show Avg. Monthly Basin Values

Show US Baseflow

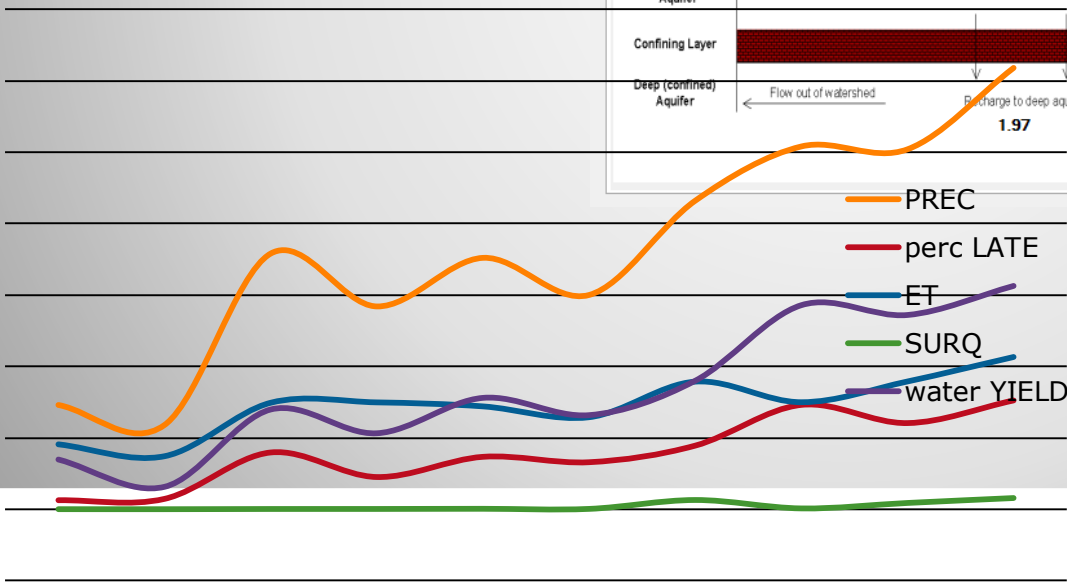
Messages and Warnings

Surface runoff ratio may be low (< 0.2)
 Groundwater ratio may be low
 Lateral flow is greater than groundwater flow, may indicate a problem
 Water yield may be excessive
 Surface runoff may be too low

Water Balance Ratios

Streamflow/Precip	0.45
Baseflow/Total Flow	0.98
Surface Runoff/Total Flow	0.02
Perc/Precip	0.22
Deep Recharge/Precip	0.01
ET/Precipitation	0.4

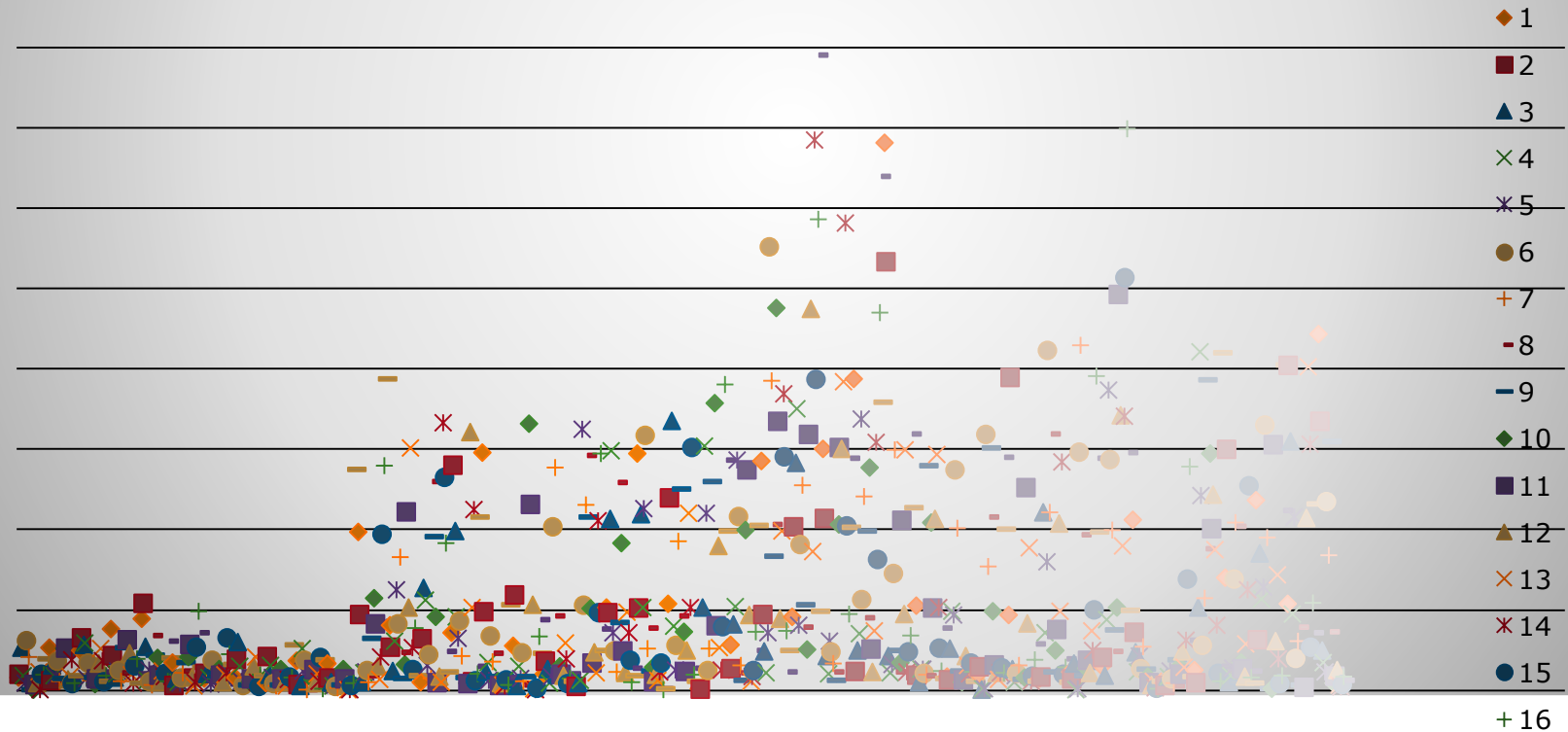
— PREC
 — perc LATE
 — ET
 — SURQ
 — water YIELD



Results

The ratio vary between 10 to 70 t/ha/yr Average Ratio=19 t/ha/an ,and maximum ratio is 160 t/ha/an

Annual average Erosion distribution ratio by HRU

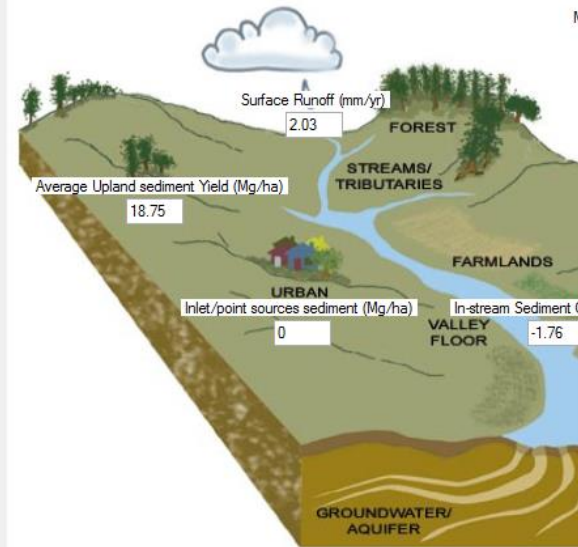


Results

SWAT Error Checker Version 1.1.1.0 Released February 26, 2017

Average value 32.22t/ha

Setup Hydrology Sediment Nitrogen Cycle Phosphorus Cycle Plant Growth Landscape Nutrient Losses Land Use Summary Instream Processes Point Sources Reservoirs Ab



Maximum upland sediment yield (Mg/ha)
158.09

Sediment loss from the landscape is dependent upon r factors. Sediment overestimation in SWAT is most cor due to inadequate biomass production. This often occ specific land uses. If your maximum upland sediment y excessive, use the landuse summary tab to identify the land use.

SWAT also modifies sediments to account for in-stream deposition and erosion of stream banks and channels. there is little or no measured data to differentiate betwe upland sediment and in-stream sediment changes. Stre be either a net source of sediment, or a sink. In-stream sediment modification is impacted by physical channel characteristic 's (slope, width, depth, channel cover, ar

Erosion rate by sub_basin



Legend

MonitoringPoint

• <all other values>

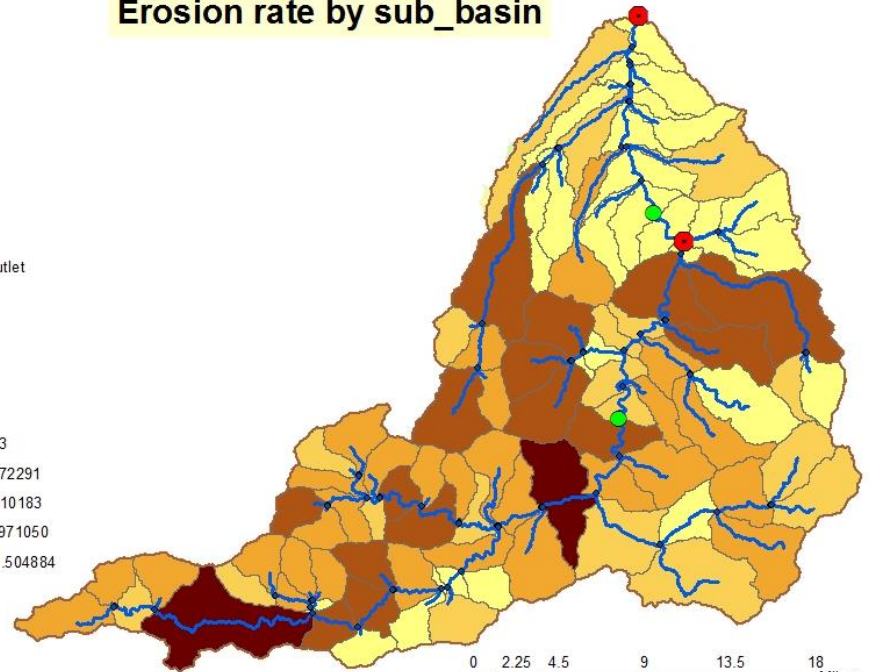
Type

- ◆ Linking stream added Outlet
- Manually added Outlet
- Reservoir
- Reach

sed

erosion_su

- 0.000000 - 11091.705273
- 11091.705274 - 27315.472291
- 27315.472292 - 53917.410183
- 53917.410184 - 111032.971050
- 111032.971051 - 169811.504884
- Watershed
- Basin



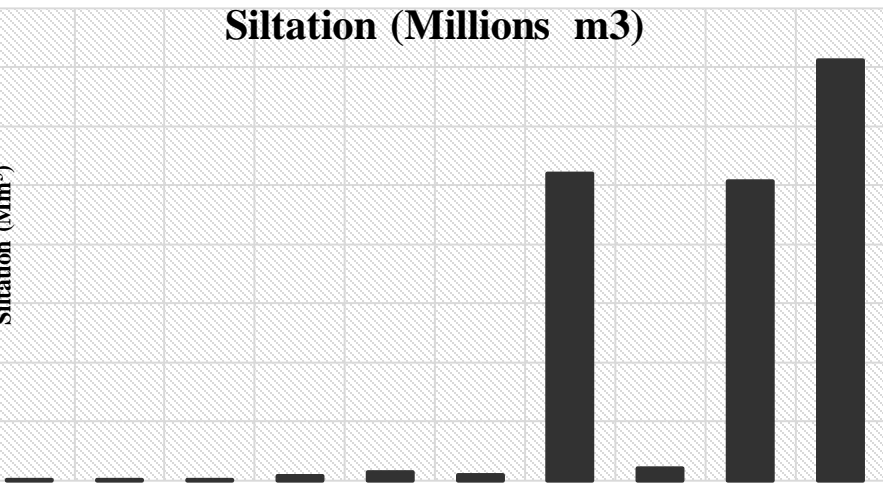
0 2.25 4.5 9 13.5 18 Miles

Results

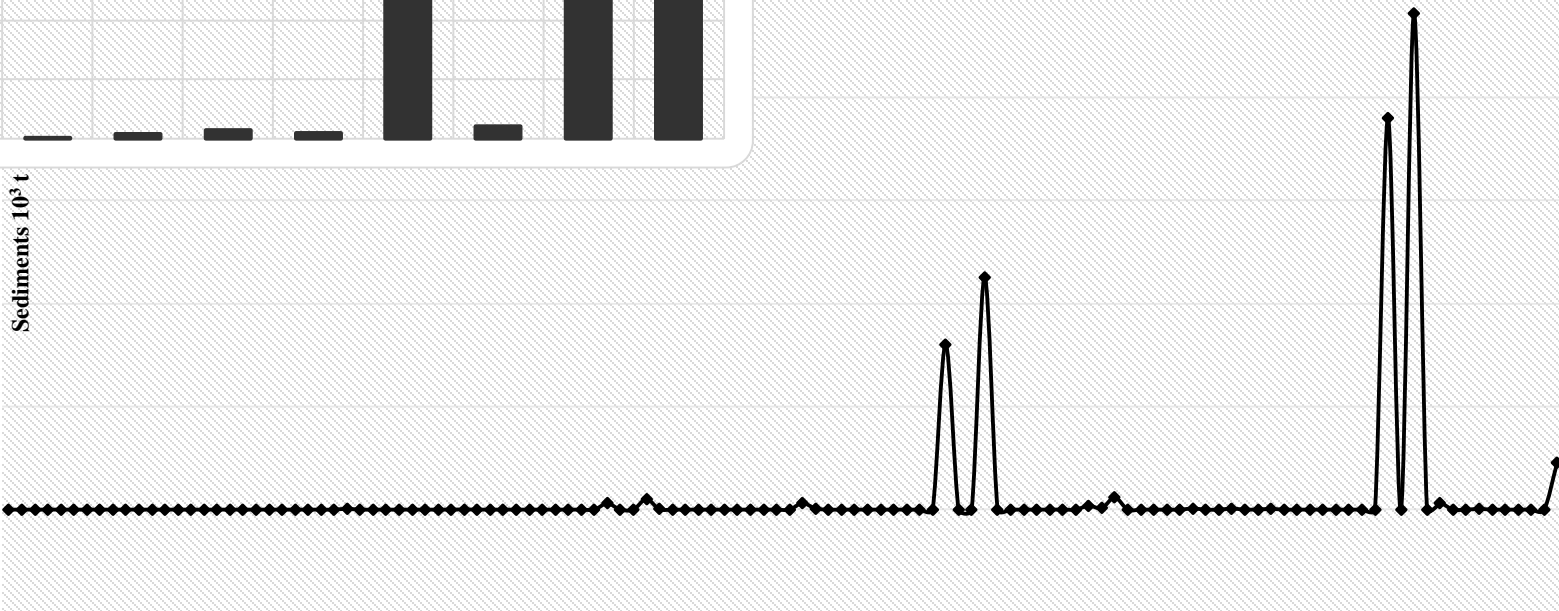
Siltation 1.8mm³/yr .

for the monthly changes in sediment supply to the dam Lalla takerkoust it reacts by runoff process

ed. this figure shows that most of the sediment that reaches the dam is completed in period of floods



Sediments 10³ t



Conclusion and perspective

- **Quantify solid load by sub-basin to identify the most influenced in the process of erosion**
- **Collecting more climatic data and MES for calibration and validation of the model**
- **The study can be continued in the same method in neighboring watersheds in order to compare results and also for a regional study that is to say, locate areas at risk in the Tensift basin**



Barrage Takerkoust

Toubkal, 4106 m

2015 SWAT international Conference
SARDINIA, ITALY

Marrakech

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Oued Tensift

Supervisor: Pr
:N.Laftrouhi

Amal Markhi: Phd
Student