Modeling of a River Basin Using SWAT Model and SUFI-2

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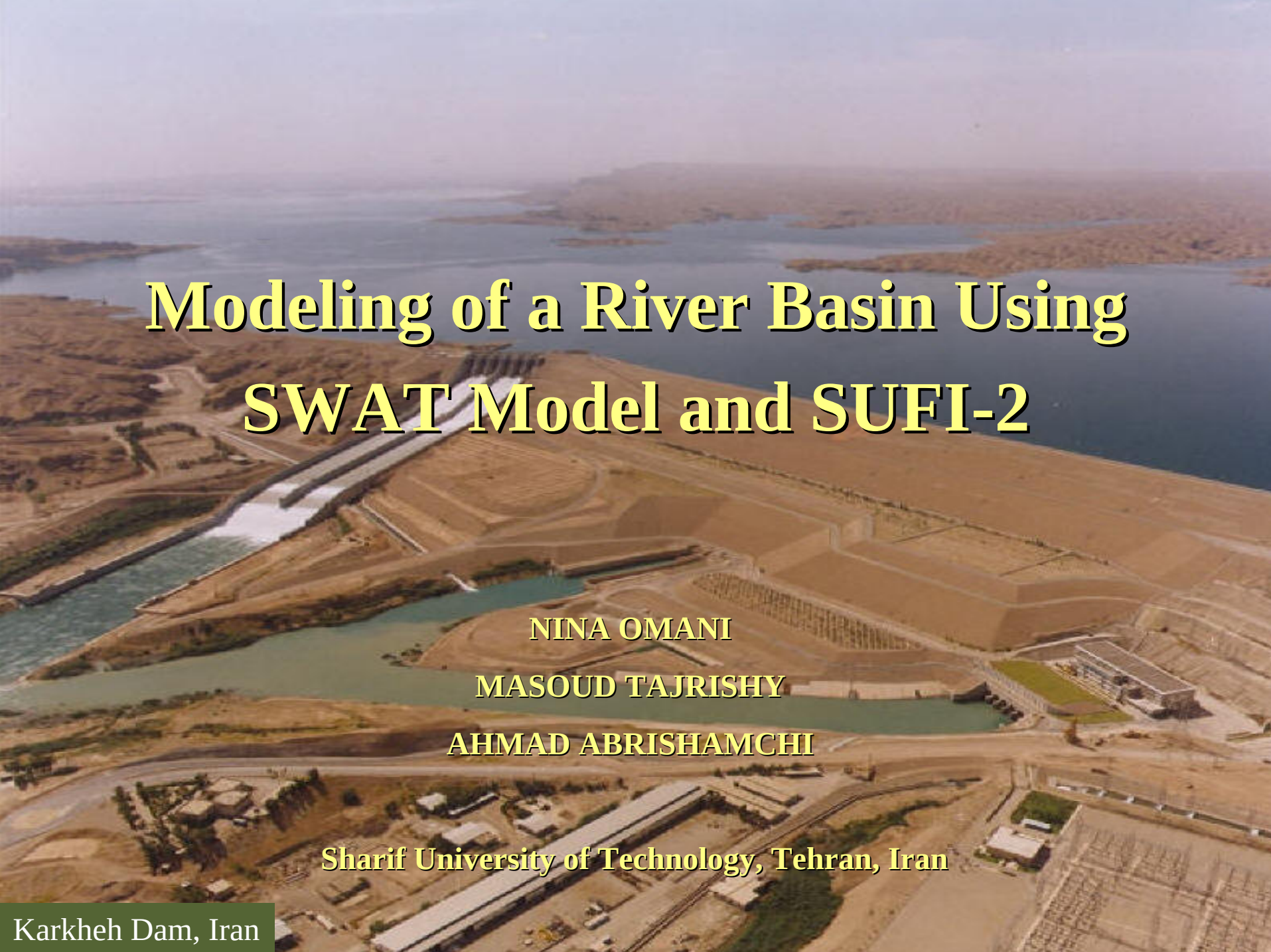
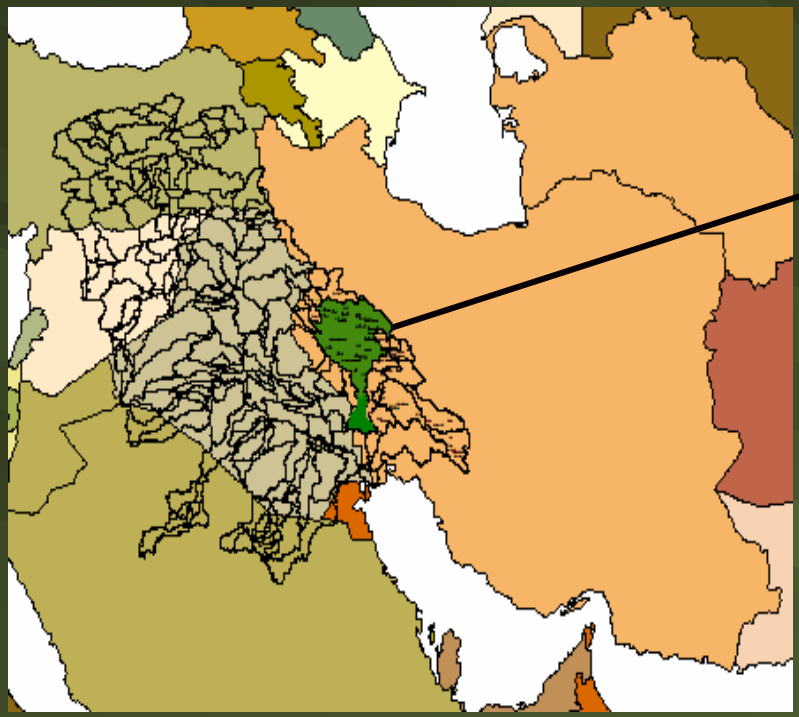
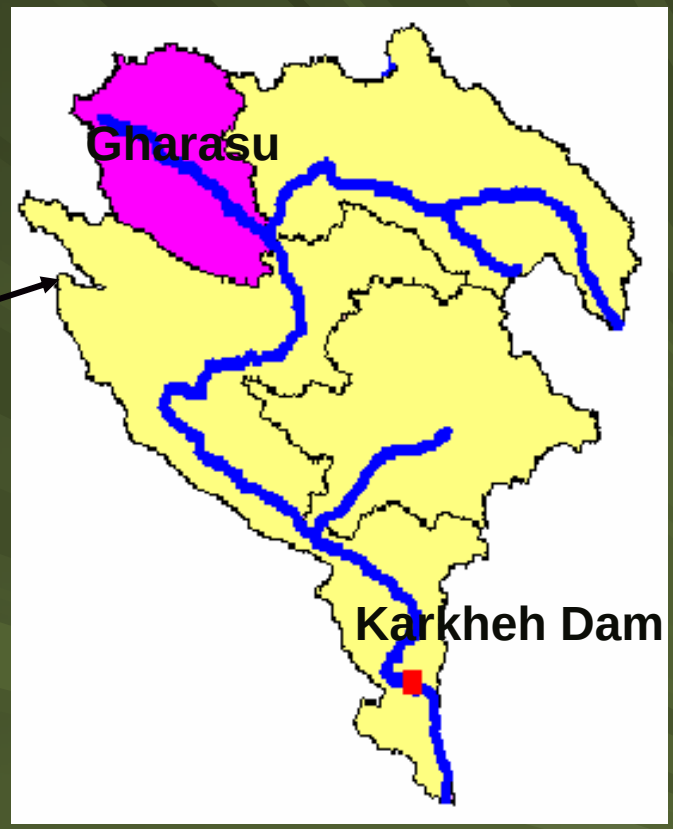


Karkheh Dam, Iran

Area of Gharasu Sub-basin : 5793 km2



Location of Karkheh river basin in Iran

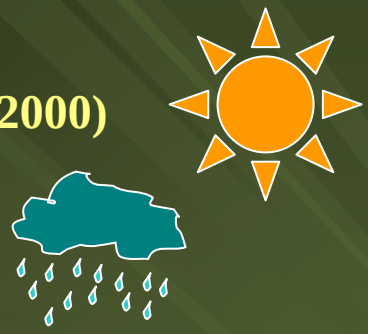


Location of Gharasu sub-basin in Karkheh River Basin

The main problem of Gharasu sub-basin is conversion of rangelands to rain-fed crop in hilly lands without any conservation practices.

This cause high erosion because most of the fields are located on steep slope.

Data Files



Daily maximum and minimum temperature (1988-2000)

Daily rainfall (1988-2000)

Location and elevation of climate stations

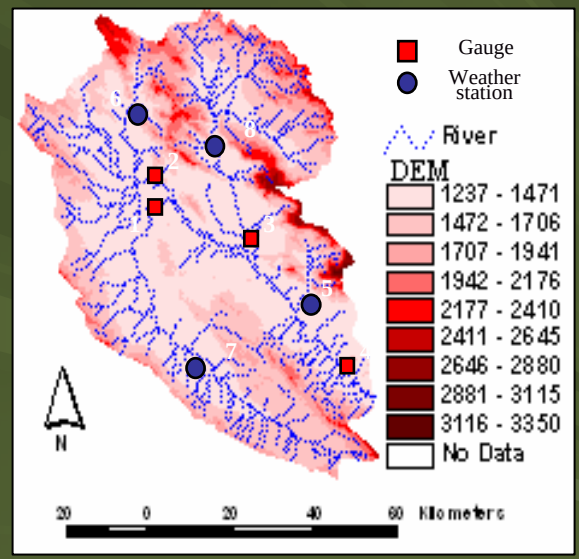
Simulated Required Input Data

Relative humidity

Wind speed

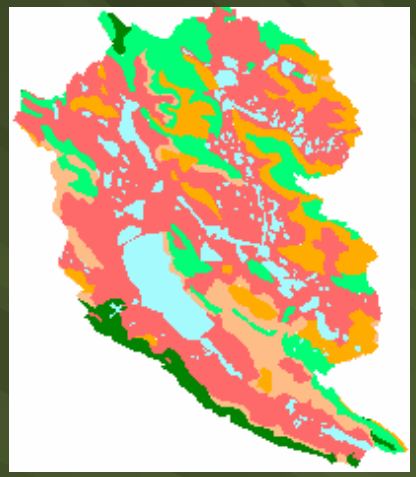
Potential evapotranspiration

Solar radiation



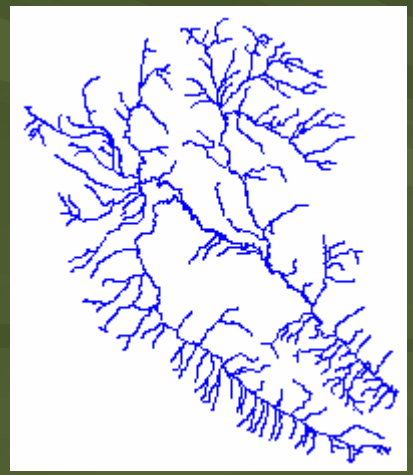
Information Layers

DEM



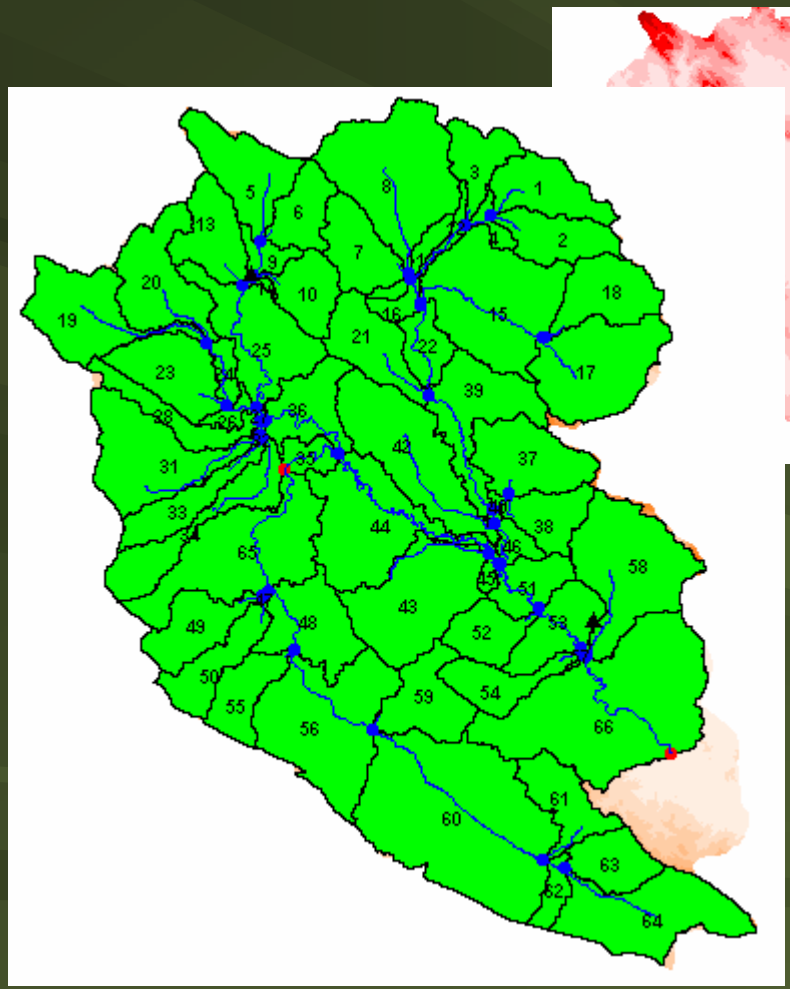
Land use

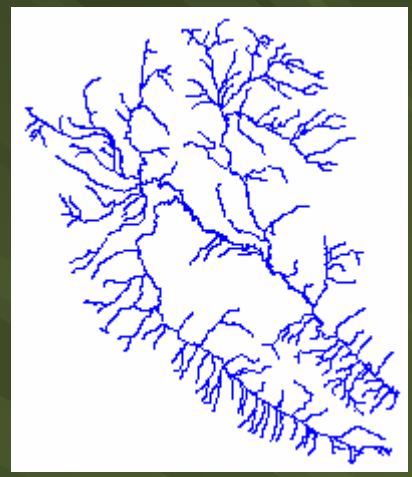
Soil

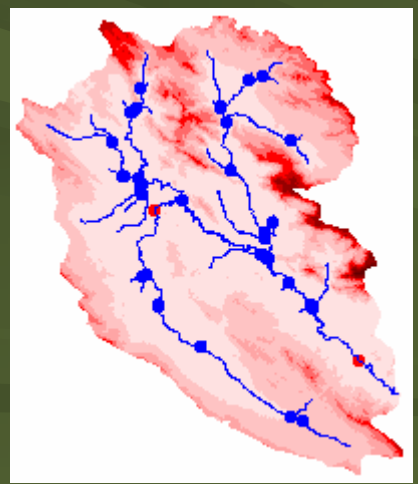


Hydrography

Watershed Delineation

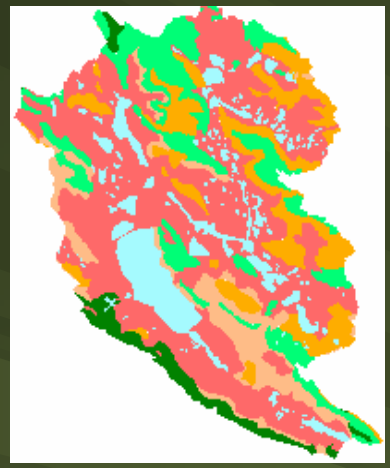






66 Sub-basins

Land Use

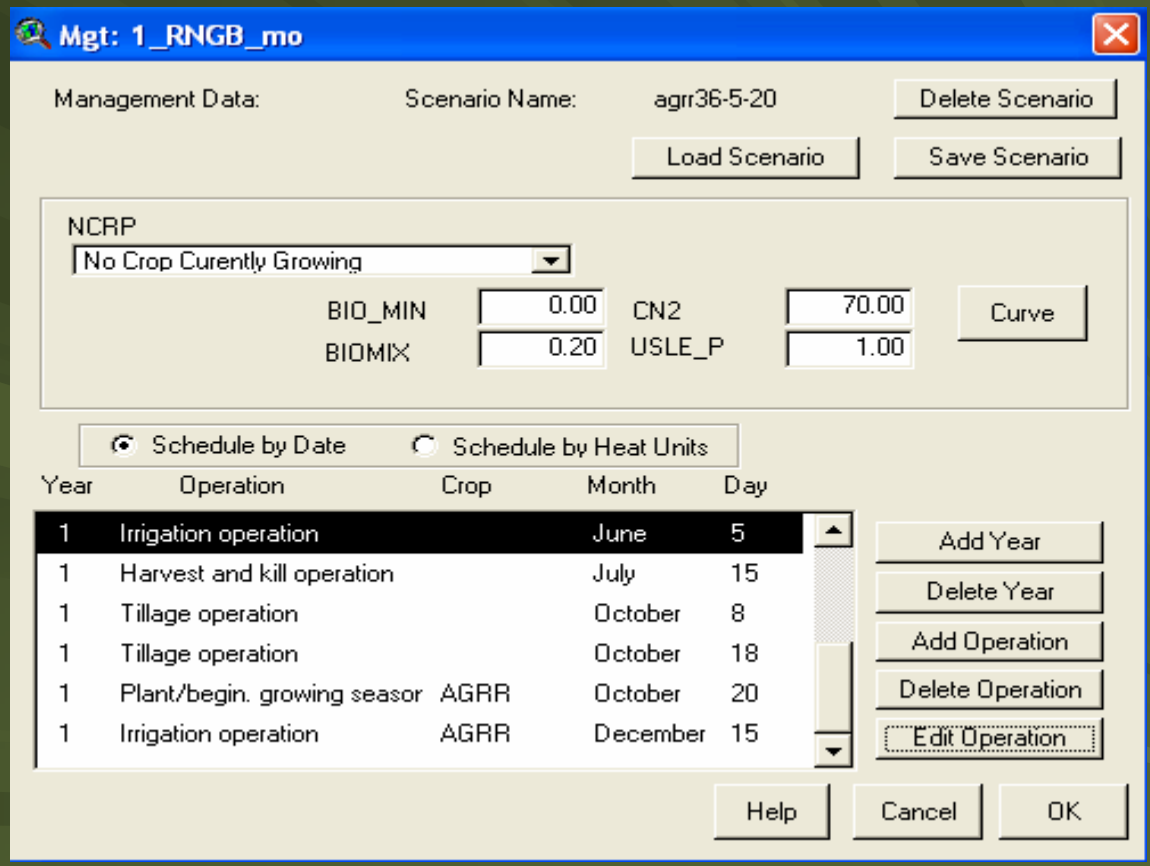


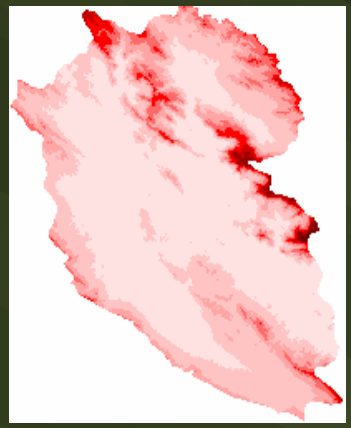
Soil

437 HRU’s

Management Data and Water Consumption

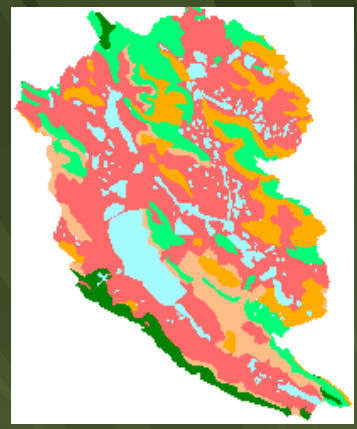
- Planting Operation
- Harvest and Kill Operation
- Tillage Operation
- Irrigation Operation
- Grazing Operation





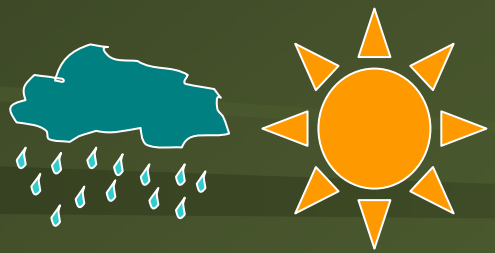
DEM

Soil

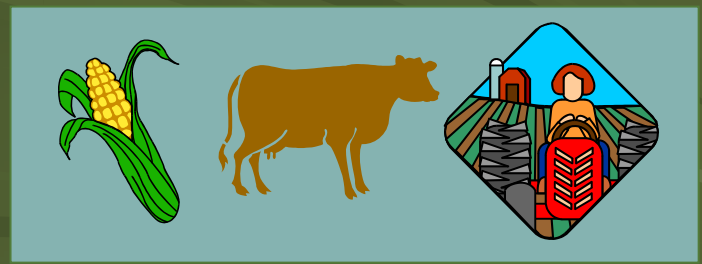


Land Use

SWAT Model



Climate

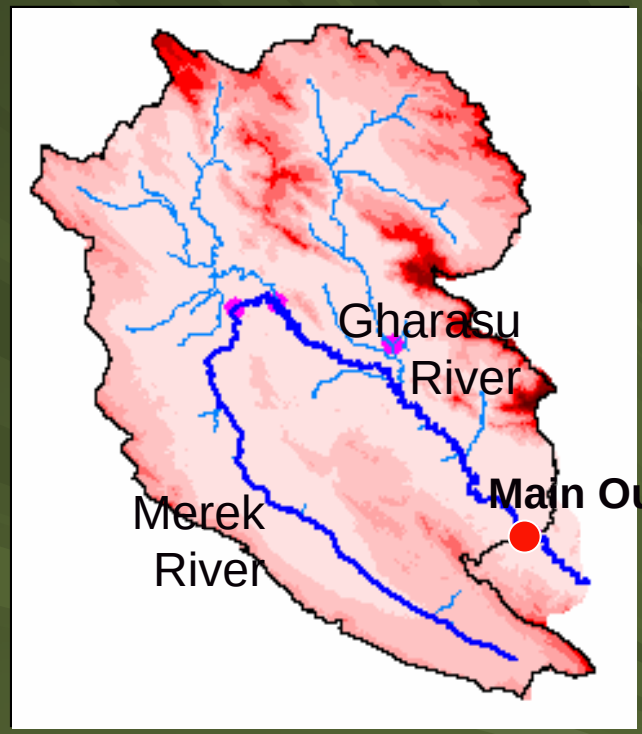


Land and Agriculture Management

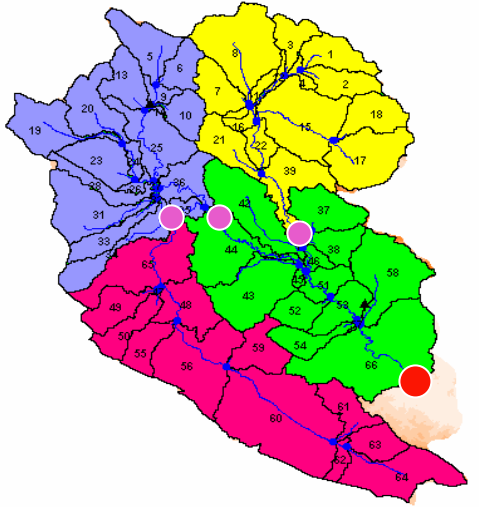
Plains

Merek River

Rivers



Main River

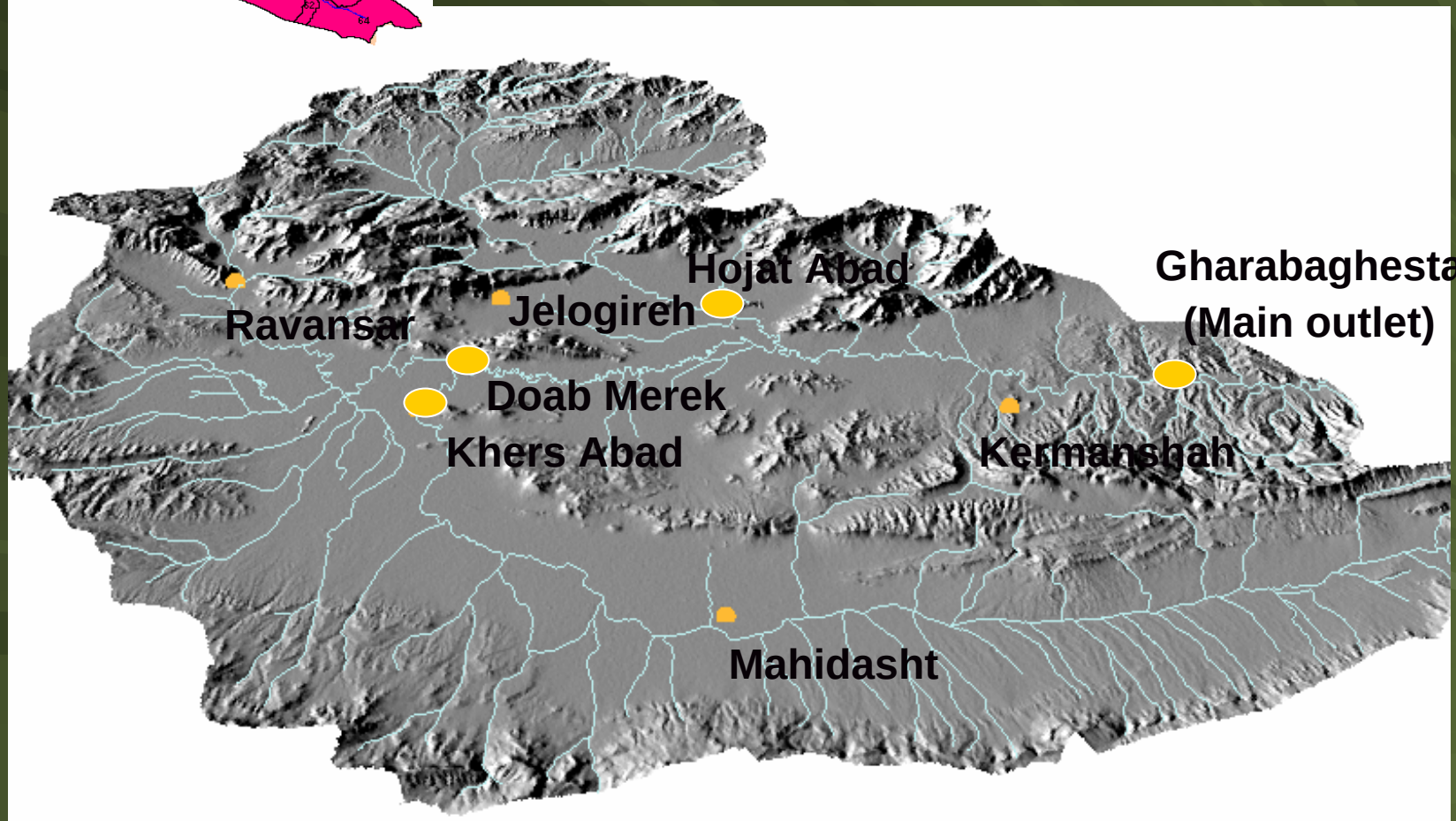


Location of stream gauges and climate stations

Warm-up period : 1987-1990

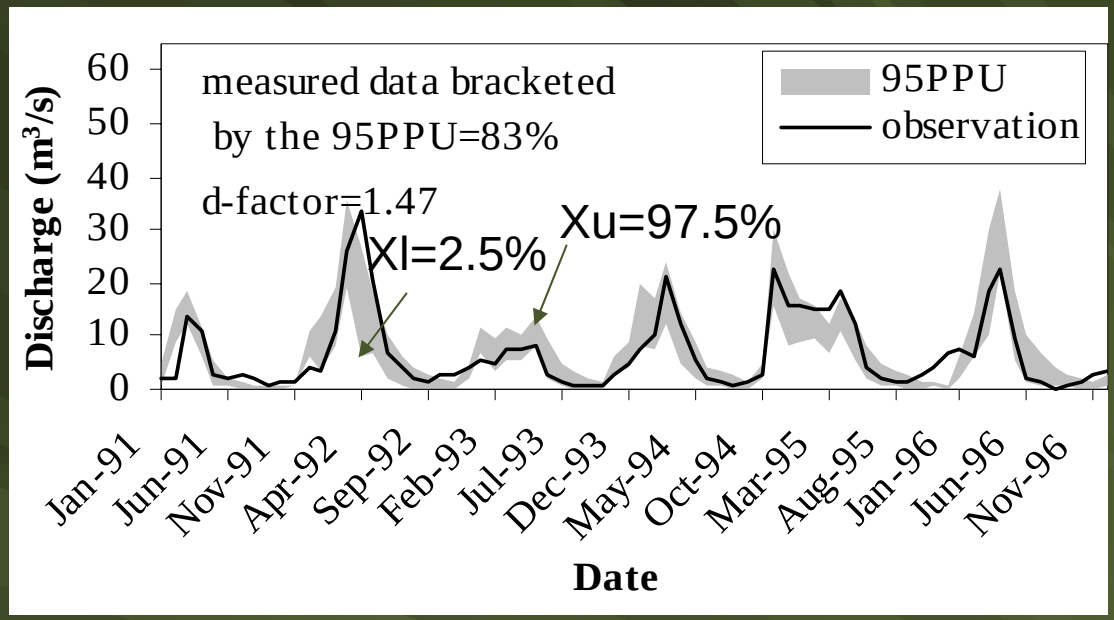
Calibration : 1991-1996

Validation : 1997-2000



Initial and final values of SWAT calibration parameters for stream flow and TSS.

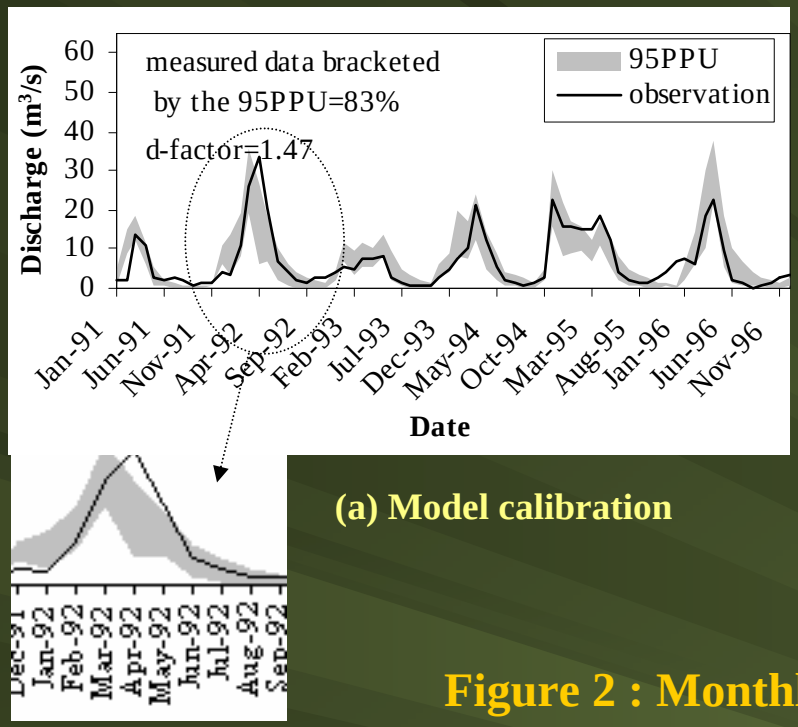
Parameter	SWAT variable name	Final value	
		SUFI-2 calibration	SWAT calibration
ESCO	Soil evaporation compensation factor	0.48[a],0.61[b],0.56[c]	0.40
SMFMN	Melt factor for snow on December 21	2.77[a], 1.95[b],2.34[c]	2.5
SMFMX	Melt factor for snow on June 21	2.82[a], 1.98[b],2.45[c]	2.6
GW_REVAP	Groundwater "revap" coefficient	0.06[a],[b],0.04[c]	0.04[a],0.06[b],0.02[c]
SMTMP	Snow melt base temperature (°C)	+3.55	+4
ALPHA_BF	Base flow alpha factor (days)	[0.08 , 0.23]	0.118[a], 0.098[b], 0.05[c]
CH_K2	Effective hydraulic conductivity in the main channel (mm/hr)	45,71	40[a], 60[b],[c]
GW_DELAY	Groundwater delay time (days)	[43 , 100]	Varied by HRU
GWQMN	Threshold depth of water in the shallow aquifer required for return flow to occur.	[-20 , 171]	40[a],[b], 20[c]
OV_N	Manning's n value for the over land flow	[-0.13 , 0.24]	0.29[a] , 0.3[b],[c]
SFTMP	Snow fall temperature (^{0}C)	1.91	2.0
REVAPMN	Threshold depth of water in the shallow aquifer for "revap".	[-33 , 118]	20[a],[b], 10[c]
PRF	peak rate adjustment factor for sediment routing in the main channel	0.38	0.5
SPEXP	channel re-entrained exponent parameter	1.04	1.05
SPCON	channel re-entrained linear parameter	0.0016	0.002
CH_EROD	channel erodability factor	0.32	0.0
CH_COV	channel cover factor	0.49	0.0



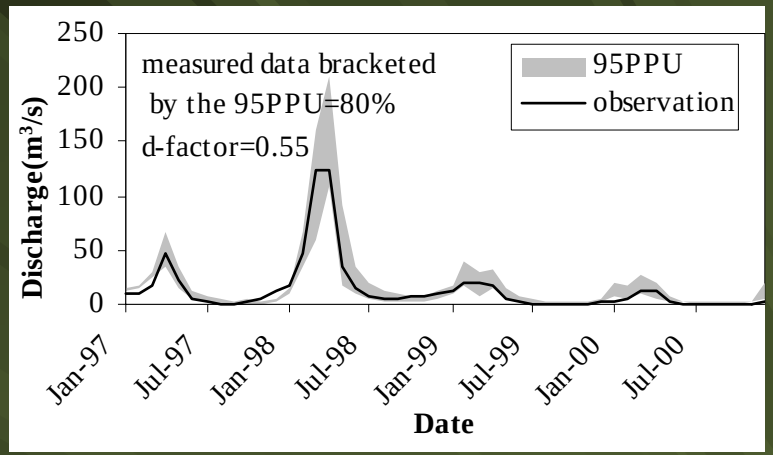
$$d\text{-}factor = \frac{\bar{d}_X}{\sigma_X}$$

$$\bar{d}_X = \frac{1}{k}\sum_{l=1}^{k}(X_{\mathrm{U}} - X_{\mathrm{L}})_l$$

Figure 1 : Monthly stream flow at main

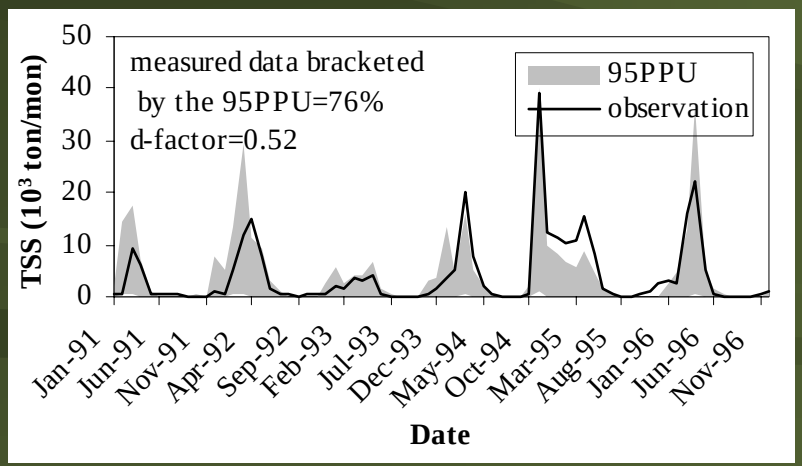


(a) Model calibration

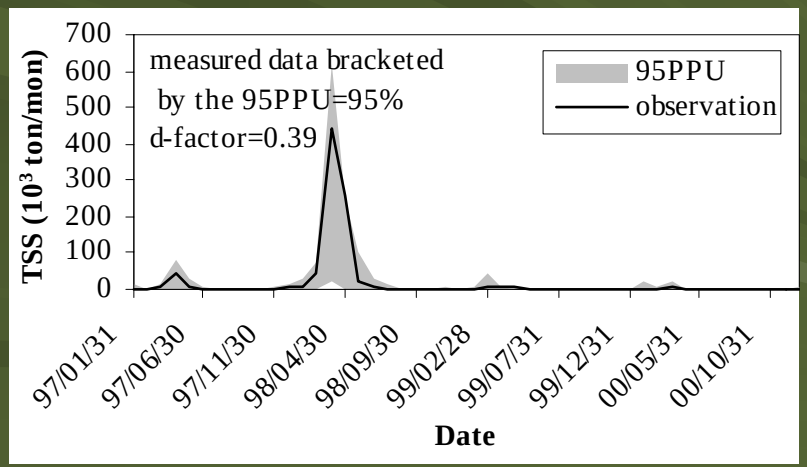


(b) Model validation

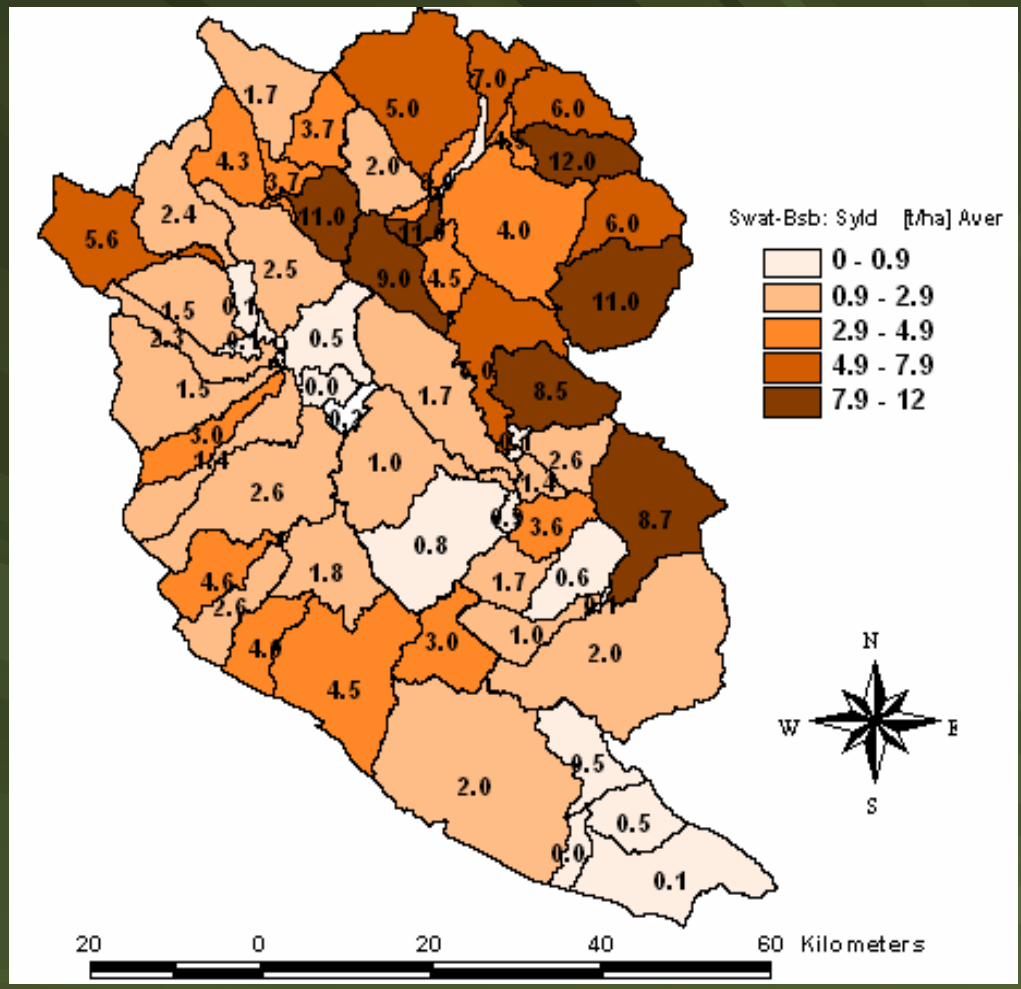
Figure 2 : Monthly TSS at main outlet



(a) Model calibration



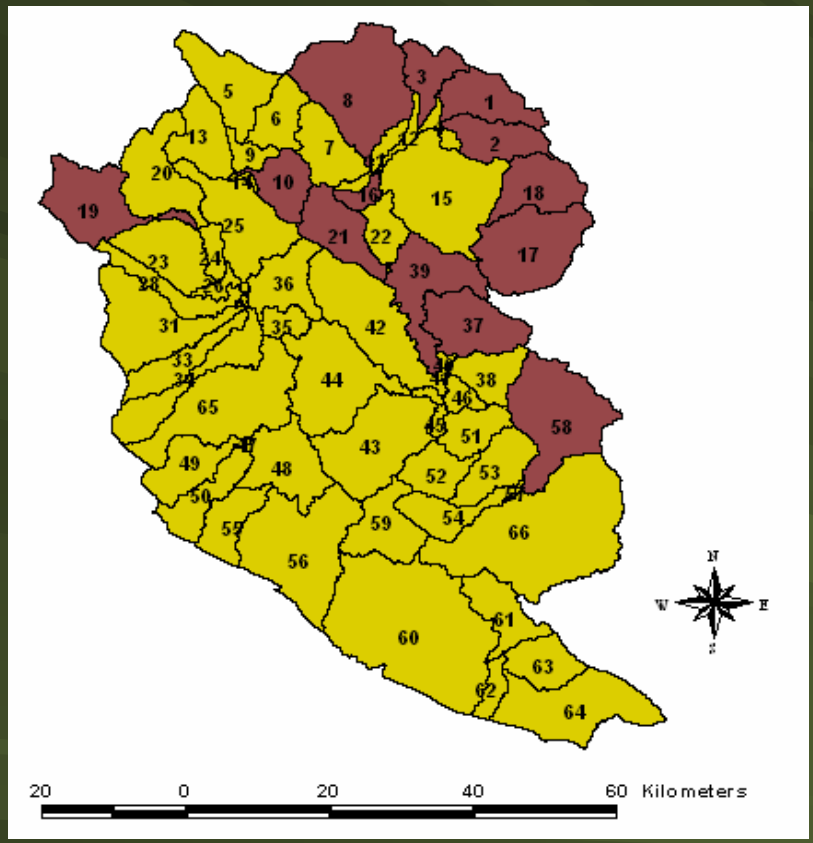
(b) Model validation

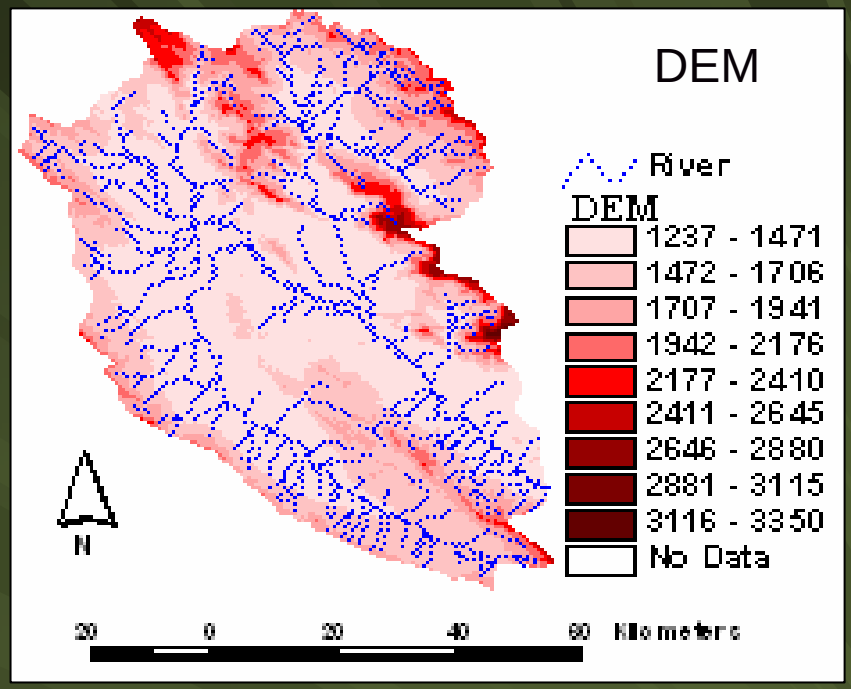


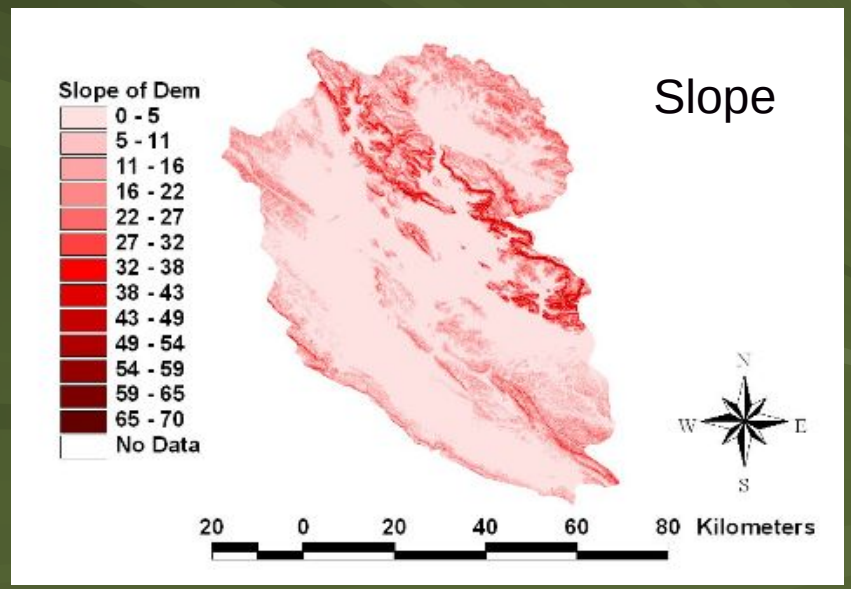
Sensitive sub-basins to erosion

SWAT model predicted sediment yield per hectare of sub-basin from 1991-1996

Main factors of erosion in critical sub-basins



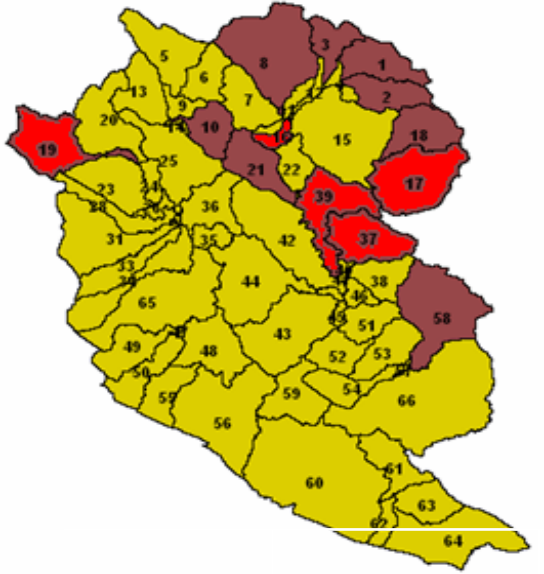




Management Scenarios for Soil Conservation

1- Support practices such as contouring and terracing.

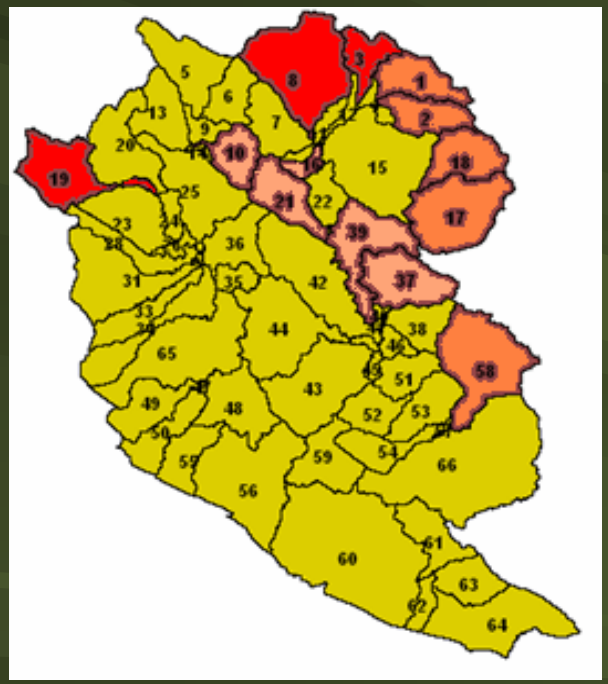
2- Land cover change in hilly and mountainous areas of basin with consideration of land capability.



1- Summary of support practices results on sediment yield

Sub-basin	Area of HRU (%)	Initial sediment yield (ton/ha)	Predicted sediment yield (ton/ha)		Sediment yield reduction of Sub-basins (%)
			Contouring (Reduction %)	Contouring and Terracing (Reduction %)	
16	9	25.0	19.5 (22)	15.1 (40)	5
	3	0.6	0.28 (53)	0.28 (53)	
17	3	29.0	25.1 (13)	18.8 (35)	1
19	4	13.8	9.8 (29)	7.5 (46)	2
37	3	42.1	34.3 (19)	16.8 (60)	4
	4	22.6	20.3 (10)	13.7 (39)	
	1.5	1.3	0.0 (100)	0.65 (50)	
39	5	28.0	22.9 (18)	17.7 (37)	5
	6	7.8	5.1 (35)	3.2 (59)	

2- Summary of land use conversion results on sediment yield



Sub-basin	Initial sediment yield (ton/ha)	Predicted sediment Yield after land cover changing (ton/ha)	Sediment yield Reduction of sub-basins (%)
3	6.83	0.42	94
19	4.12	0.25	94
8	4.63	0.33	93
17	7.52	2.98	60
1	5.12	2.13	58
18	4.63	2.05	56
2	10.21	6.94	32
58	6.32	4.73	25
21	6.15	5.24	15
37	8.75	8.85	0.03
39	7.93	7.83	0.03
10	6.71	6.52	0.01
16	3.42	3.51	0.01

conclusions

- Contouring and terracing will effectively reduce sediment loading of rain fed lands in hillsides.

- Changing agricultural practices such as increasing forest, conversion of rain-fed area in steep slope land to orchards and woods will reduce erosion about 50 percent within hilly and mountainous sub-basins.

- SWAT model is a capable tool for simulating hydrologic components and erosion in Gharasu river basin.

- Large amount of measured data at the outlet of the basin are necessary for calibration by using SUFI-2 but the more number of parameter can be determined in short time.


Thank you