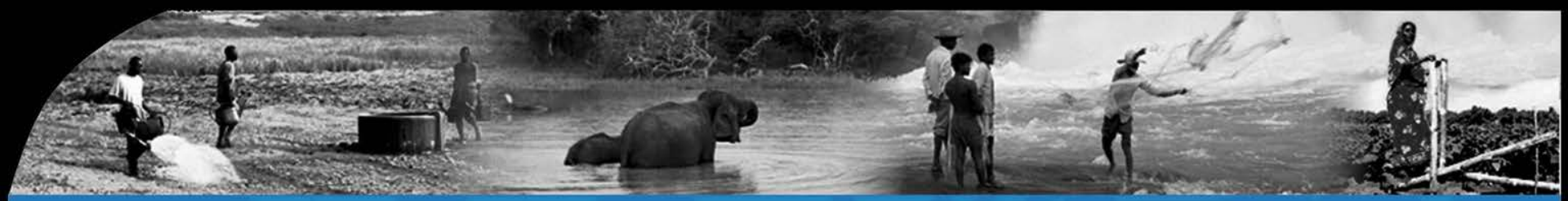

Applying Climate Reanalysis Data (CFSR) to Force Watershed Models in the Ethiopian Highlands

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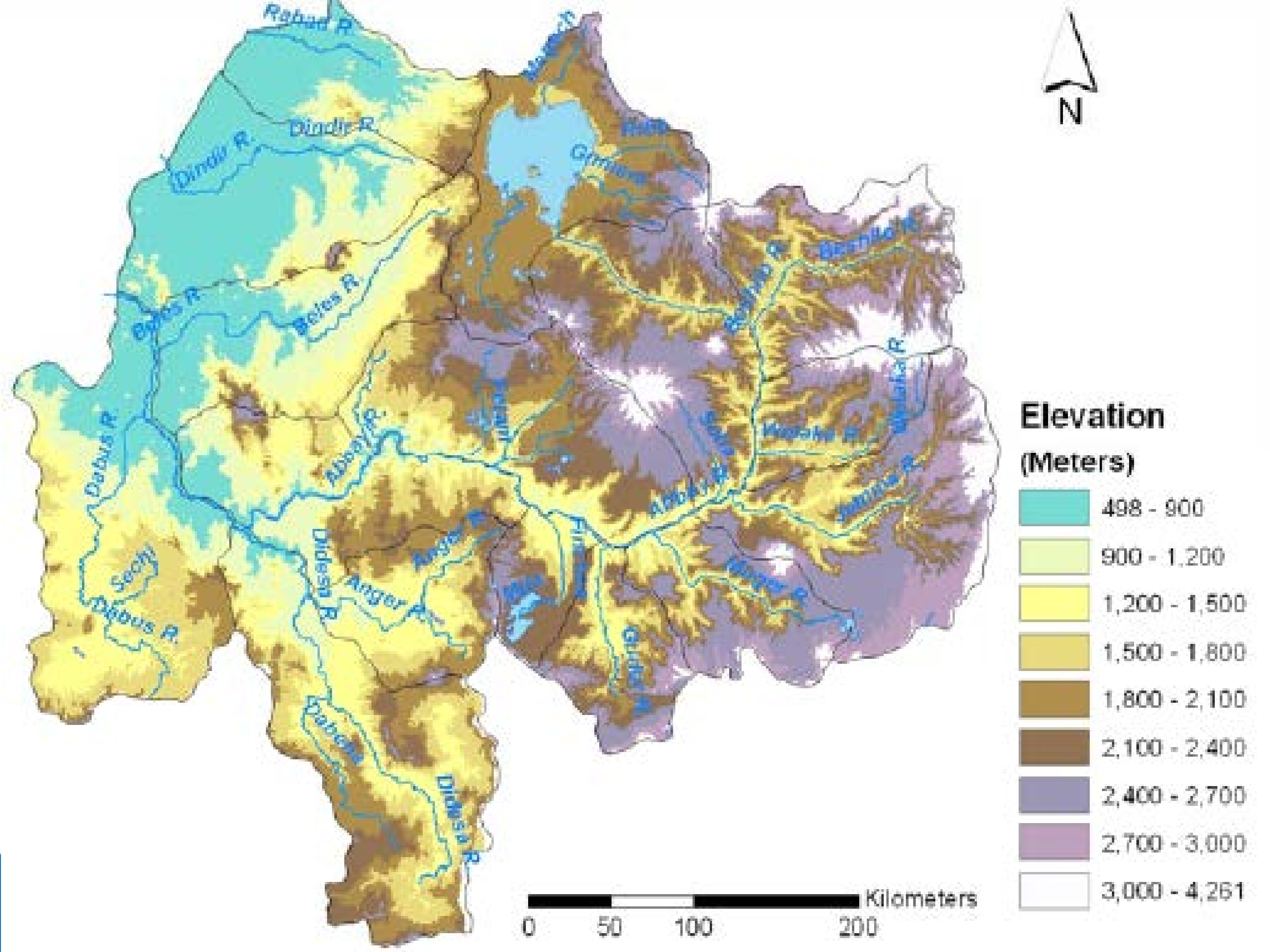
Background

- Modeling landscape processes requires detailed climatic and geographic datasets
- Meteorological stations in most parts of Africa are very sparse and most watersheds are un-gauged
- Climate records are incomplete; high percentage of missing data and relevant variables
- Poor data accessibility due to lack of data sharing agreement among trans-boundary riparian countries)

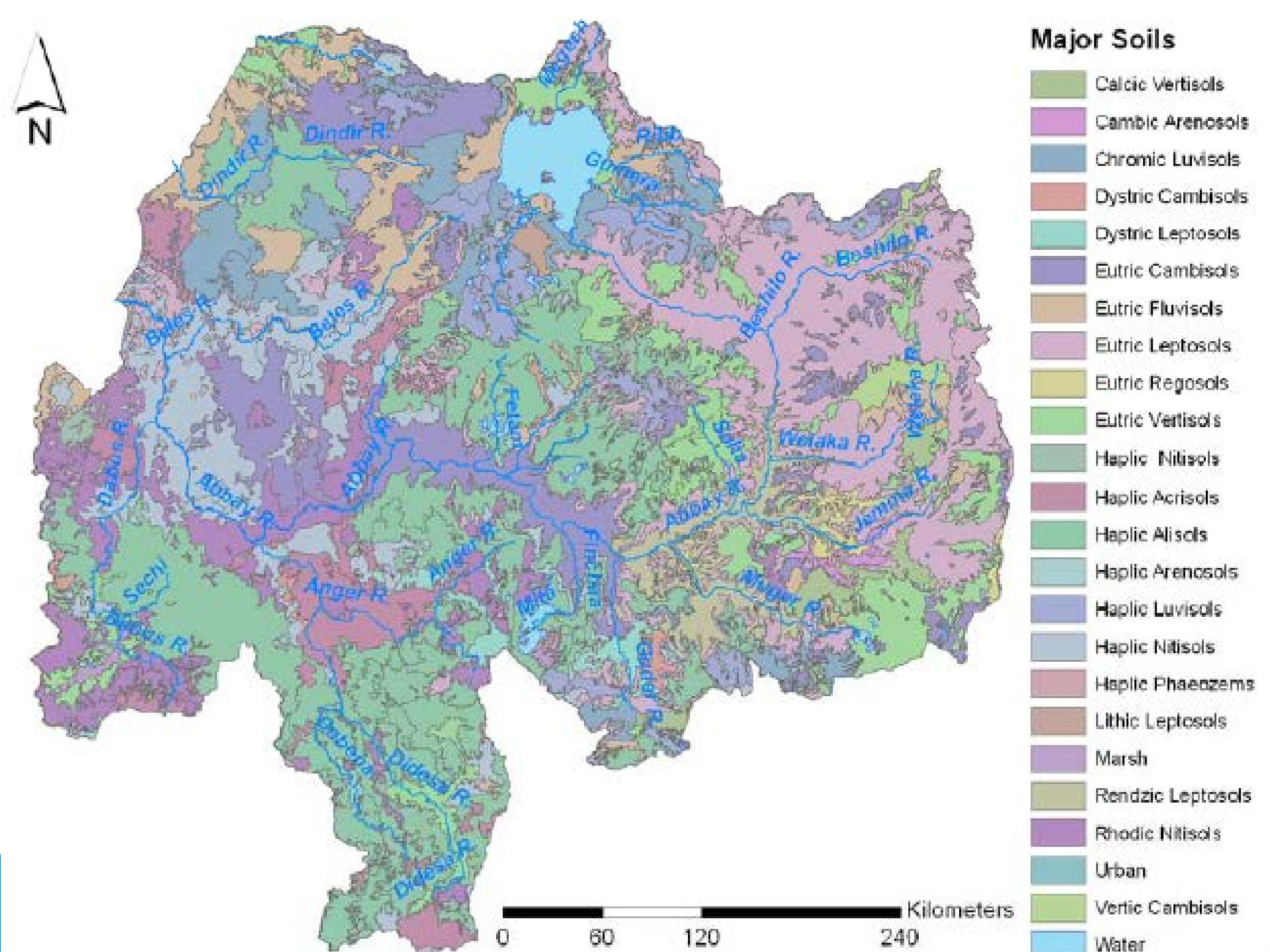
→ **High-resolution global reanalysis data for SWAT modeling applications in Africa**

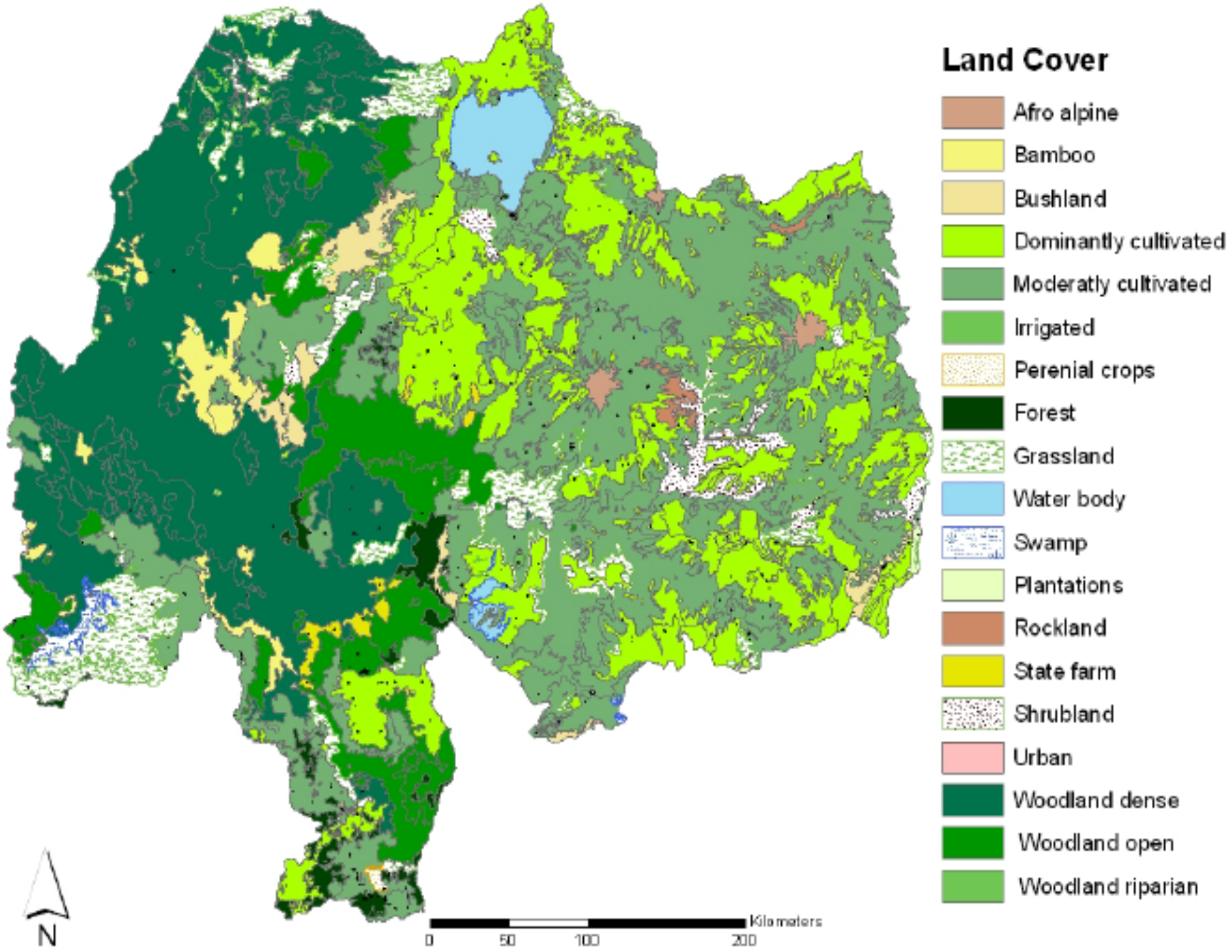
Study Area

Blue Nile:	176,000 km^2 (Tana Basin)
	200,000 km^2 (all Blue Nile)
Altitude range:	500 masl @ Sudan border
	1,800 masl @ Lake Tana
Annual Rainfall:	780-2,200mm 70% June-September
Tmax:	10-38^{o}C
PET:	1,000 – 2,280mm
Flow:	1,410 - 1964 m^{3}s^{-1} border
	(44.5 - 61.9B m^3)
	80% July-October

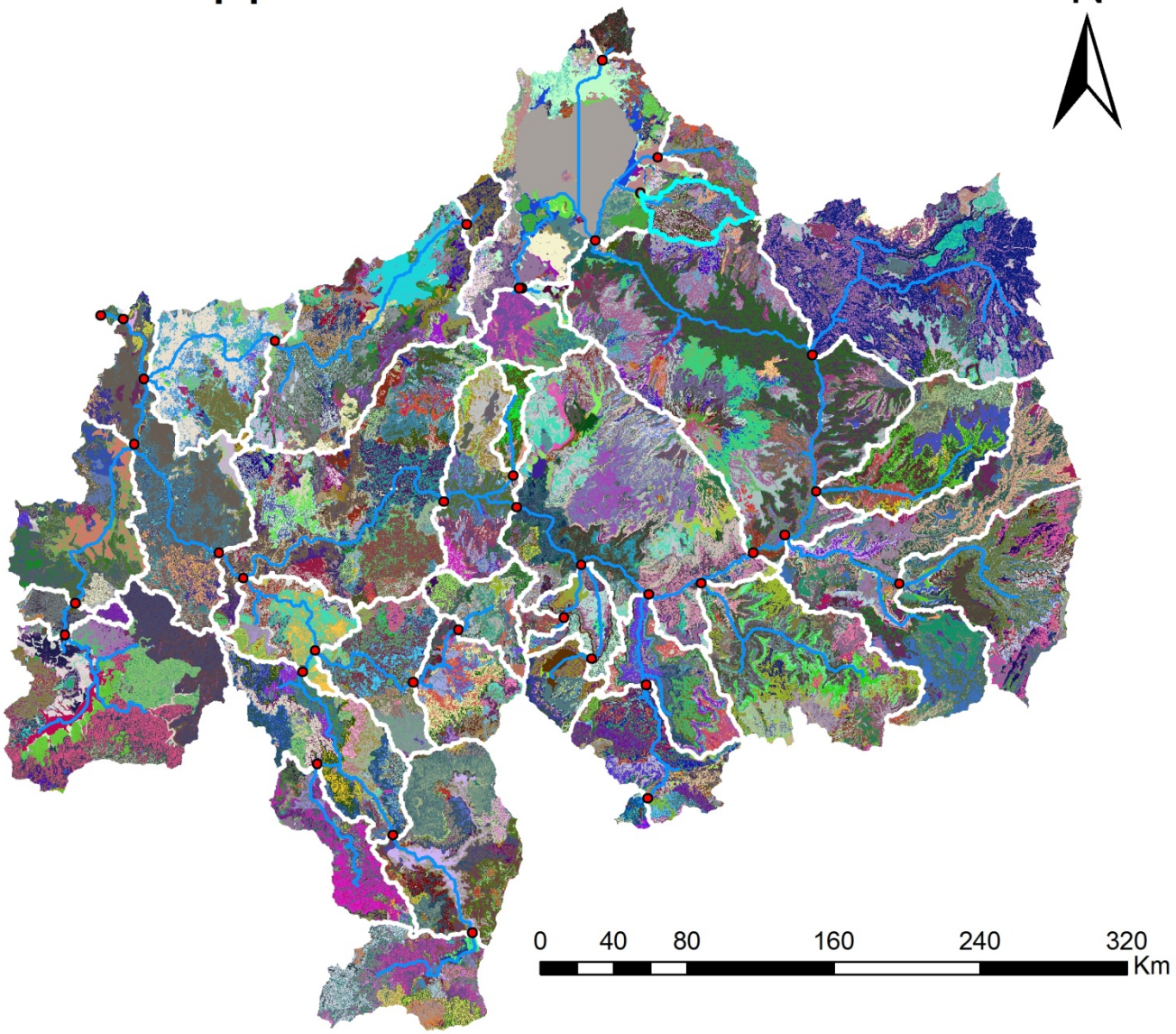


N
Rahad R.
Dindir R.
Dindir R.
Beles R.
Beles R.
Dabus R.
Dabus R.
Abbay R.
Abbay R.
Didesa R.
Didesa R.
Anger R.
Anger R.
Guder R.
Muger R.
Beshilo R.
Welaka R.
Elevation
(Meters)
498 - 900
900 - 1,200
1,200 - 1,500
1,500 - 1,800
1,800 - 2,100
2,100 - 2,400
2,400 - 2,700
2,700 - 3,000
3,000 - 4,261
Kilometers
0
50
100
200

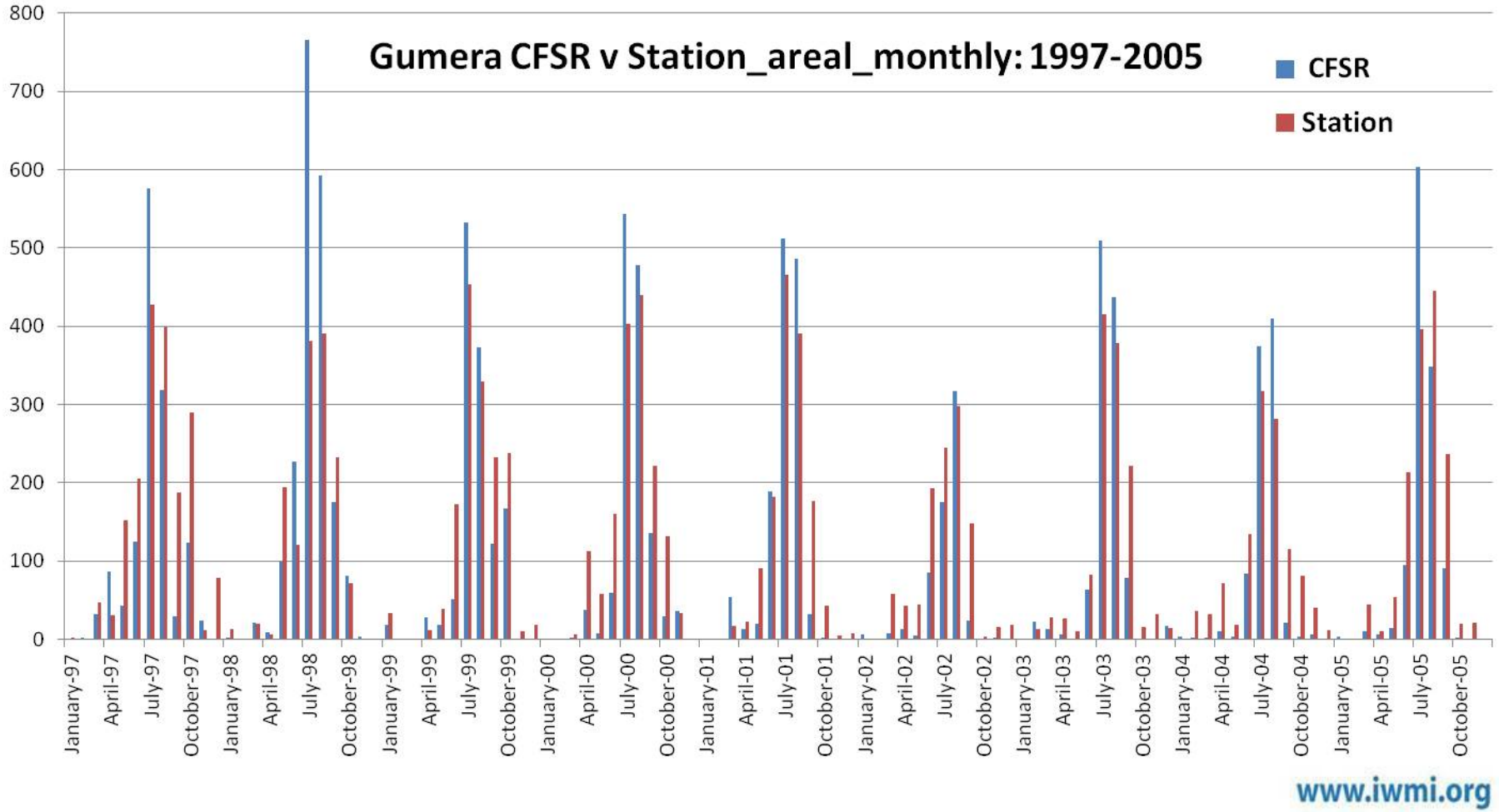

N
Major Soils
Calcic Vertisols
Cambic Arenosols
Chromic Luvisols
Dystric Cambisols
Dystric Leptosols
Eutric Cambisols
Eutric Fluvisols
Eutric Leptosols
Eutric Regosols
Eutric Vertisols
Haplic Nitisols
Haplic Acrisols
Haplic Alisols
Haplic Arenosols
Haplic Luvisols
Haplic Nitisols
Haplic Phaeozems
Lithic Leptosols
Marsh
Rendzic Leptosols
Rhodic Nitisols
Urban
Vertic Cambisols
Water
Dindir R.
Bales R.
Abbay R.
Anger R.
Didesa R.
Gilgel
Beshilo R.
Wetaka R.
Jemma R.
Muger R.
Finchaa
Mile
Kesem R.
Kilometers
0
60
120
240


Land Cover
Afro alpine
Bamboo
Bushland
Dominantly cultivated
Moderatly cultivated
Irrigated
Perenial crops
Forest
Grassland
Water body
Swamp
Plantations
Rockland
State farm
Shrubland
Urban
Woodland dense
Woodland open
Woodland riparian
N
0
50
100
200
Kilometers

Upper Blue Nile SWAT

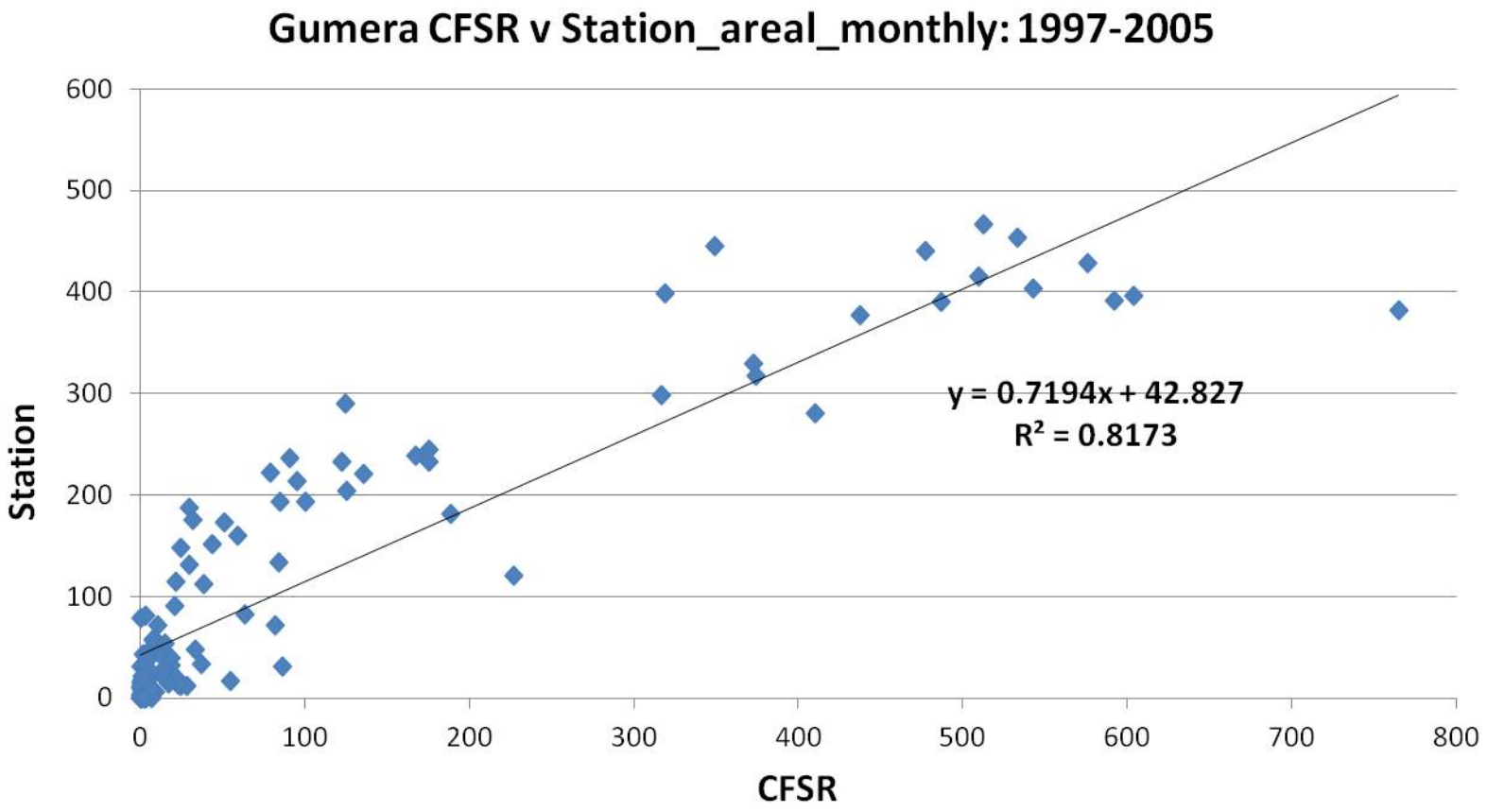


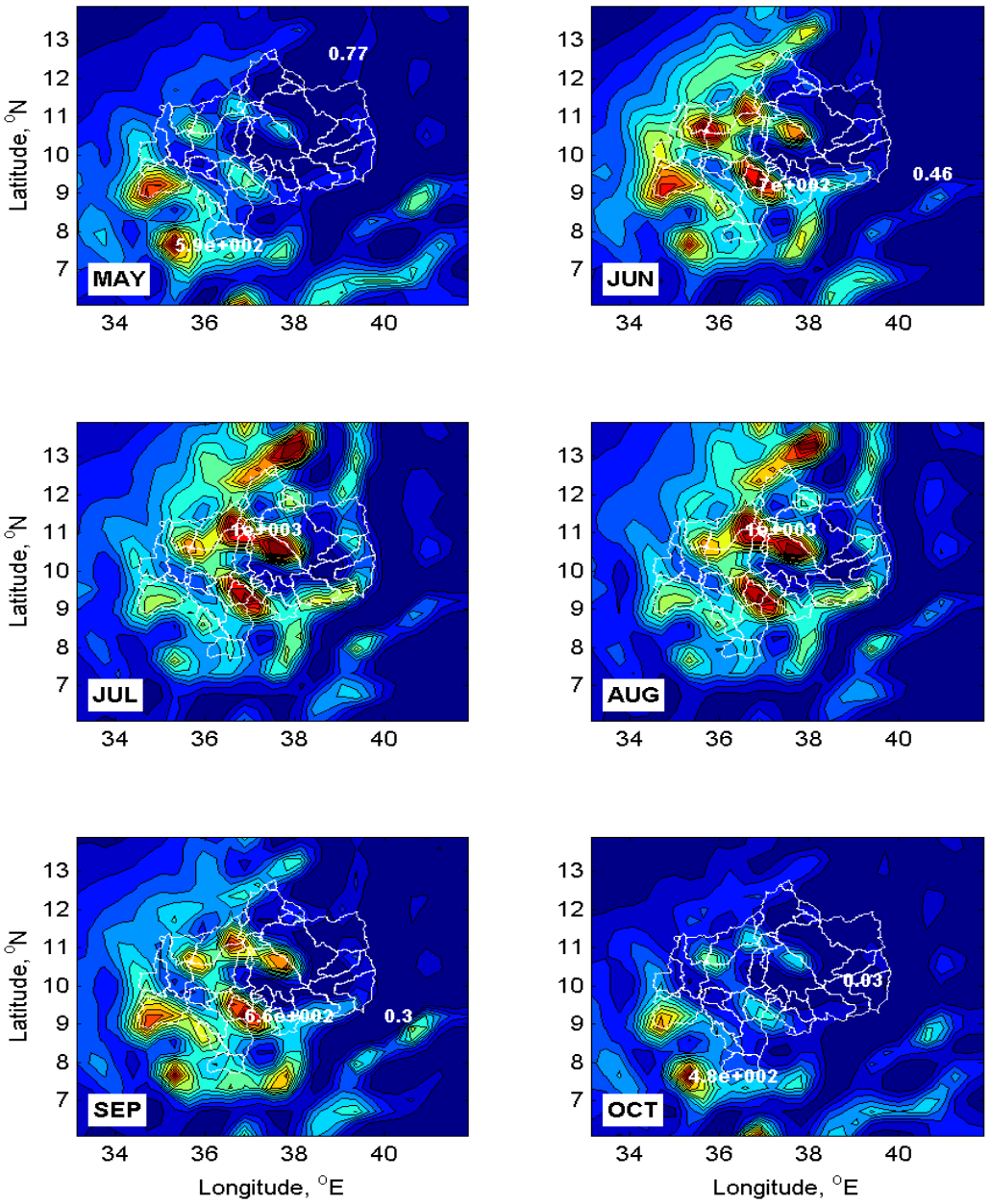
Gumera: CFSR vs. Gauge Data 1



www.iwmi.org

Gumera: CFSR vs. Gauge Data 2




MAY
JUN
JUL
AUG
SEP
OCT
0.77
0.46
0.3
0.03
Latitude, °N
Longitude, °E
13
12
11
10
9
8
7
34
36
38
40

Applications of CFSR Data

- Weather generator files for areas with missing and incomplete climate datasets
  - Solar radiation, relative humidity, wind speed
  - Maximum half-hour rainfall
- SWAT weather input files for un-gauged watersheds
- Climate downscaling and bias correction
- Study of large-scale water and energy fluxes

Maximum Half-hour Rainfall

- **Strict sense simple scaling property**: the probability distribution of maximum rainfall depth is invariant of time scale (Burlando and Rosso, 1996)

$$H_{\lambda D} \overset{d}{\approx} \lambda^{\eta} H_{D}$$

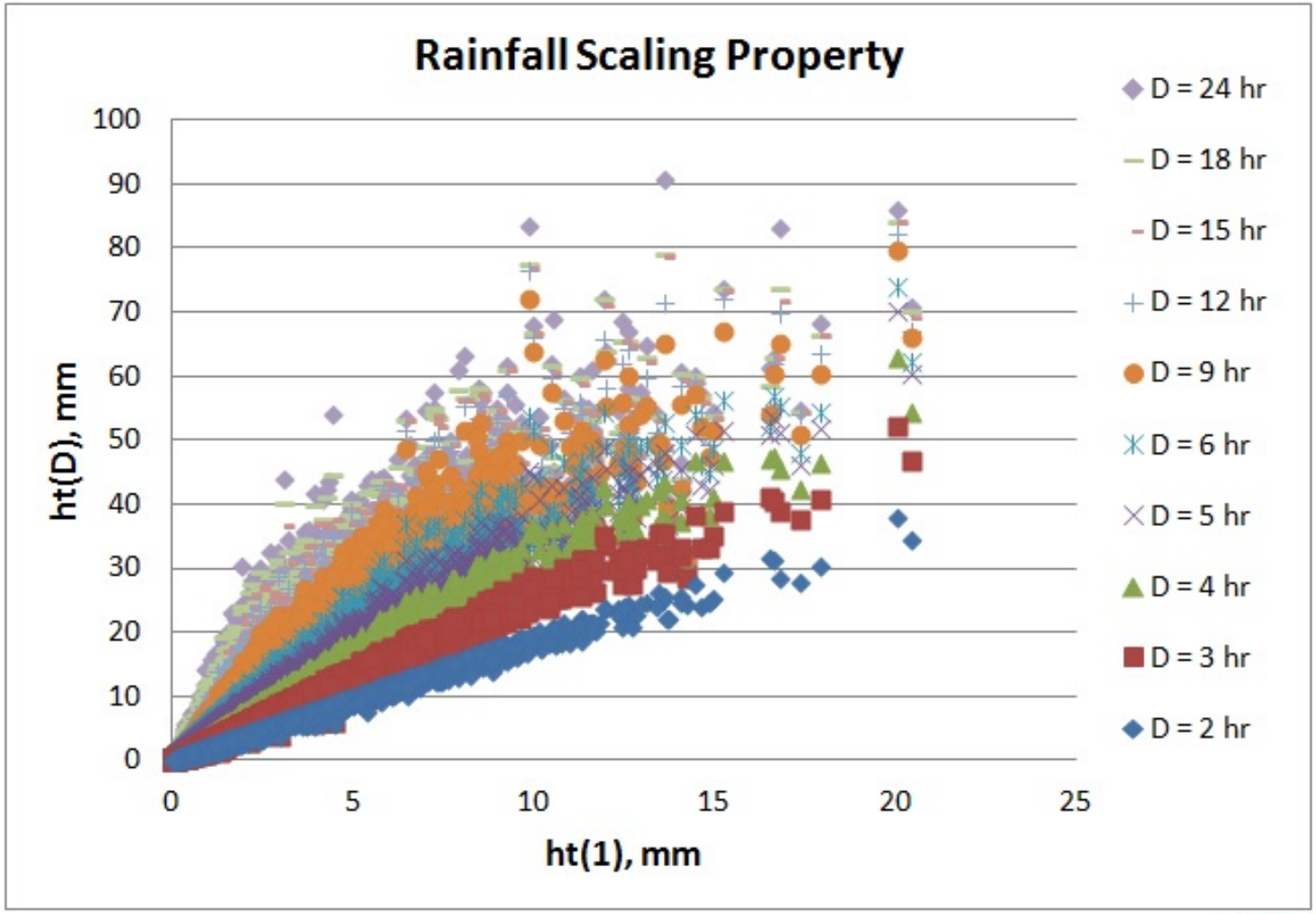
- **Wide sense simple scaling property**: extends the scale-invariant property to quantiles and moments

$$h_t(\lambda D) = \lambda^{\eta} h_t(D)$$

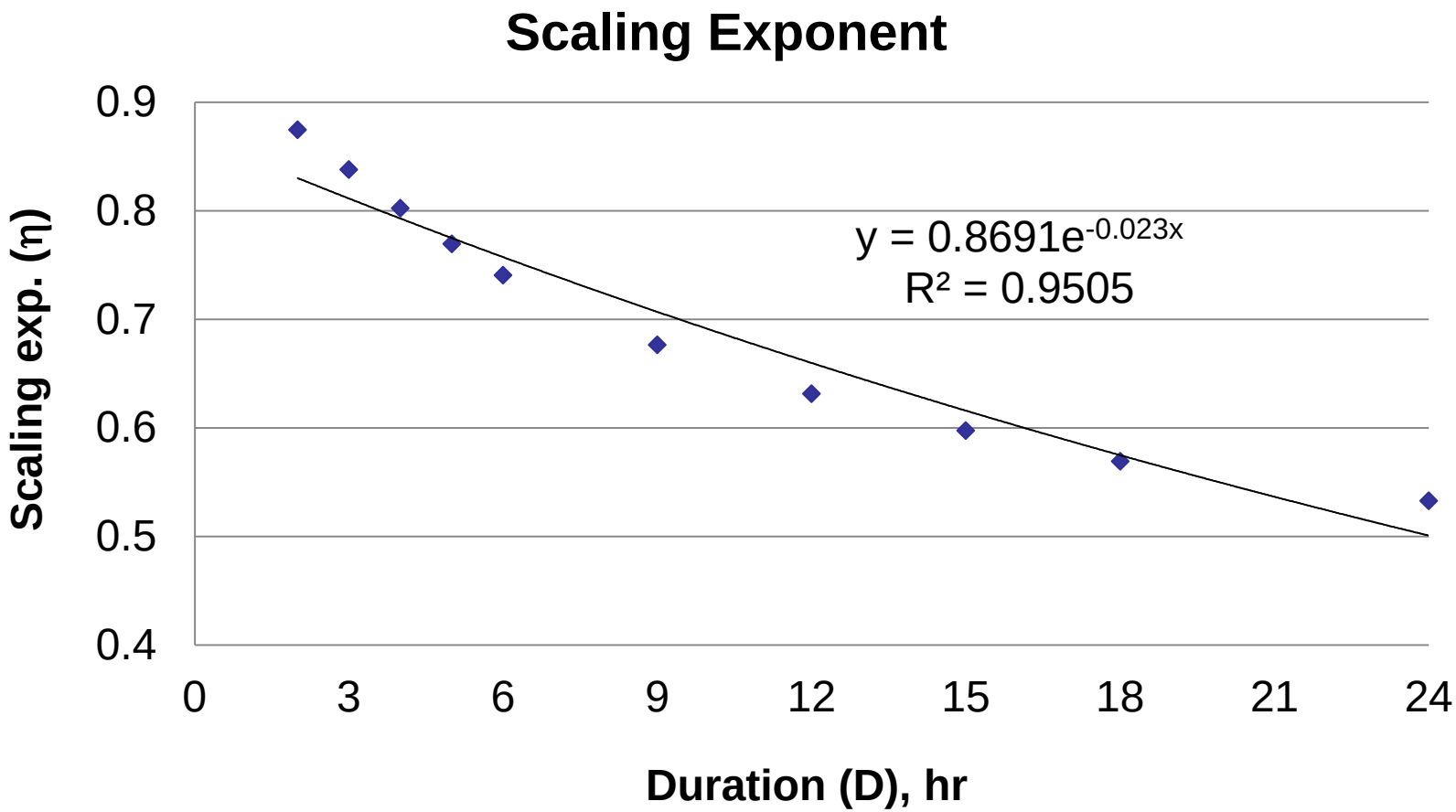
- If the **reference duration is 1hr**, then $\eta = D$

$$h_t(D) = D^{\eta} h_t(1)$$

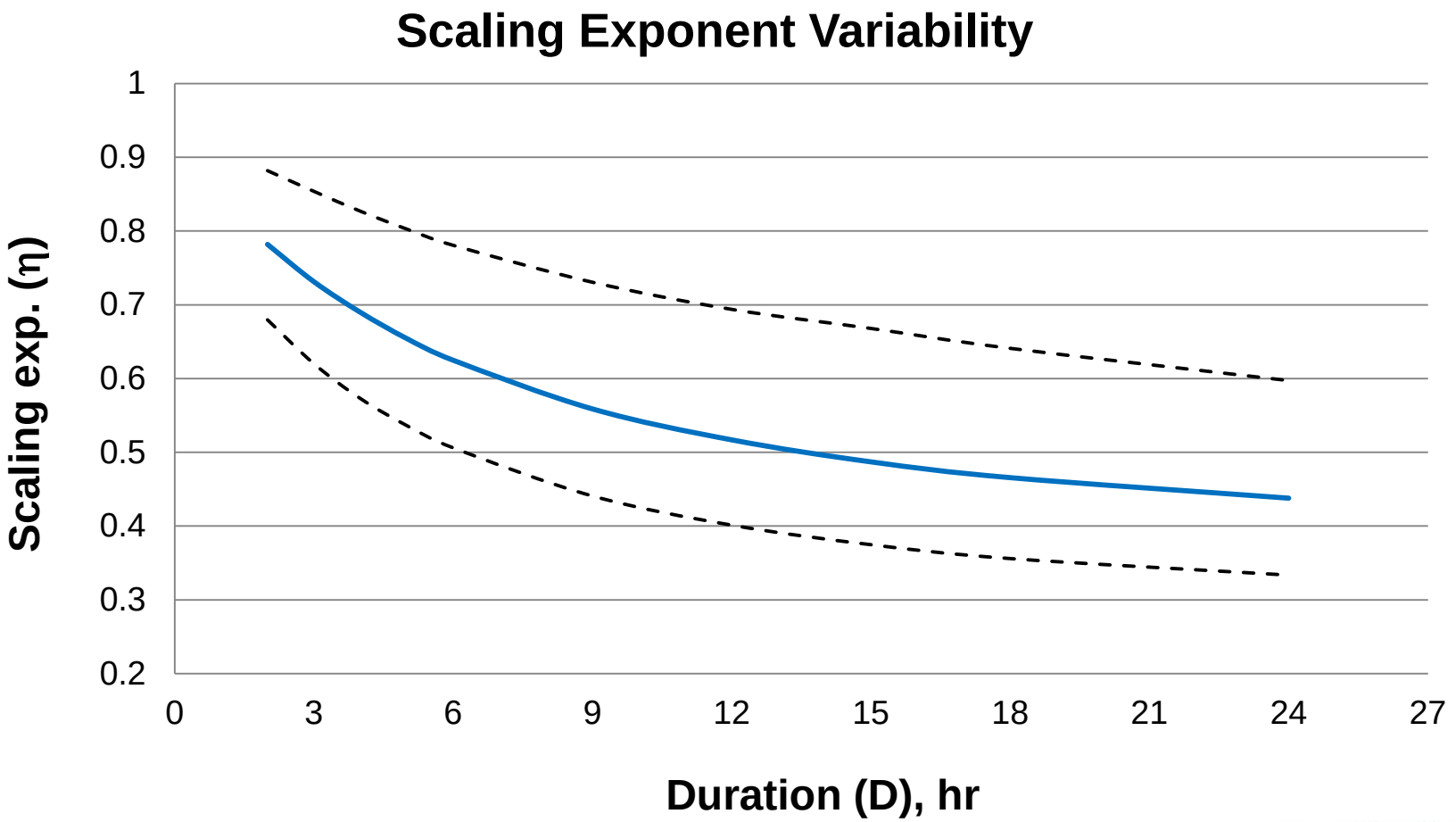
Maximum Half-hour Rainfall - 2



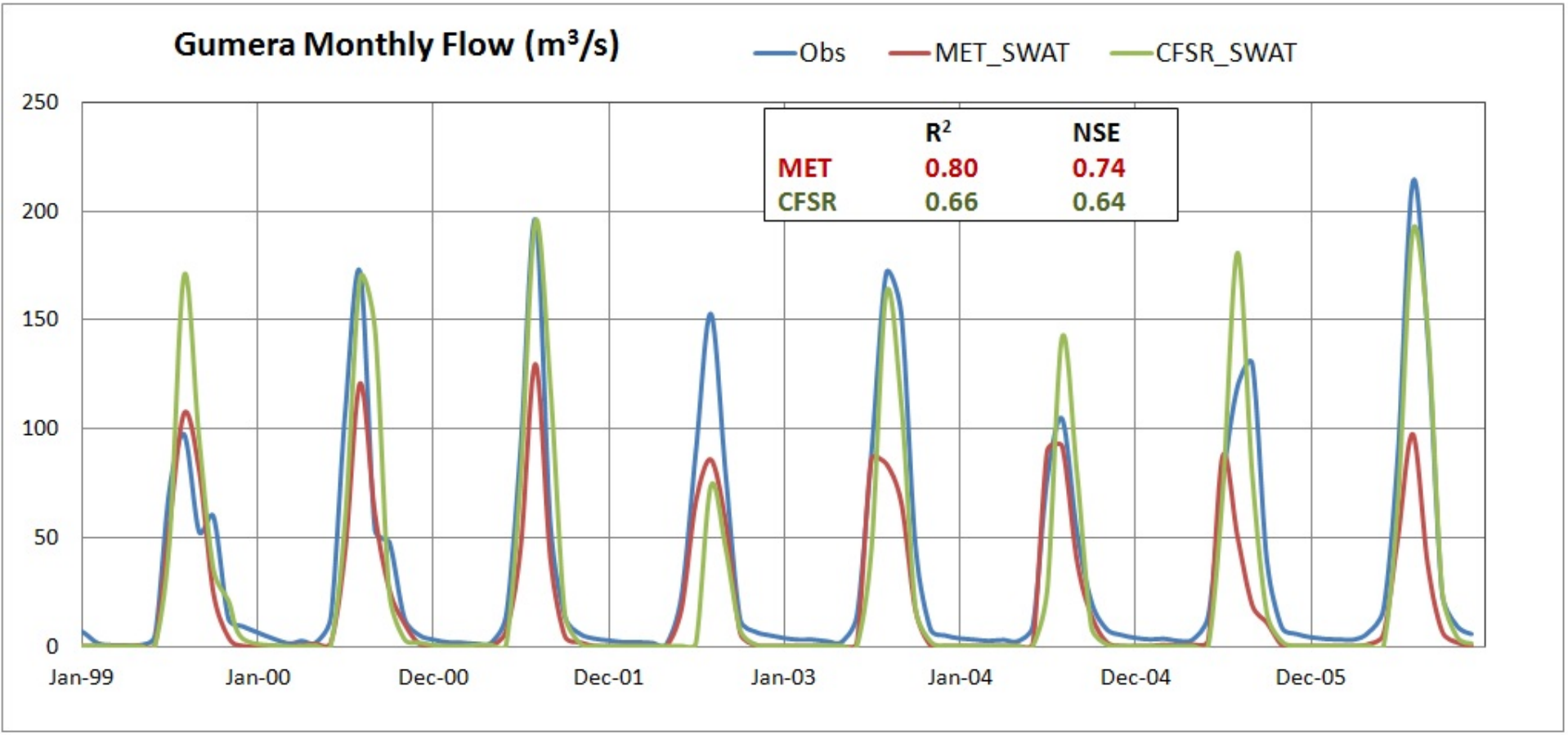
Maximum Half-hour Rainfall - 3



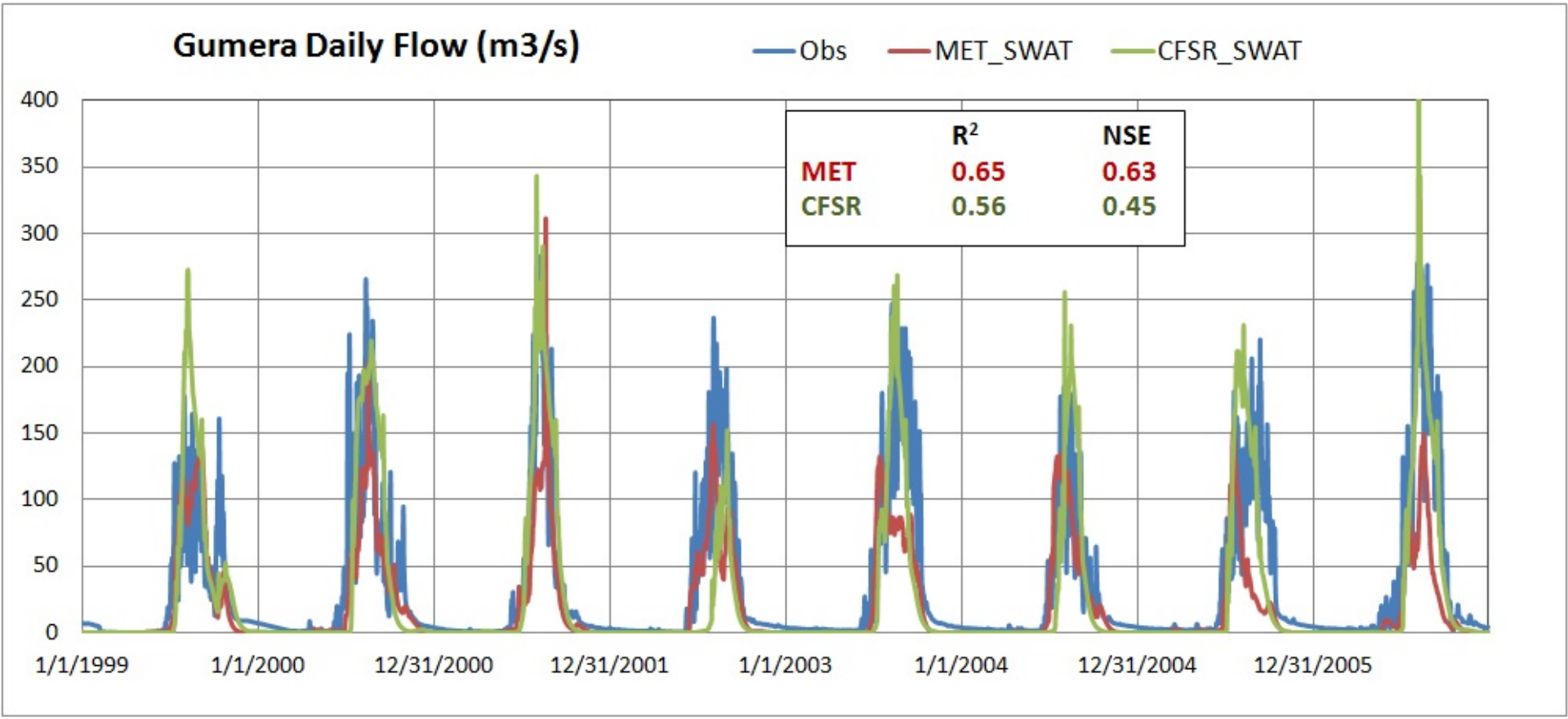
Maximum Half-hour Rainfall - 4



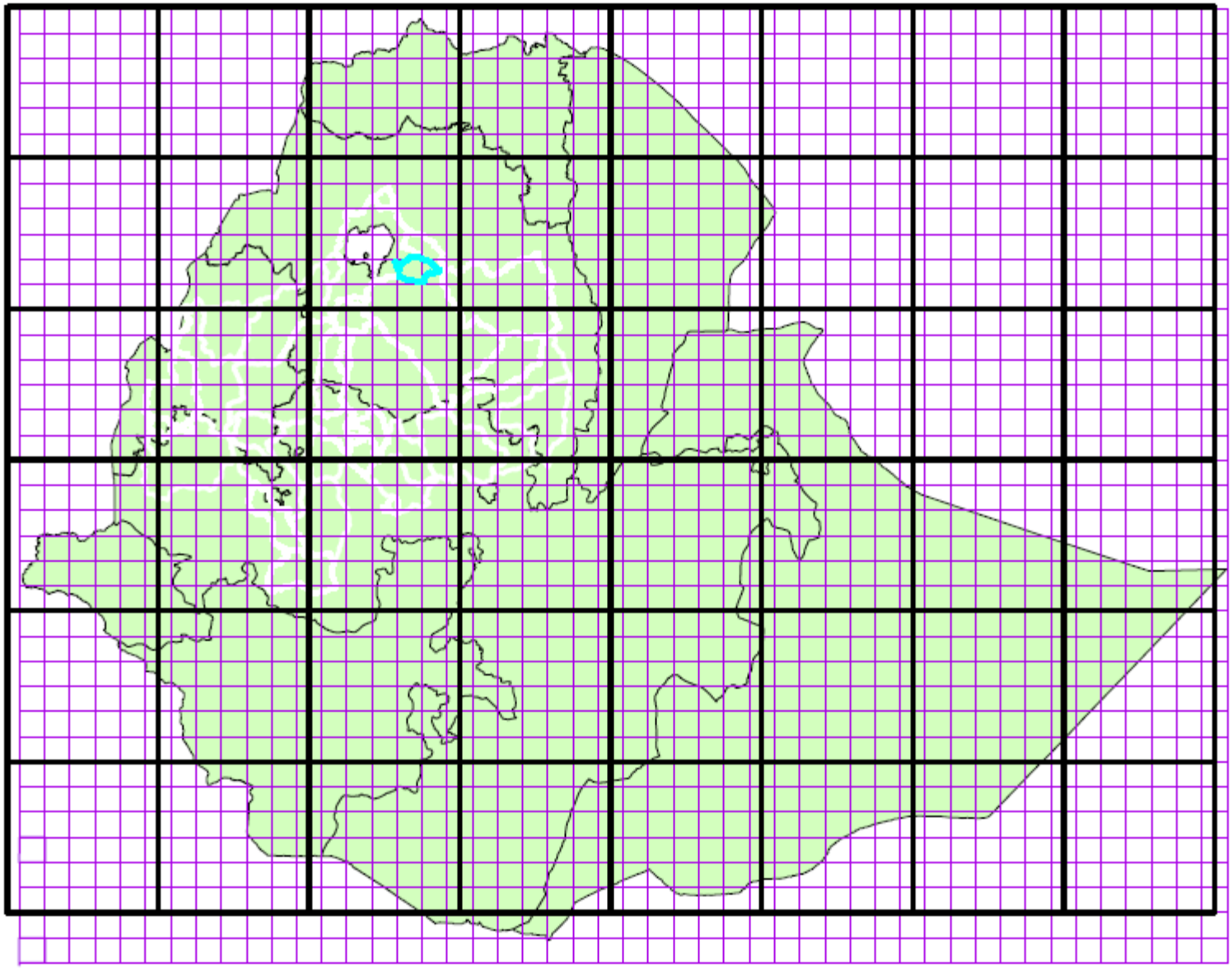
CFSR for SWAT Modeling - 1



CFSR for SWAT Modeling - 2

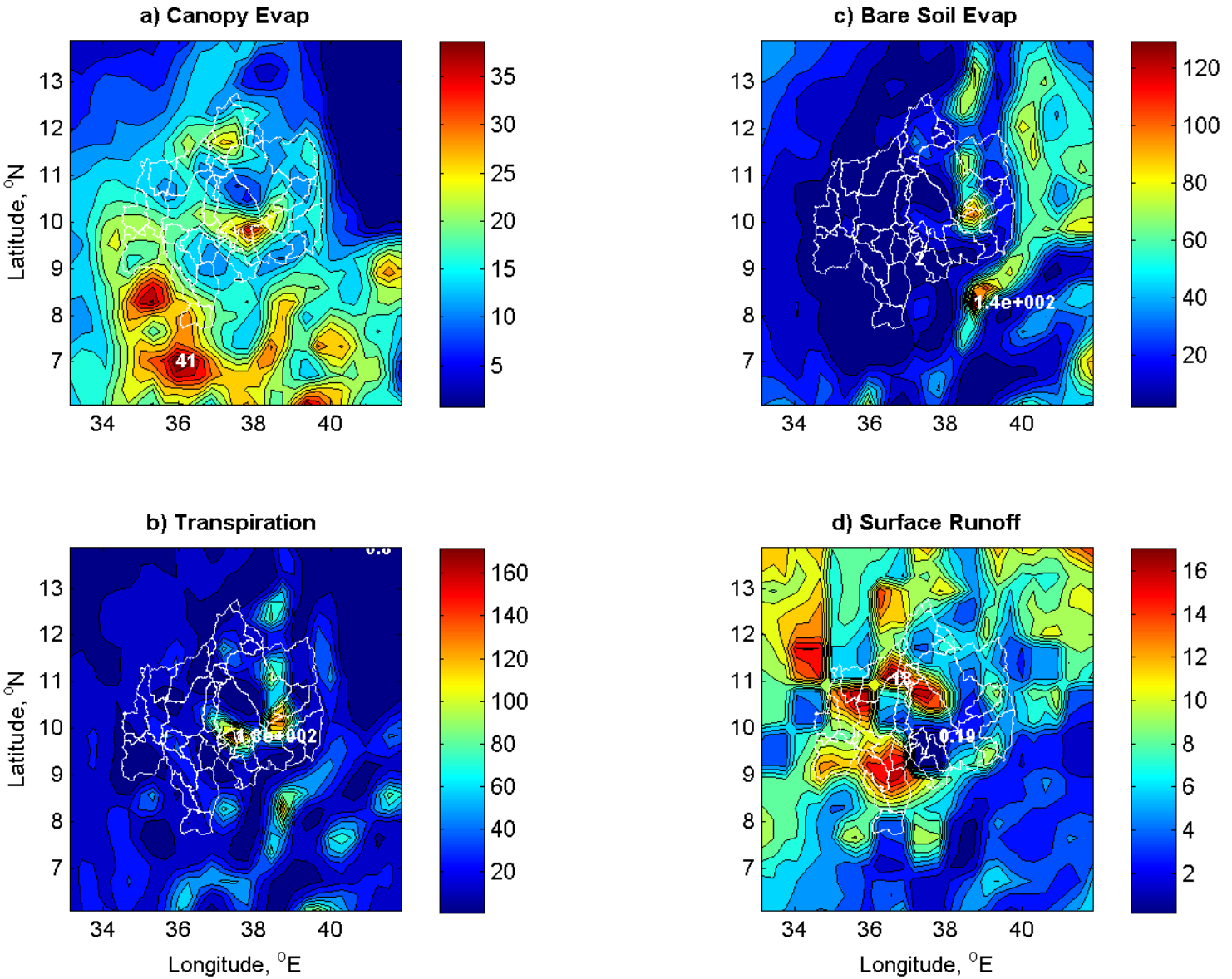


CFSR for Spatial Downscaling



CFSR for Water Fluxes Study

(percentage of water fluxes relative to rainfall in wet season)



Conclusions

- High resolution reanalysis data had great potential to improve modeling of landscape processes
- CFSR data has comparable performance as gauged climate data for SWAT modeling in Ethiopian highlands
- The spatial pattern of CFSR data is useful for spatial downscaling and bias correction of GCM data
- The water fluxes of the CFSR data could be to study large-scale fluxes without doing cumbersome data assimilation

Thank You!