Evaluation of the SWAT Model Setup Process Through A Case Study in Roxo Catchment, Portugal

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1. INTRODUCTION - Background

- This study was performed in the context of "Individual Final Assessment (IFA)" to fulfill the requirements of Master Degree in Geo-Information and Earth Observation in ITC International Institute in 2006, Enschede, NL.

- Focus of the study: "*How to gather data to setup a SWAT Model?*" rather than "*How to model?*".

- Also, data accuracy and, the sensitivity of the model to some parameters were checked in terms of data quality needs.

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1. INTRODUCTION - SWAT Setup Steps

The sequence of the key procedures for a SWAT model application (Di Luzio et al., 2002):

1. Delineate the watershed and define the HRUs
2. (Optional) Edit weather and soil databases (which is in fact necessary for the SWAT applications outside the U.S.)
3. Define the weather data
4. Apply the default input files writer
5. (Optional) Edit the default input files
6. Set up and run SWAT
7. (Optional) Apply a calibration tool
8. (Optional) Analyze, plot and graph SWAT output

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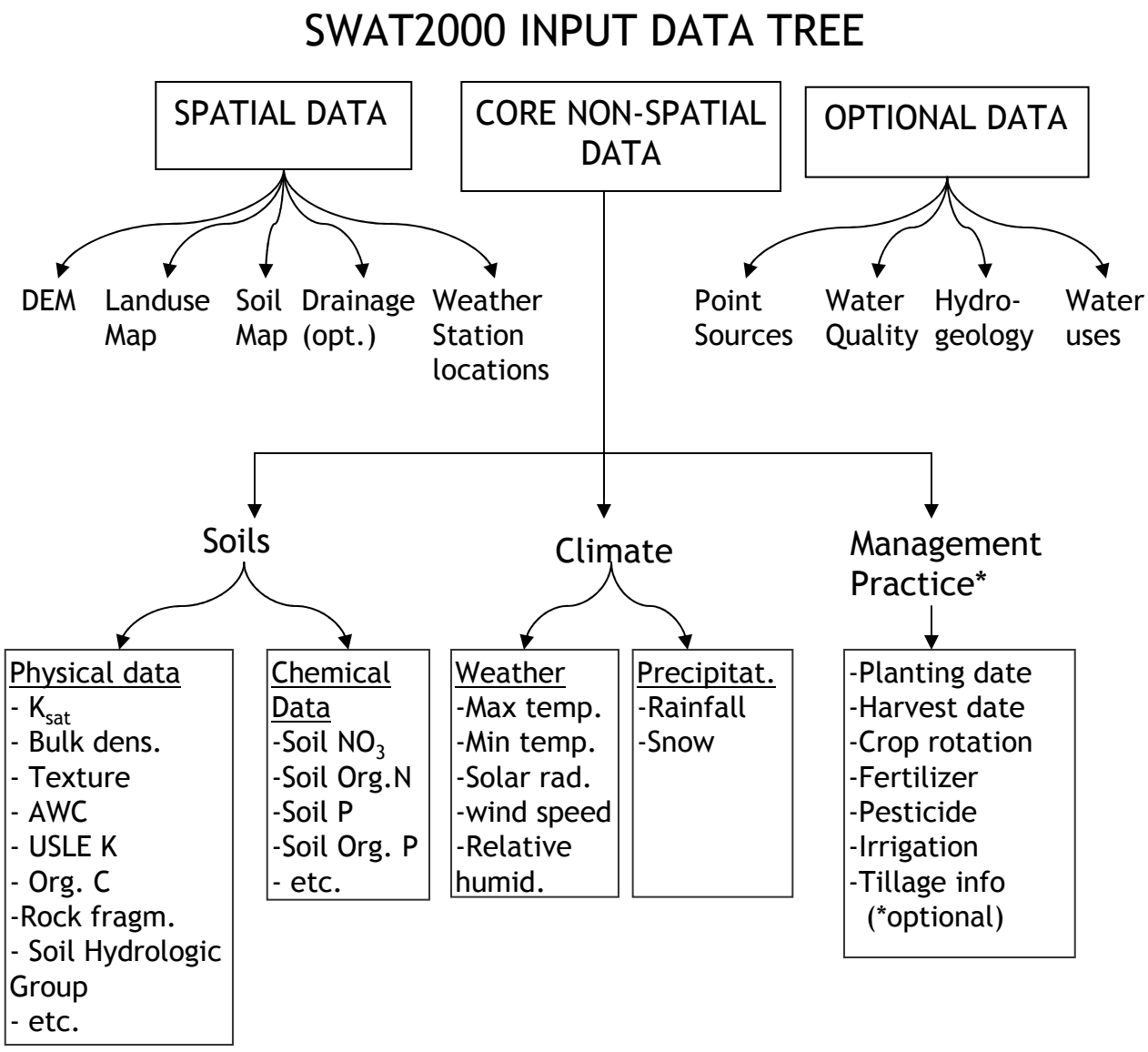
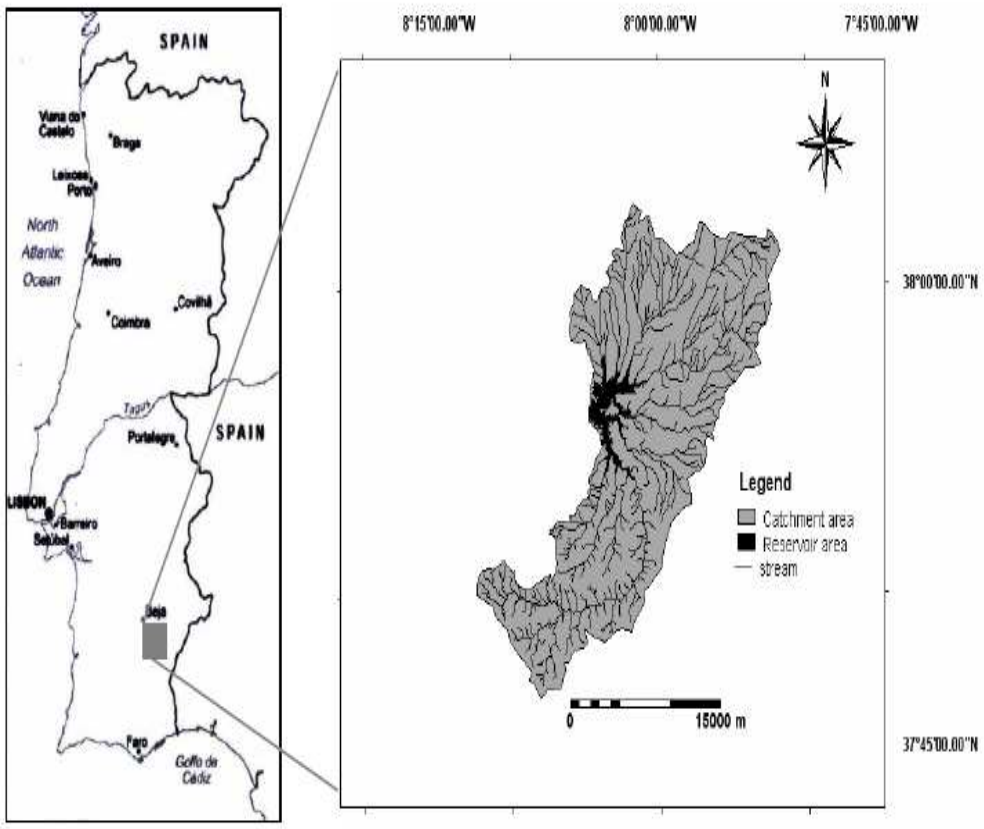
1. INTRODUCTION - Why Data Needed?



2. METHODOLOGY – Study Area



- Roxo reservoir catchment is located at Beja district of Alentejo Province in southern Portugal.

Area:	353.2 km^2
Roxo reservoir:	13.8km^2 (seasonal variation)
Elevation:	122.5 – 280 masl. (ranging flat to gently slope)
The climate:	Mediterranean with warm winter and dry summer
Landuse:	mainly agriculture (both rain-fed and irrigated)

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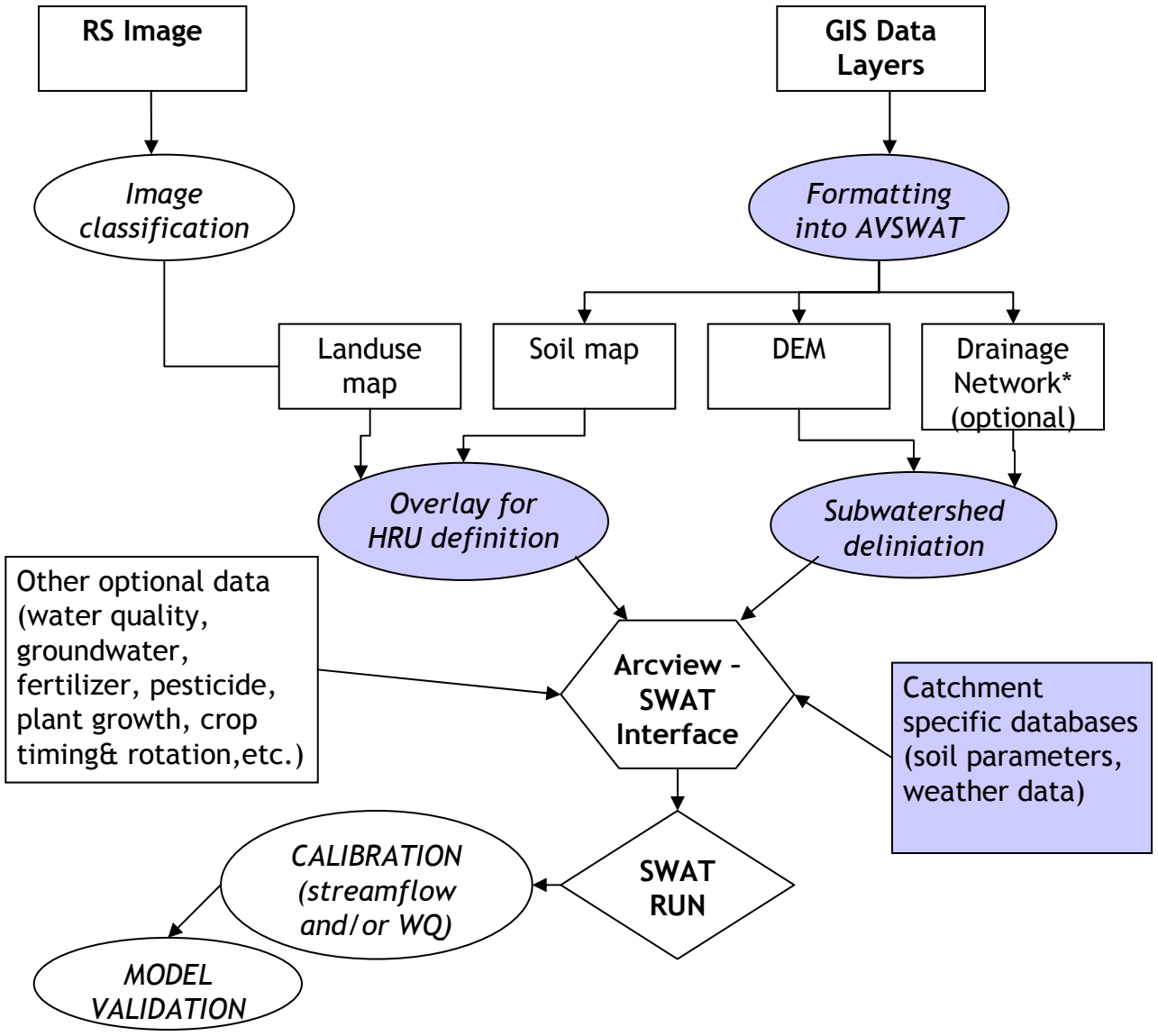
2. METHODOLOGY - Model Preparation

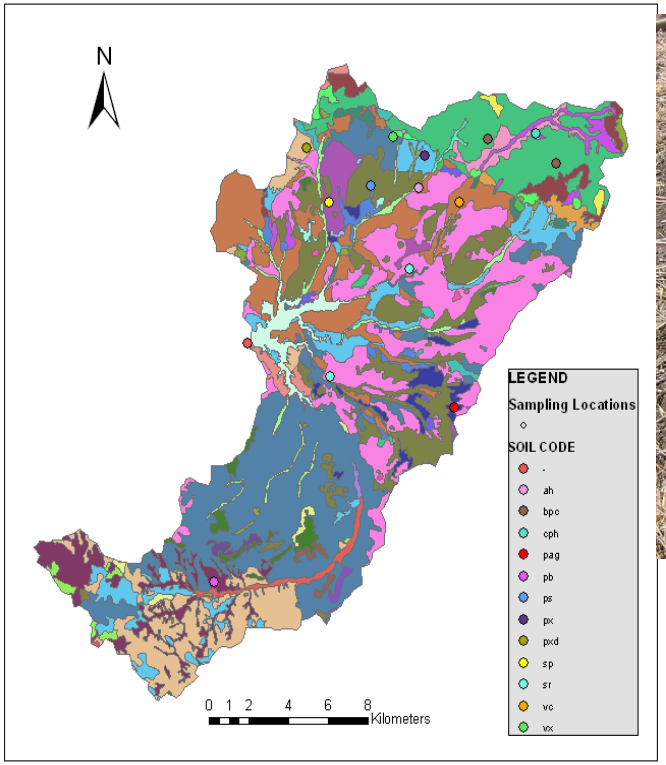


2. METHODOLOGY - Fieldwork & Lab Analyses

Date and place: 05-11th July 2006, Roxo catchment, Portugal

Purpose: Soil data for the SWAT Model

Planning (Mobile GIS in the field!)



Soils sampled > 1% represented in the catchment

Fieldwork

- Undisturbed soil samples in rings (duplicated in each sampling site)
- Mixed soil in plastic bags (Several points around the sampling site and above 200gr in total)

Lab Analyses

Physical Parameters: Ksat, Bulk Denisty and Particle Size Distribution.

Chemical Parameters: Organic Matter Content, N content, P Content.

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3. RESULTS – Soil Physical Data

Part1. Physical data by soil type															
Parameter	***Explanation***	***Range***	***Unit***	***Source of data***	**SOILS ROXO**										
SNAM	Soil name			Soil map	***Cph***	***Bpc***	***Px***	***Vx***	***Sr***	***Vc***	***Ah***	***Ps***	***Sp***	***Pxd***	***Pb***	***Pag***
NLAYERS	# of layers in the soil	1-10		assumed 1 for all	1	1	1	1	1	1	1	1	1	1	1	1
HYDGRP	Soil hydrologic group	A-D		S.H.G Table by US Soil Cons. Service	C	D	C	B	A	B	D	B	A	A	C	B
SOIL_ZMX	Maximum rooting depth of soil profile	0-3500	mm	(SWAT default value!)												
ANION_EXCL	Fract. of porosity	0.01-1.0	fraction	(SWAT default value!)												
SOIL_CRK	Crack vol. pot. of soil	0-1.0	m3/m3	(SWAT default value!)												
TEXTURE	Texture of soil (optional)	Optional		SWC Calculator based on P.S.D.	Clay	Clay	Clay loam	Clay loam	Clay loam	Clay loam	Clay loam	Loam	Silty clay loam	Loam	Clay loam	Silty loam
Part2. Physical data by soil layer																
Parameter	***Explanation***	***Range***	***Unit***		Cph	Bpc	Px	Vx	Sr	Vc	Ah	Ps	Sp	Pxd	Pb	Pag
SOIL_Z	Depth from soil surf. to bottom of layer	0-3500	mm	Soils Portugal Report	200	250	175	165	360	330	200	250	620	150	150	100
SOIL_BD	Moist bulk density	1.1-2.5	g/cm3	Laboratory Results	1.51	1.87	1.81	1.87	1.97	1.54	1.52	1.66	1.79	1.59	1.55	1.69
SOIL_AWC	AWC of the soil layer	0-1.0	mm/mm	SWC Calculator based on P.S.D.	0.12	0.12	0.13	0.13	0.13	0.12	0.12	0.13	0.15	0.13	0.12	0.12
SOIL_K	saturated hydraulic conductivity	0-2000	mm/hr	Laboratory Results	2.16	0.78	3.12	7.44	17.1	7.56	1.02	5.52	7.68	11.8	4.08	5.88
SOL_CBN	Organic carbon content	0.05-10	%	Laboratory Results (from chemical analy.)	1.0	0.9	1.3	1.1	0.9	1.4	0.9	1.3	1.5	1.7	0.9	0.8
CLAY	Clay content	0-100	%	Laboratory Results	42.6	46.9	40.6	35.5	35.5	36.5	44.8	27.0	36.6	29.0	37.4	25.3
SILT	Silt content	0-100	%	Laboratory Results	23.1	22.6	32.1	31.9	29.5	24.6	21.6	36.0	41.0	32.4	31.4	34.8
SAND	Sand content	0-100	%	Laboratory Results	34.4	30.5	27.3	32.7	35.0	38.9	33.7	37.0	22.5	38.6	31.1	39.9
ROCK	Rock fragment content	0-100	%	Laboratory Results	5.8	2.6	14.3	17.5	16.8	8.9	16.6	15.5	12.8	23.3	17.6	26.1
SOL_ALB	moist soil albedo	0.0-0.25	fraction	SWAT default value												
USLE_K	USLE equation soil erodibility factor	0.00-0.65	0.013 t m^2 hr (m^3 t cm)	Spreadsheet by C.M. (Geometric mean particle diameter)	0.329	0.318	0.320	0.333	0.333	0.333	0.324	0.330	0.320	0.331	0.331	0.321

3. RESULTS - Possible data sources

SPATIAL DATA SOURCES:

Digital Elevation Model (DEM)

1) Contour map of the area

2) Toposheets

3) Global SRTM data (90m resolution)
http://srtm.usgs.gov/index.htm

Landuse Map

1) RS image (image classification)

2) Internet resources
- European Corine Landcover database (EEA), 1:100,000 or 1:500,000 scale
http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667
- Global landcover (1992-1996), 1km resolution,
http://edcdaac.usgs.gov/1km/comp10d.asp

Soil Map

1) Soil maps (digital preferably) from national, regional authorities

2) Internet resources
-European digital archive on soil maps of the world
http://eusoils.jrc.it/esbd_archive/EUDASM/indexes/access.htm
- World Soil Information (global, regional, national maps)
www.isric.org/UK/About+Soils/Soil+data/

River network

1) Digitizing from toposheets

2) Drainage extraction from available DEM

3) An online global hydrograph, derived from 1km resolution
http://edcdaac.usgs.gov/gtopo30/hydro/index.asp

4) JRC River and Catchment Database for Europe
http://agrienv.jrc.it/activities/catchments

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3. RESULTS - Possible data sources

SOURCES FOR CORE NON-SPATIAL DATA:

Climate

1) Meteorology data providers (national, regional)

2) Internet resources
-www.worldclim.org
(global climate grids with 1km^2 resolution)

- World's largest archive of climate data
www.ncdc.noaa.gov/oa/ncdc.html

Soil

1) Fieldwork & laboratory analyses

2) Literature data (especially on texture) in combination with Soil Water Characteristics program.

3) Internet resources
- World Soil Information
www.isric.org/UK/About+Soils/Soil+data/

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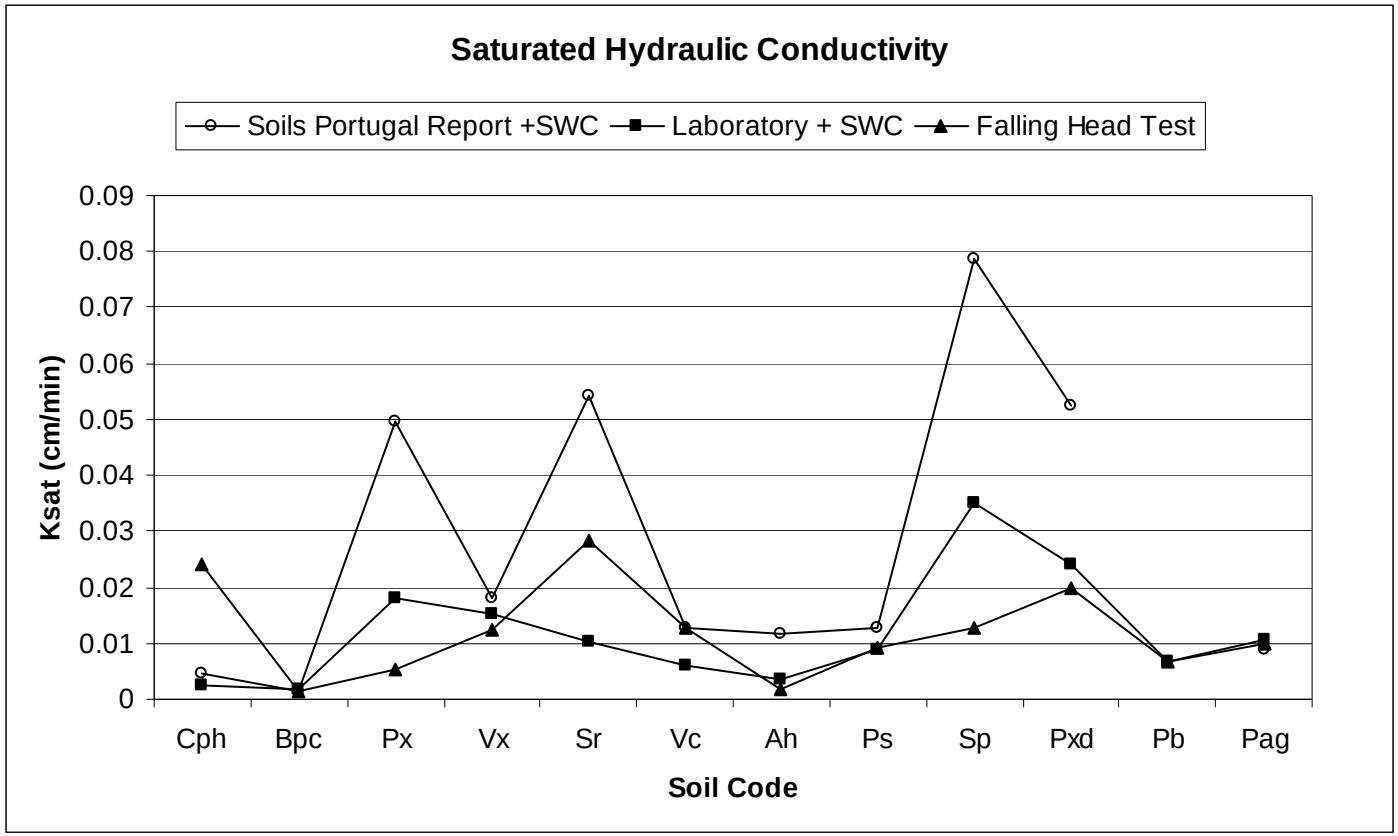
3. RESULTS - Data Accuracy

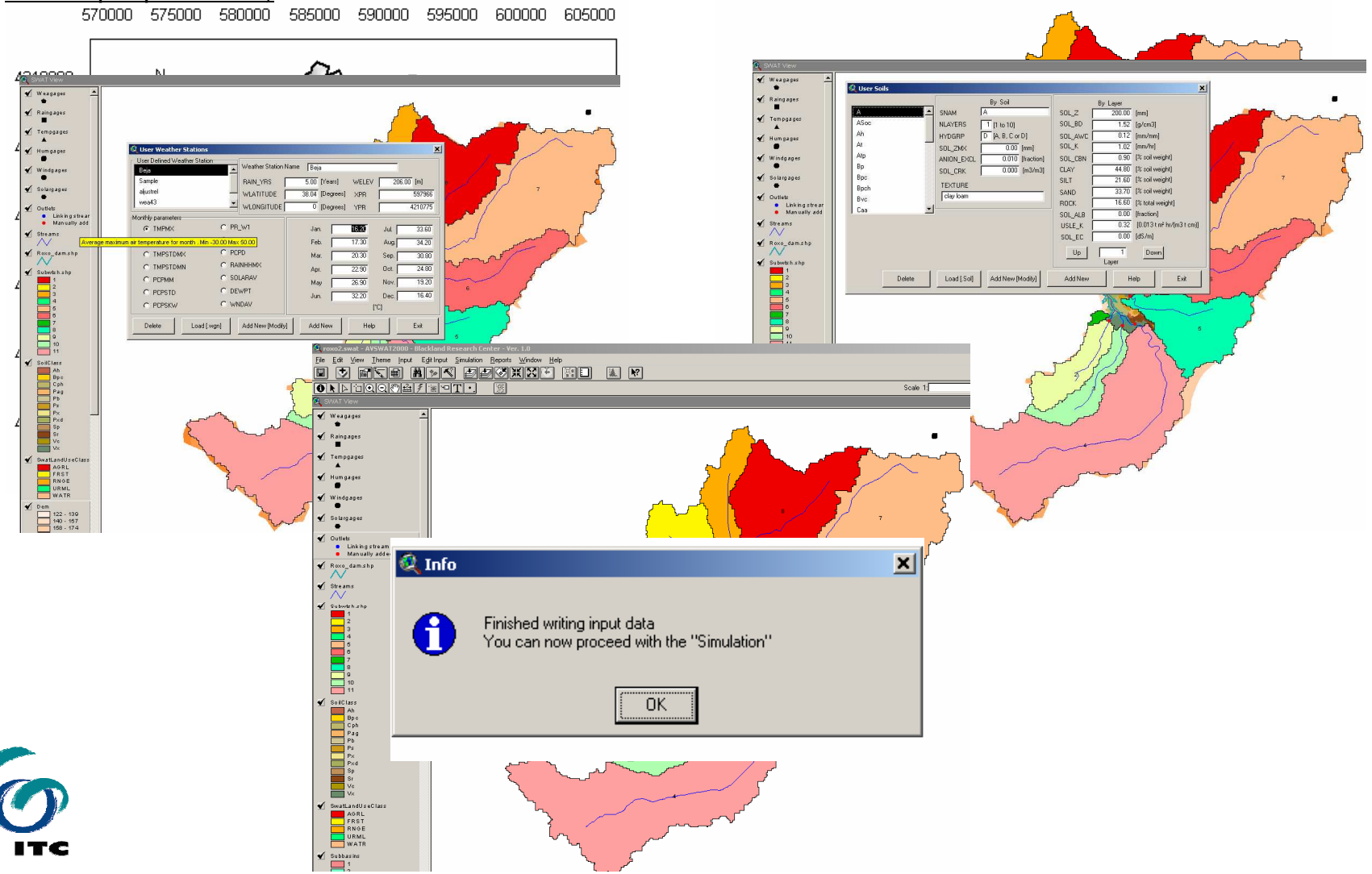


*SWC - Soil Water Characteristics: Hydraulic Properties Calculator. Available at: http://hydrolab.arsusda.gov/soilwater/Index.htm.

3. RESULTS – Model setup

SWAT for Roxo Catchment is ready to run!

(Watershed delineation + HRU and Sub-watershed definition + Edit weather and soil databases + Define weather data + Write input parameter)



3. RESULTS - Parameter Sensitivity

Sensitivity of the SWAT Model to the Soil AWC (Available Water Capacity) Parameter

	Qout (m^3/s)		
Sub basin	AWCini	AWCini +0.05	% change
1	2.397	2.185	-0.09
2	0.099	0.092	-0.08
3	0.091	0.084	-0.08
4	0.090	0.084	-0.08
5	0.606	0.560	-0.08
6	0.102	0.091	-0.12
7	0.137	0.123	-0.11
8	0.297	0.269	-0.10
9	0.496	0.449	-0.10
10	0.227	0.205	-0.11
11	0.198	0.179	-0.10
		Avg=	**-0.10**

	Qout (m^3/s)		
Sub basin	AWCini	AWCini -0.05	% change
1	2.397	2.704	0.14
2	0.099	0.110	0.13
3	0.091	0.102	0.13
4	0.090	0.100	0.12
5	0.606	0.674	0.12
6	0.102	0.118	0.16
7	0.137	0.156	0.15
8	0.297	0.338	0.15
9	0.496	0.564	0.14
10	0.227	0.258	0.14
11	0.198	0.224	0.14
		Avg=	**+0.14**

*Model Run from 1999 to 2004. First year is for priming the model.
Q is the average of 4 yrs run.

4. DISCUSSION AND CONCLUSION

- How long does a SWAT Model Setup take?

  - EU funded EUROHARP Project made a rough estimation of 3-4 months necessary to setup, run, calibrate and validate the SWAT Model (starting from available data).

  - Roxo case: Data collection and setup of main components of SWAT with an initial run was reached within 6 weeks.

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4. DISCUSSION & CONCLUSIONS

Some lessons learned!

- Importance of “how to get model input data” rather than “how to model with default values”
- Necessity for implementation of an effective data collection strategy: determination of sensitive parameters, utilization of appropriate data warehouses and GIS, complementary fieldwork and laboratory analyses.
- When planned and implemented properly,
  fieldwork + laboratory + other tools (Mobile GIS, Freeware Application Tools- SWC Calculator (USDA), spreadsheets and GIS) were found very effective and feasible to establish a data hungry model like SWAT within a reasonable time and budget!

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THANK YOU…

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