Application of SWAT Model to Estimate the Runoff and Sediment Load from the Right Bank Valleys of Mosul Dam Reservoir

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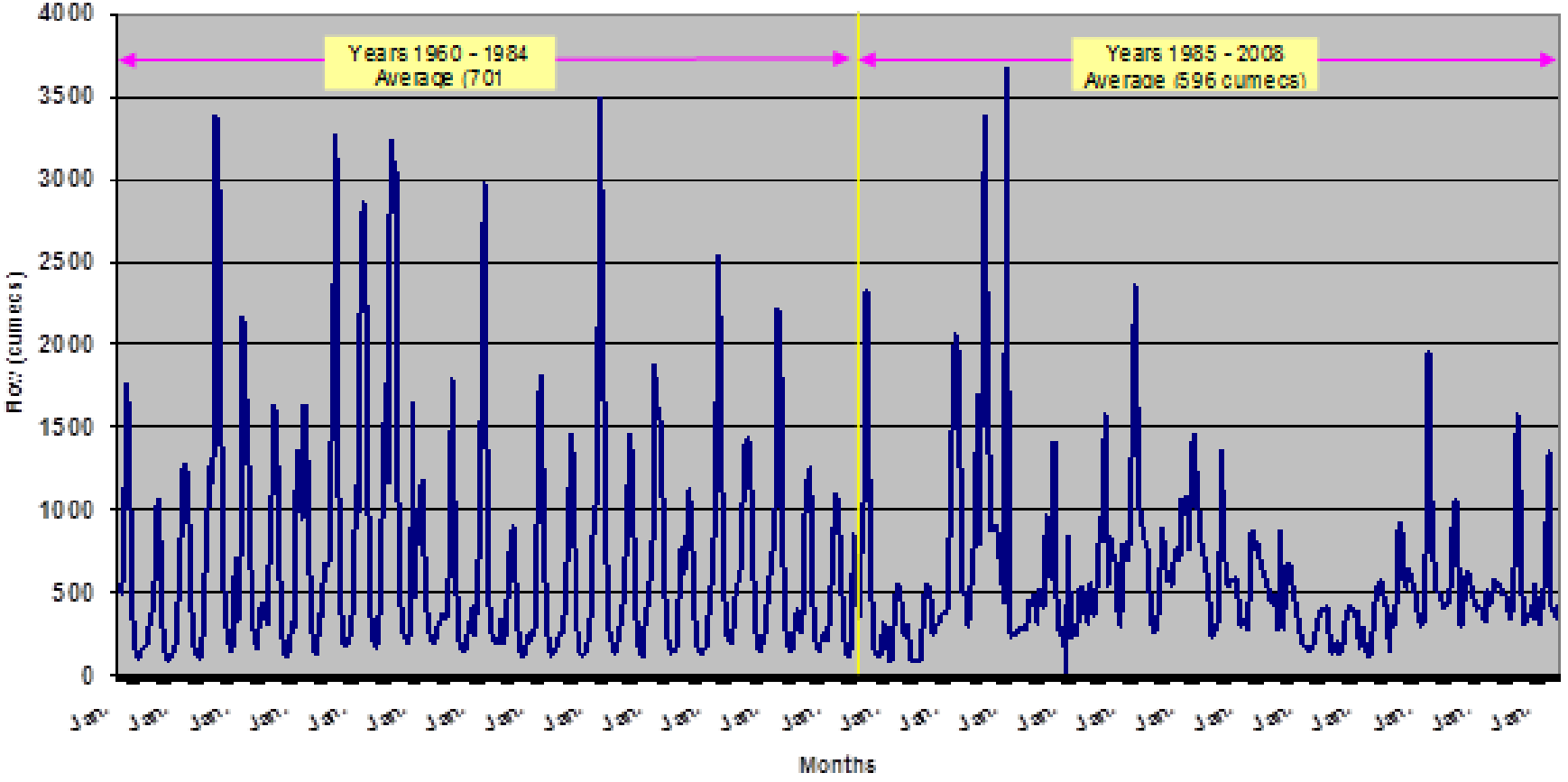
Figure 1.Map of Iraq

- Rivers Tigris and Euphrates form the main water resources of Iraq
- Average annual flow of the Euphrates is estimated to about 30 km^3/year (951 m^3/sec)
- Average annual flow of the Tigris River is 21.2 km^3/year (672 m^3/sec)

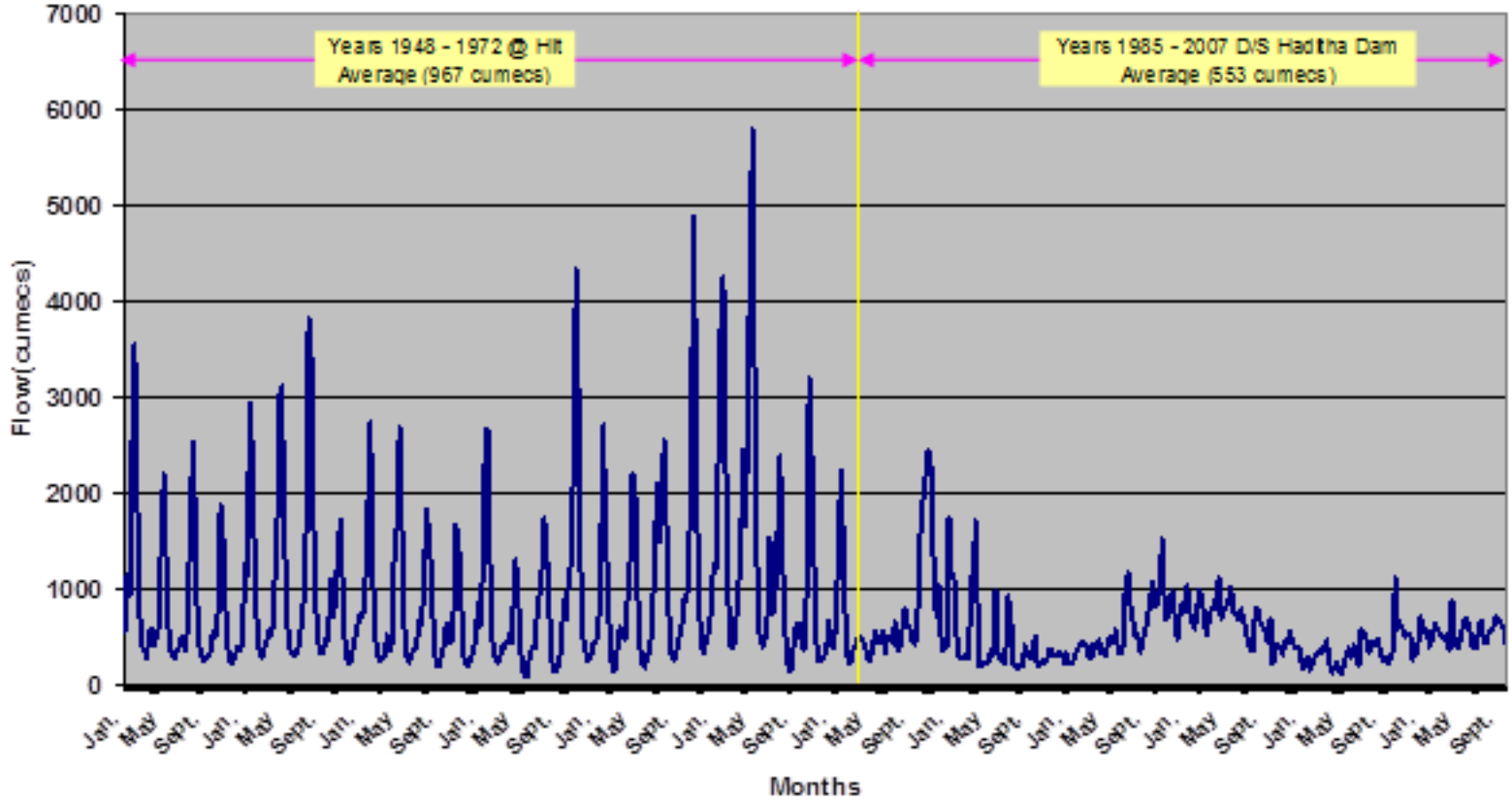
-The Tigris River mean discharge at Mosul city prior to 1984 was 701 m^3/sec and dropped to 596 m^3/sec afterward (decreased 15%).



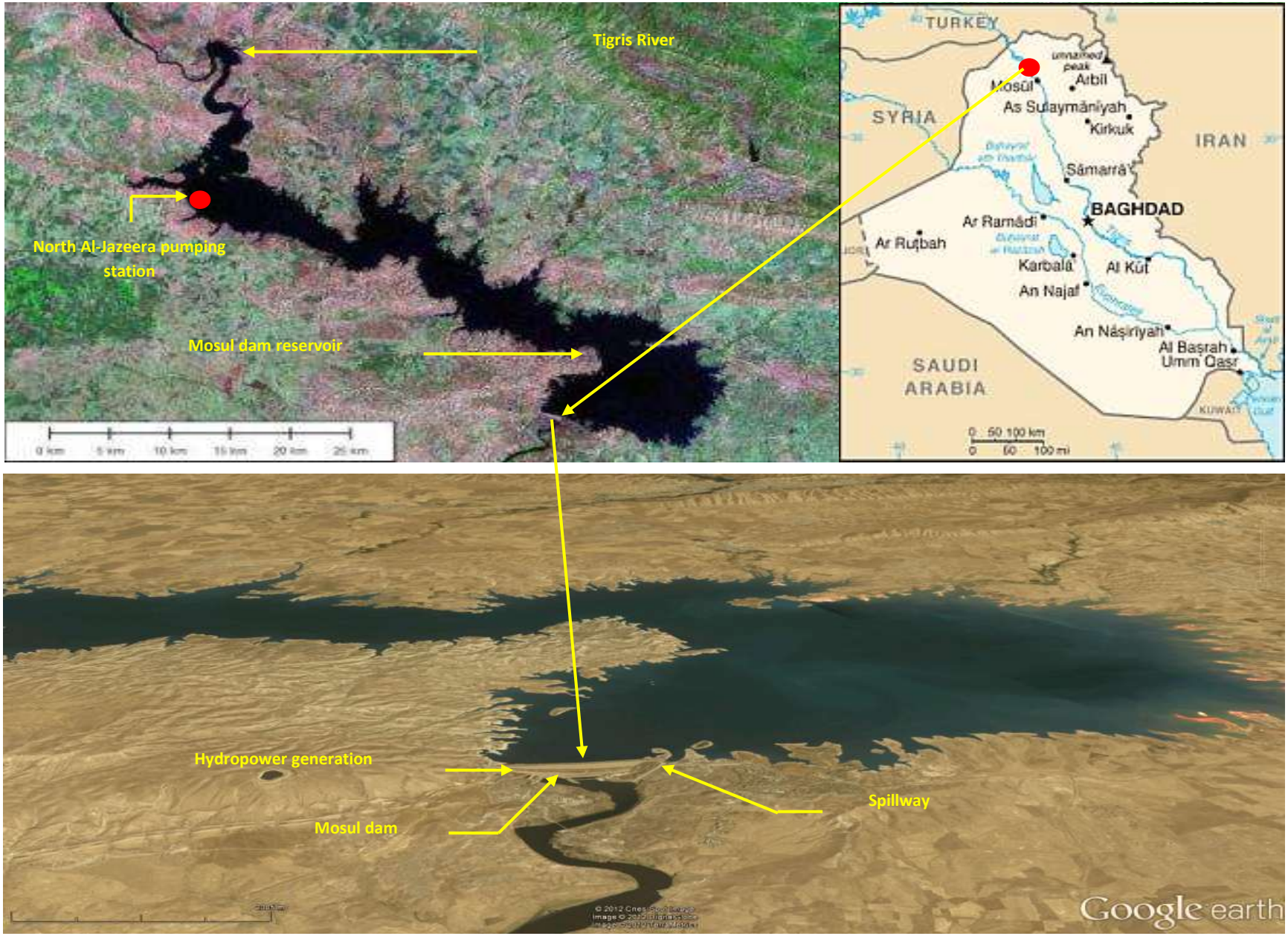
Water Discharge of River Tigris at Mosul City for the period 1960-2008.

-Iraq used to receive 21.2 Km^3/year of water from the Tigris River and once Ilisu dam is constructed, this is likely to drop to 9.7 Km^3 which means that 47% of the river flow will be depleted.

-The Euphrates River mean discharge at Hit and Haditha cities prior to 1972 was 967m^3/sec and dropped to 553 m^3/sec after 1985 (decrease is 43%).



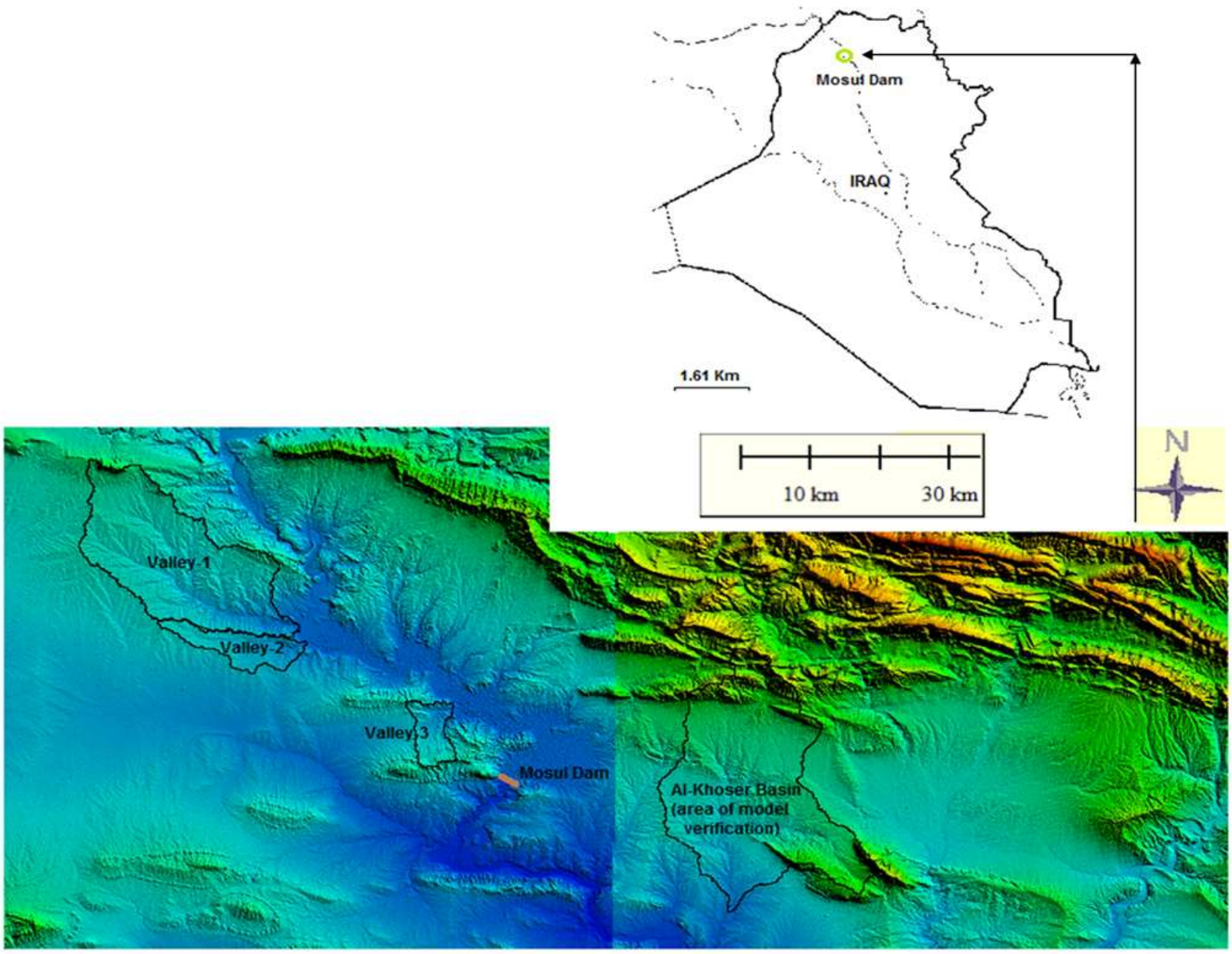
Water Discharge of River Euphrates at Hit and Hadiththa cities for the period 1948-2007.


Tigris River
North Al-Jazeera pumping station
Mosul dam reservoir
TURKEY
SYRIA
IRAN
SAUDI ARABIA
KUWAIT
Mosul
Arbil
As Sulaymāniyah
Kirkuk
Sāmarrā'
BAGHDAD
Ar Ramādi
Ar Ruṭbah
Karbalā'
Al Kūt
An Najaf
An Nāṣiriyah
Al Başrah
Umm Qasr
Hydropower generation
Mosul dam
Spillway
Google earth

-Mosul dam is one of the biggest hydraulic structures in Iraq

- The water surface area of its reservoir is 380 Km^2 with a storage capacity of 11.11×10^9 m^3 at maximum operation level 330 m.a.s.l
- 8.16×10^9 m^3 live storage and 2.95×10^9 m^3 dead storage

- There are three main valleys entering the reservoir from the left side.
- They contribute water and sediment during rain events.
- High percent of studied area is a planted with seasonal crops (wheat and barley), vegetables and pastures.
- The soil classification is mostly of silty loam, silty clay loam, and clay.


Mosul Dam
IRAQ
1.61 Km
10 km
30 km
N
Valley-1
Valley-2
Valley-3
Mosul Dam
Al-Khoser Basin
(area of model
verification)

APPLICATION OF THE MODEL

- Soil and Water Assessment Tool (SWAT) is a physically based model was developed to simulate and predict the runoff, sediment load, and agricultural chemical yields for large and complex watersheds having different soil type, land use (Arnold et al., 1998, 2000; Neitsch et al. 2001).
- The model is a continuous simulation tool which can be applied for long period of time.

- In SWAT model, the surface runoff is estimated by two methods : curve number procedure, and Green-Ampt infiltration method.
- While the estimation of erosion and sediment load yields are based on Modified Universal Soil Loss Equation (MUSLE).

- In order to verify and evaluate the model's results in the studied area, similar watershed was used. This watershed referred to as al-Khoser Seasonal River near the study area.
- The selected watershed is similar to the studied area in geology, surface soil and climate.

- Table (1) shows the topographic properties of the three studied valleys 1, 2, and 3.

Valley No.	Area (km^2)	Slope %	Length (km)	Average level (m.a.s.l)
1	450.76	3.59	38.80	446.62
2	78.52	2.17	21.82	388.38
3	50.06	5.25	10.86	404.89

- Three single storms were measured in this area (Mohammad 2005), including the rainfall depth, runoff and sediment hydrographs. These storms were simulated in SWAT Model to evaluate and calibrate the model to be verification for the studied area.
- The observed and simulated runoff depth and sediment load for the three considered storm are shown in Table (2).

Storm No	Date	Rain (mm)	Observed Runoff Volume (MCM)	Simulated Runoff Volume (MCM)	Observed Average Sediment Load (*10^3ton)	Simulated Average Sediment Load (*10^3ton)
I	19/2/03	19	0.912	0.806	1.68	1.325
II	15/1/04	9	0.130	0.139	0.078	0.158
III	22/1/04	17	1.390	1.772	2.933	3.830

- The results showed a good agreement between the observed and simulated values for both runoff volume and sediment load.
- For the runoff volume, the determination coefficient between observed and simulated values is 0.94 and the Nash-Sutcliffe, model efficiency value (E) is 0.81.

RESULTS

- The results of total average annual runoff

  valley 1=$20.6*10^6$ m^3

  valley 2=$3.1*10^6$ m^3

  valley 3=$0.8*10^6$ m^3

- The maximum annual runoff volume for the considered valleys was in 1993 ($62.0*10^6$, $9.7*10^6$ and $2.8*10^6$ m^3 for the three valleys respectively) which are due the maximum annual rainfall depth in that year (656 mm).

- The minimum runoff volume (2008) were:

  valley 1 $0.28*10^6$ m^3

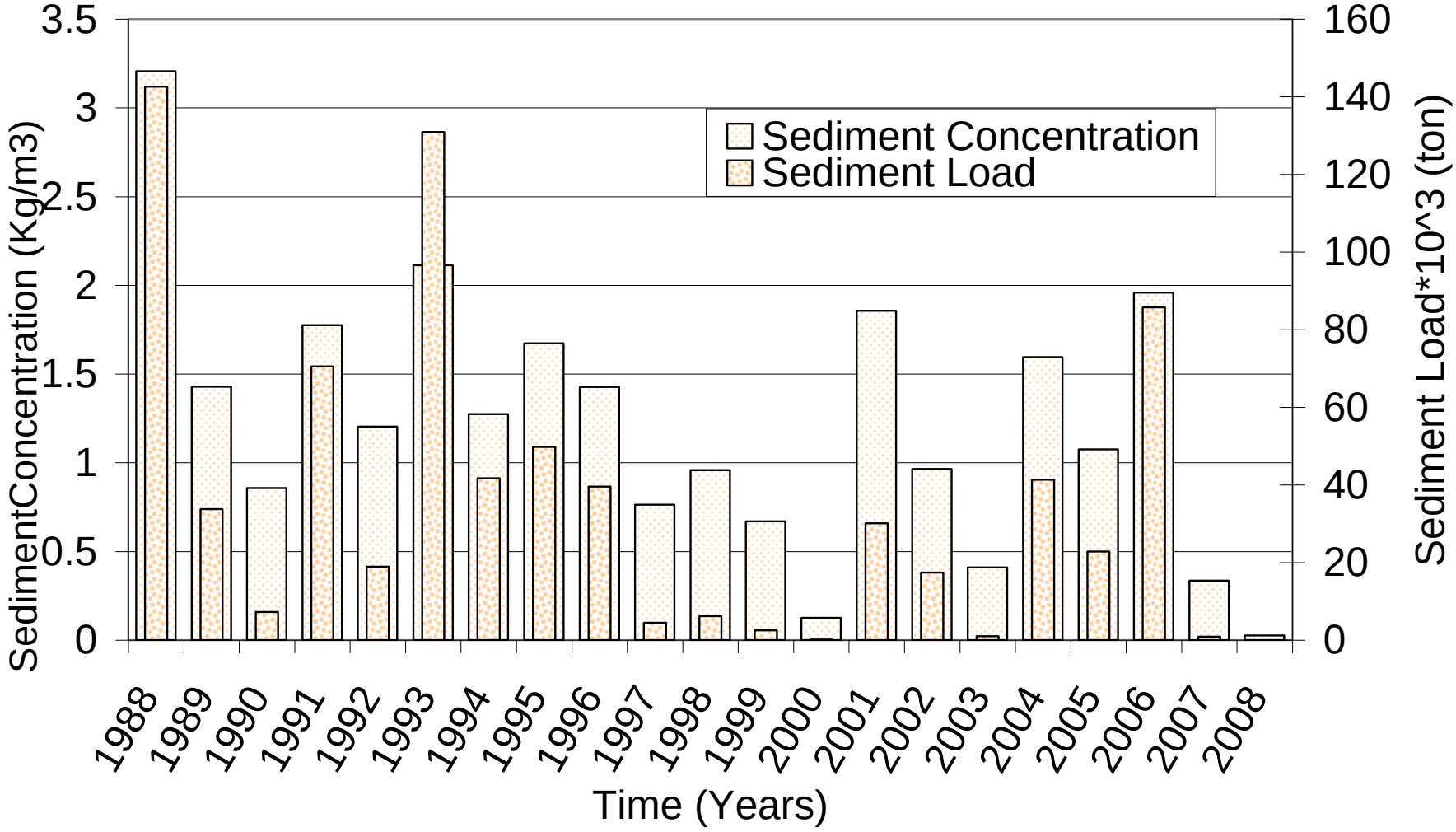
  valley 2 $0.021*10^6$ m^3

  valley3 $0.02*10^6$ m^3

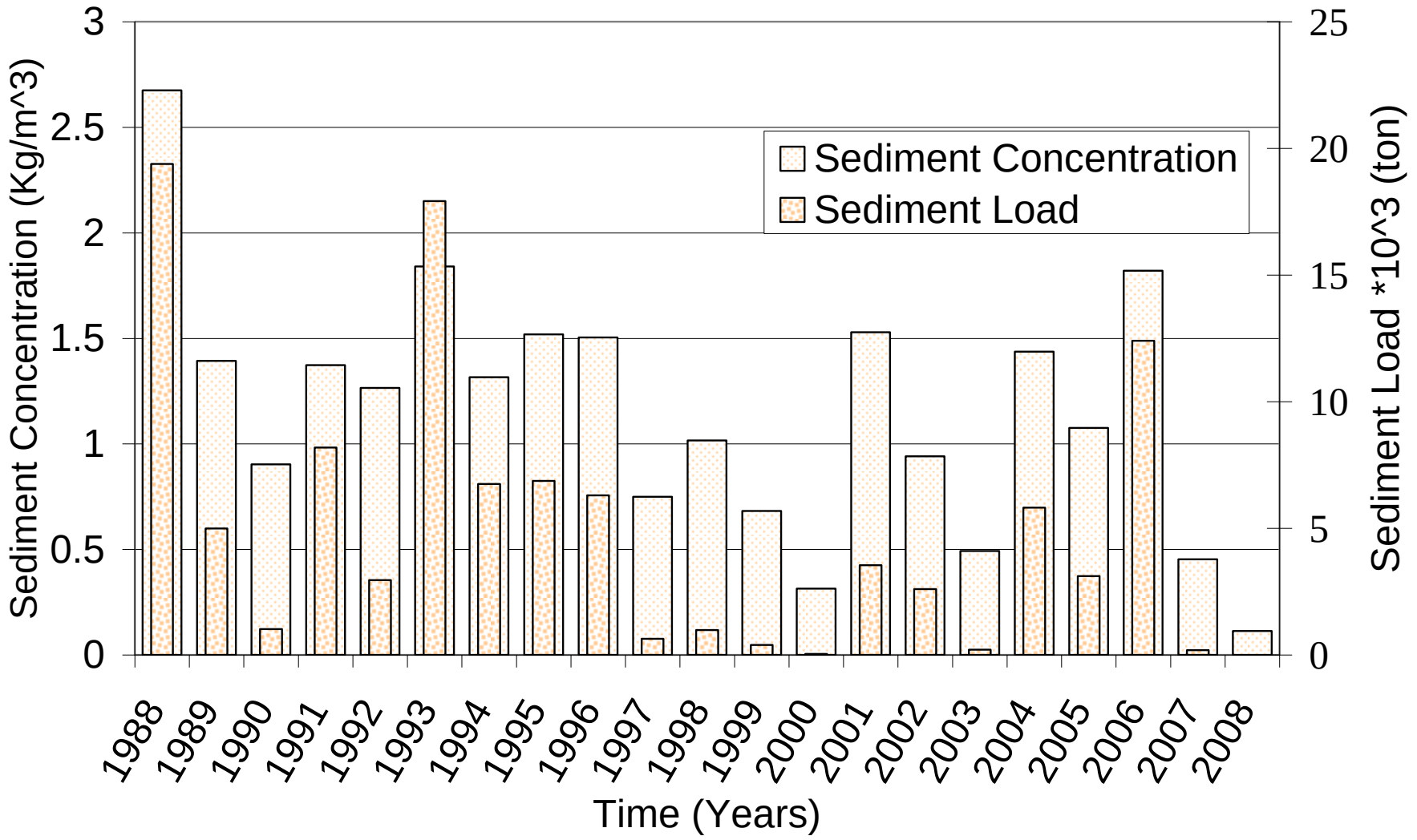
Average annual rainfall depth in 2008 was 78 mm.

- Average annual sediment loads were:

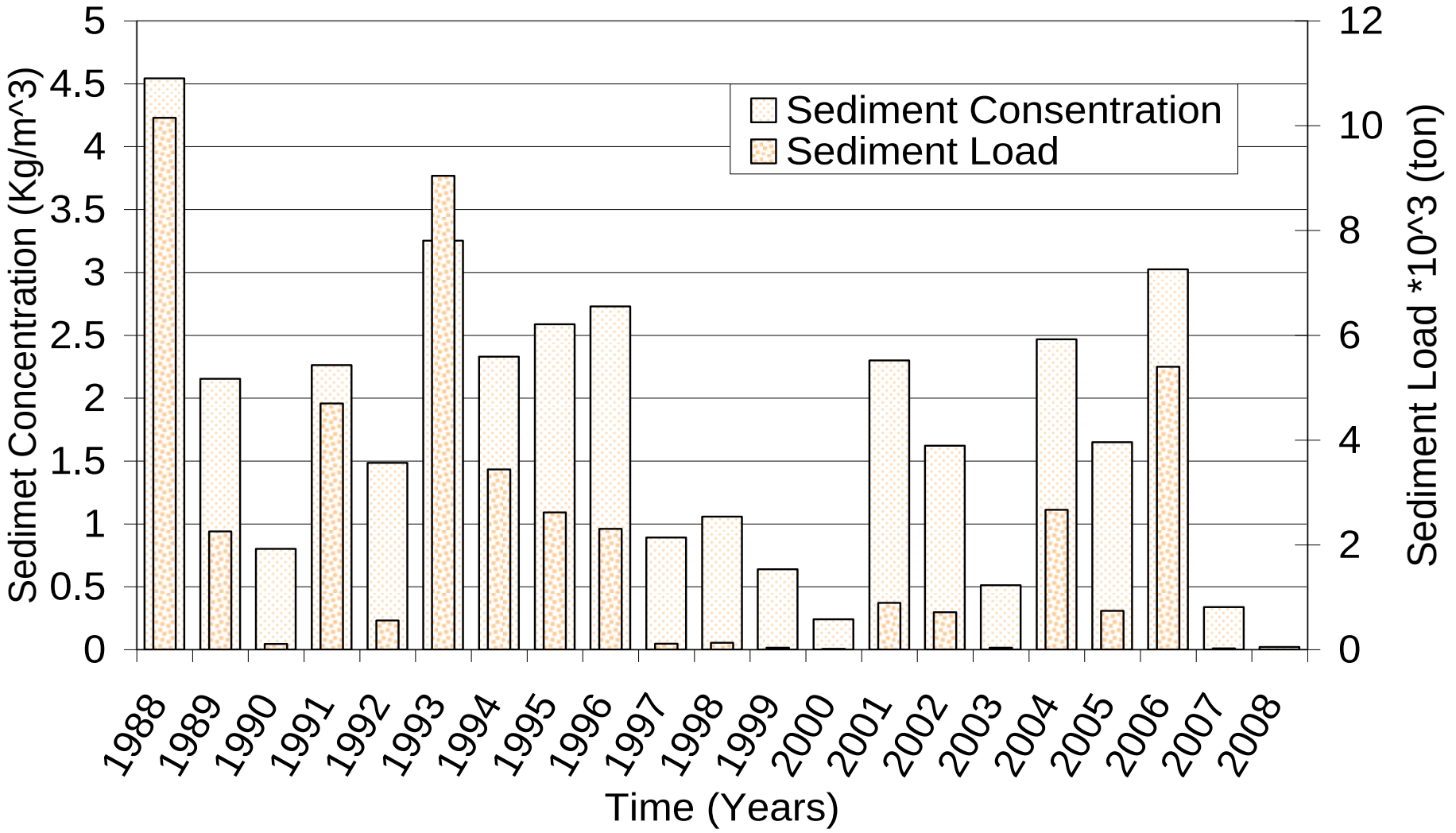
Valley 1	$35.6*10^3$ton
Valley 2	$4.9*10^3$ ton
Valley 3	$2.2*10^3$ ton


Sediment Concentration
Sediment Load
SedimentConcentration (Kg/m3)
Sediment Load*10^3 (ton)
Time (Years)
0
0.5
1
1.5
2
2.5
3
3.5
0
20
40
60
80
100
120
140
160
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008

for valley-1


Sediment Concentration (Kg/m^3)
Sediment Load *10^3 (ton)
Sediment Concentration
Sediment Load
Time (Years)
0
0.5
1
1.5
2
2.5
3
0
5
10
15
20
25
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008

for valley-2


Sediment Consentration
Sediment Load
Sedimet Concentration (Kg/m^3)
Sediment Load *10^3 (ton)
Time (Years)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
2
4
6
8
10
12
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008

for valley-3

- The total volume of sediment deposited within the reservoir $338.8*10^3$ m^3.

THANK YOU