Evaluating the Impact of Different Input Datasets and Model Configuration Uncertainty on Streamflow Simulations by Using SWAT Model

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Outline

- Introduction
- Aim and Scope
- Study Area
- Model Setup
- Results
- Conclusion

Introduction

- Performance of the watershed modeling studies is closely associated with the model input datasets

- Numerous databases are existing and freely available to the modelers in global or regional scale

- These datasets provide required input data to run models, their resolution and accuracies are needed to be investigated.

Aim and Scope

- Investigate the uncertainty caused from
  - Model input data
  - Model configuration (in terms of subbasin number)
  - Model parameterization
- For this purpose we setup a model for Melen Watershed
  - 2 different climate dataset
  - 3 different LULC dataset
  - 3 different subbasin number
- We consider only hydrology
  - Streamflow at outlet of the watershed

Study Area (Melen Watershed)

Black Sea

Melen Watershed

188 km

Marmara Sea
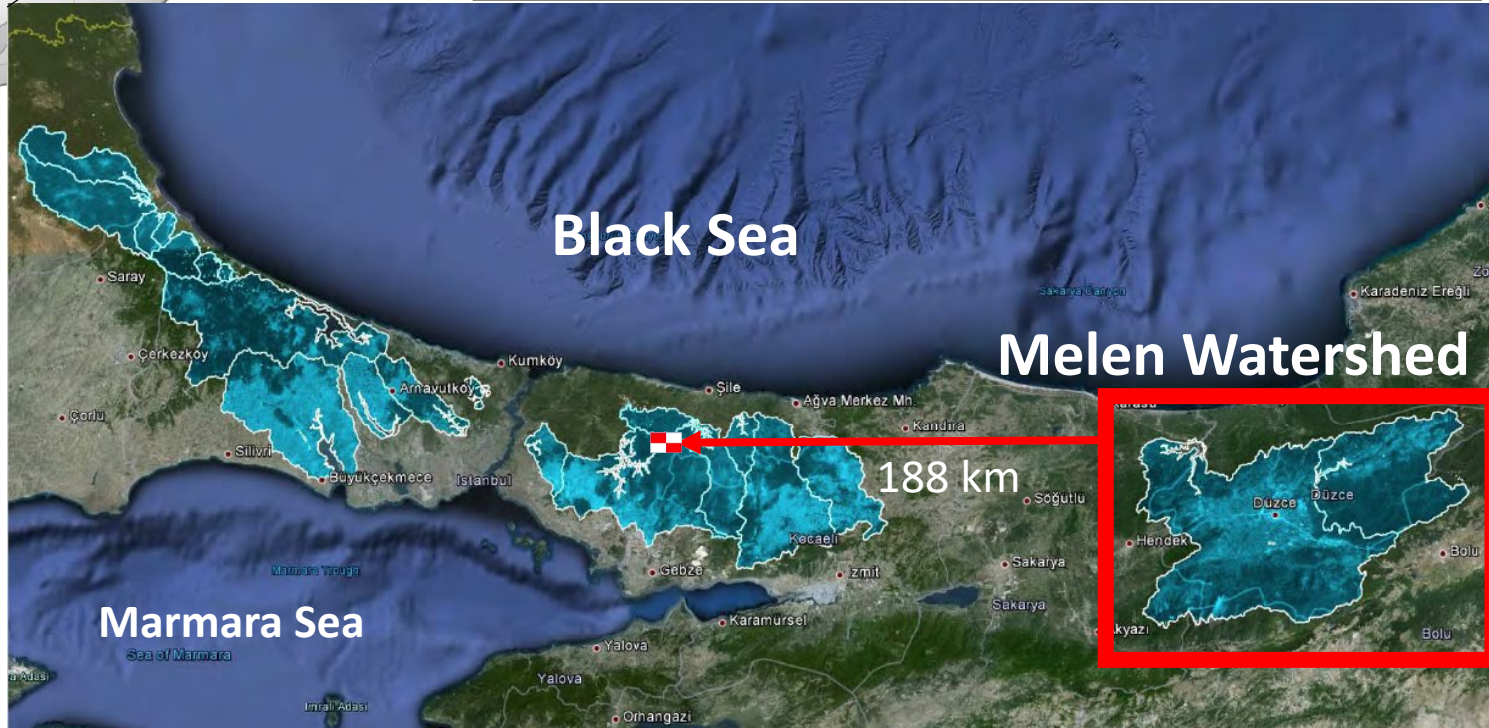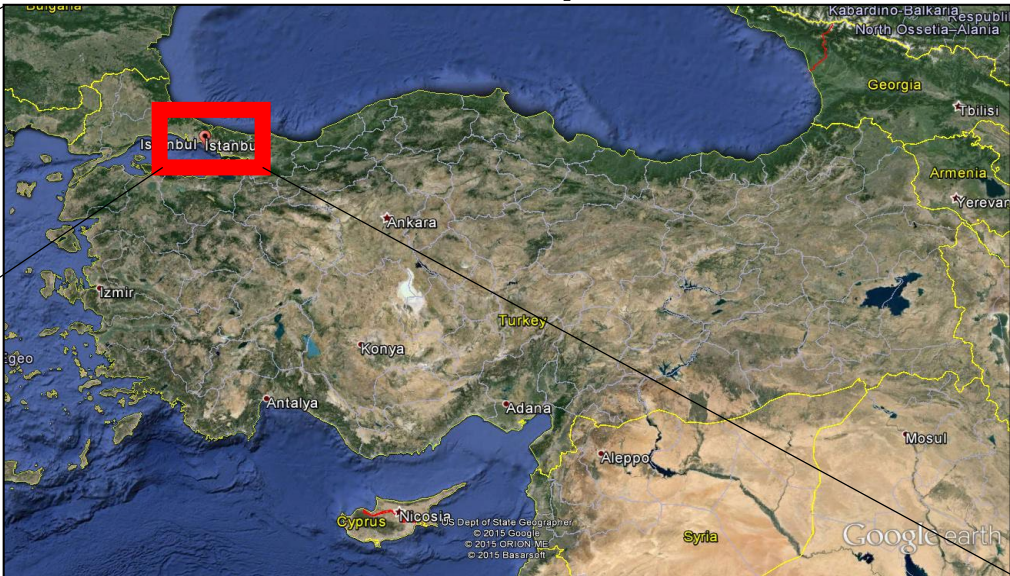
Study Area (Melen Watershed)
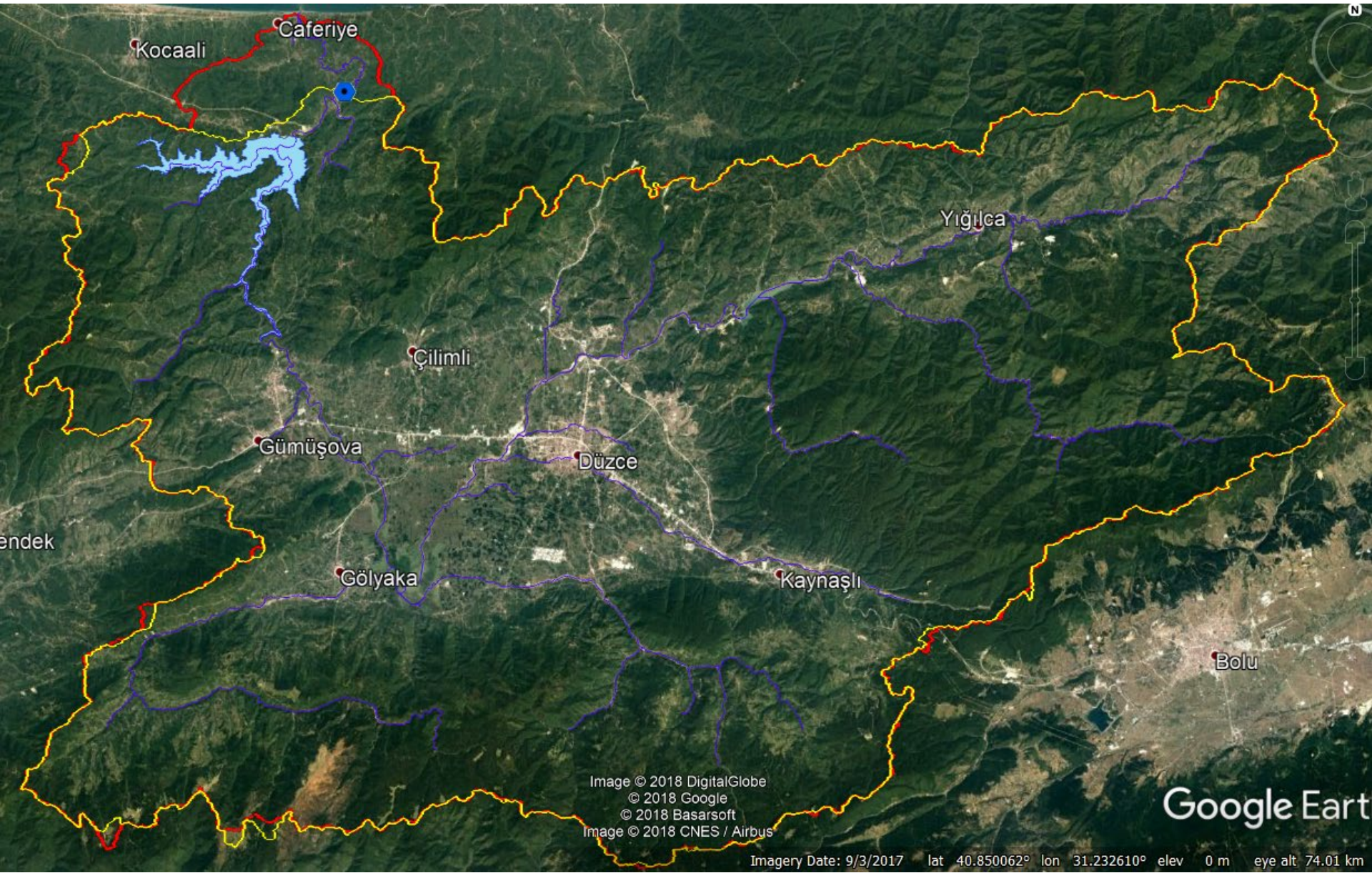
Data Sources

- Digital Elevation Map SRTM 90m

- Soil FAO

- Land Use Data Set
    - Corine Land Cover
    - Landsat Land Use Map
    - STATIP (Turkish Ministry of Agriculture)

- Climate Data Set
    - CFSR (1979-2014)
    - MGM - Local Measurement (1960-2013)

- Discharge Data
    - Turkish State of Hydraulics (1 station - monthly)
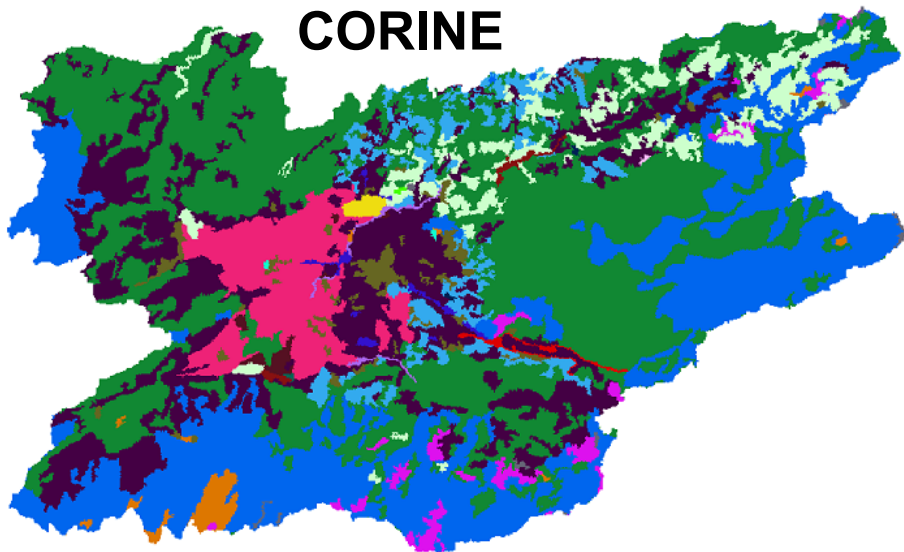
Compulsory Data

Calibration

Model Setup

- Simulation period (1995) 2000 - 2013
- 5 years warmup
- SCS-CN Method
- Hargreaves Method

- SWAT-CUP using SUFI-2 algorithm
- 60% of streamflow used for calibration
- NSE as an objective function
- Performance criteria NSE, R2, PBIAS as well as P-factor and R-factor
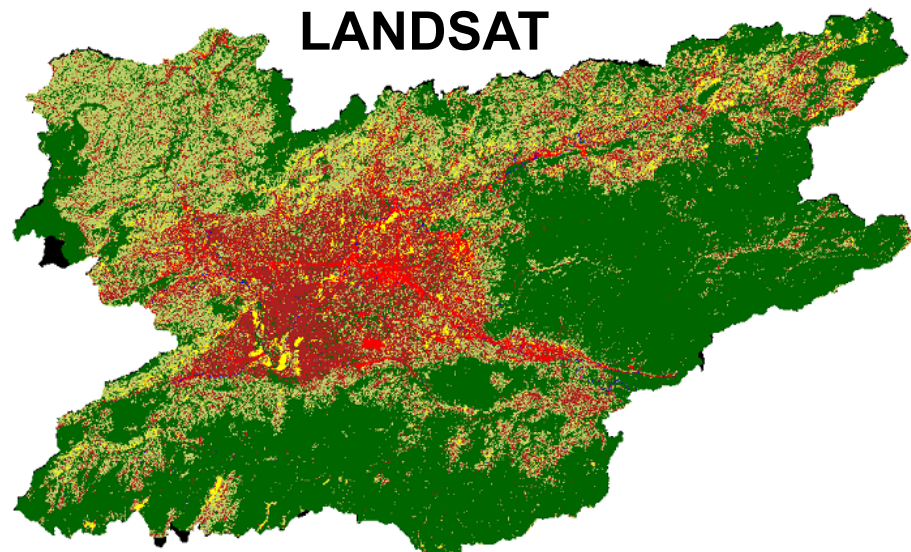
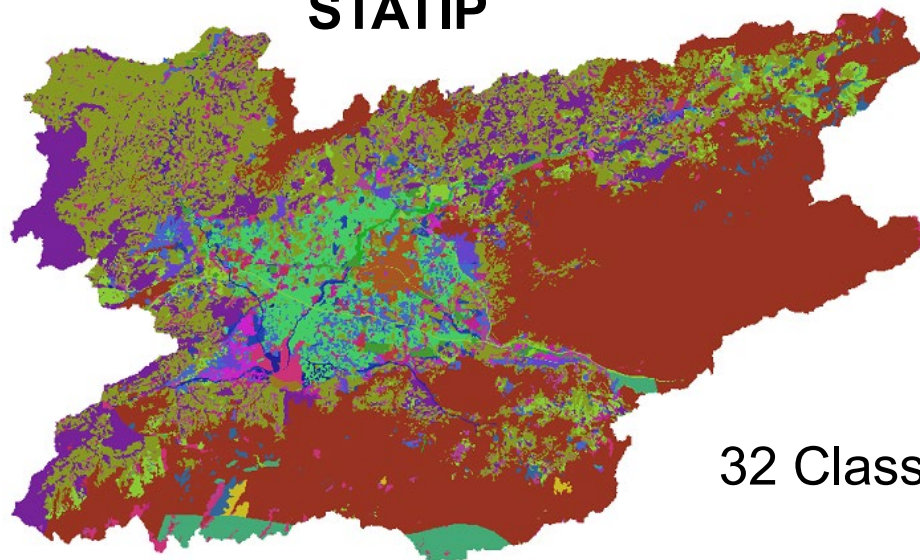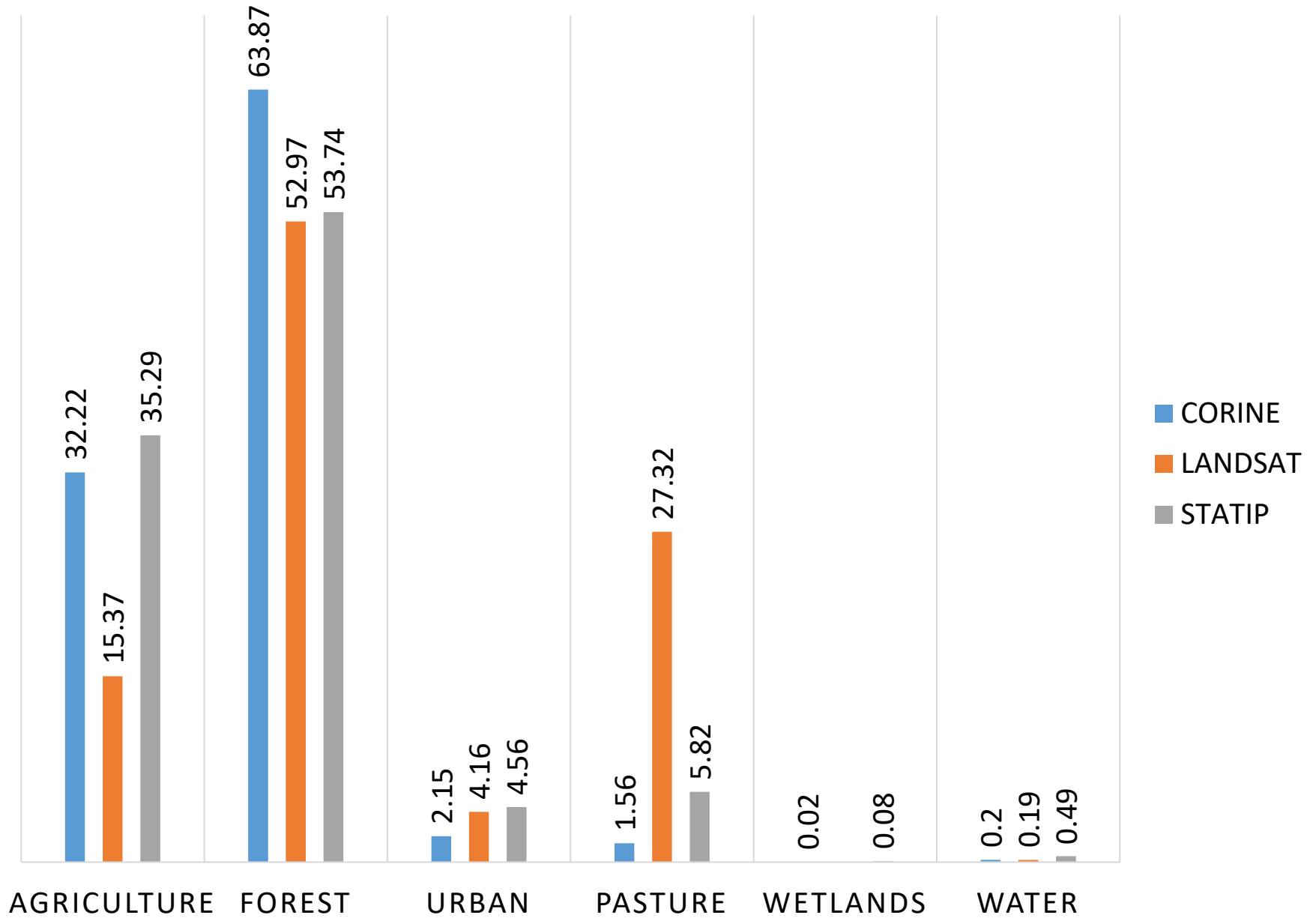# Landuse Data

CORINE

22 Classes, 100m

LANDSAT

7 Classes, 30m

STATIP

32 Classes, 10m

Landuse Data

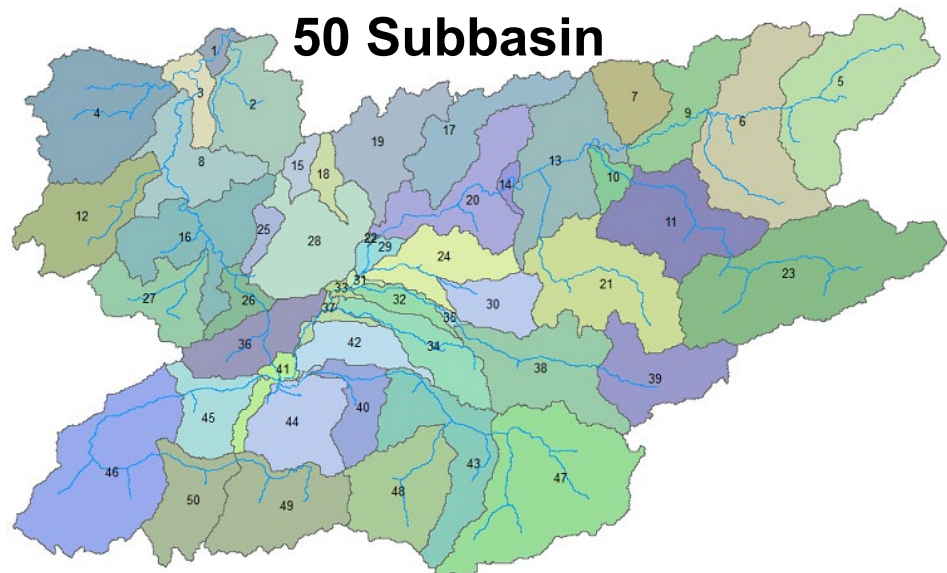|	AGRICULTURE	FOREST	URBAN	PASTURE	WETLANDS	WATER
CORINE	32.22	63.87	2.15	1.56		0.2
LANDSAT	15.37	52.97	4.16	27.32	0.02	0.19
STATIP	35.29	53.74	4.56	5.82	0.08	0.49

Subbasin Configuration
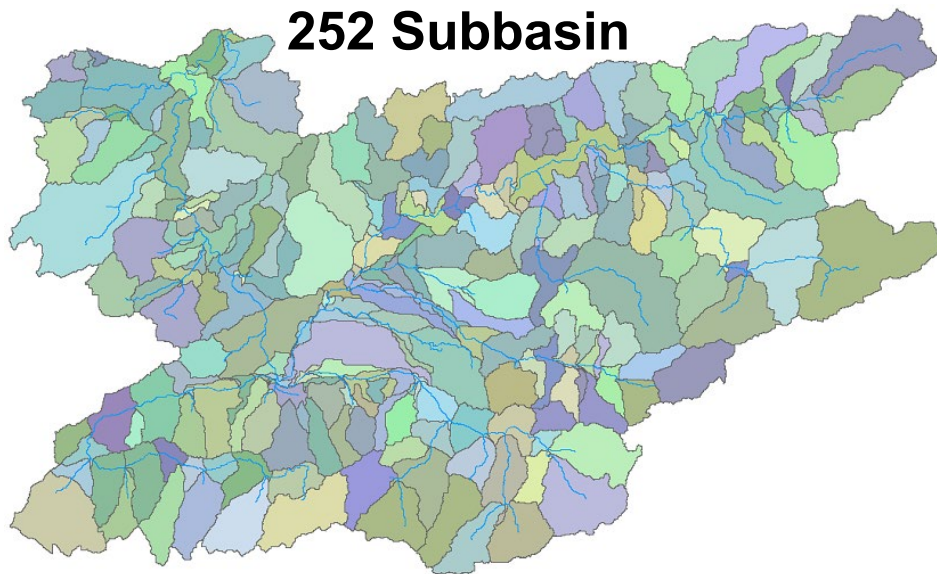

7 Subbasin
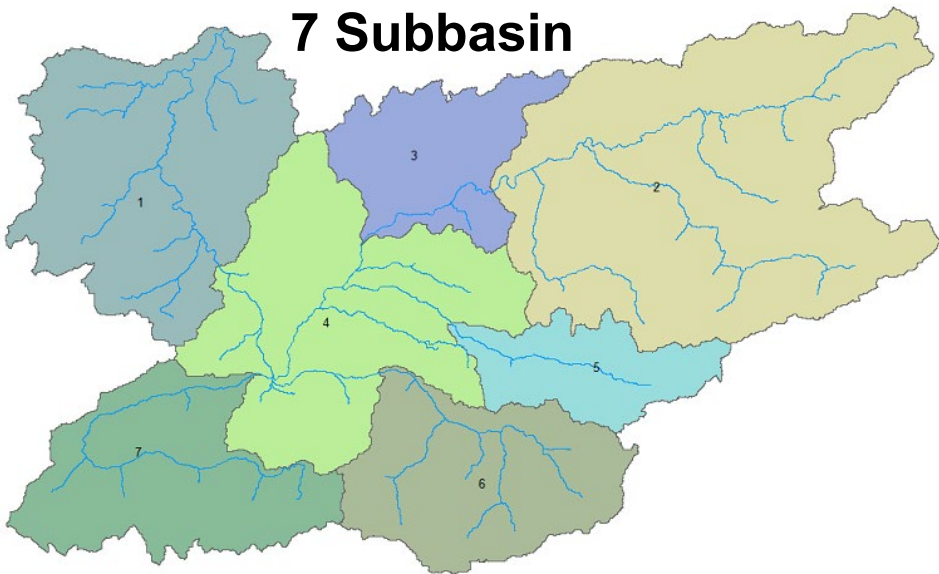
50 Subbasin

252 Subbasin

Climate Data

KARASU

Black Sea

AKCAKOCA

411309

411313

411316

N

DUZCE

407309

407313

407316
BOLU

Annual Precipitation
MGM : 840 mm
CFSR : 1011 mm

Legend

CFSR Climate Stations

MGM (Local) Climate Stations

River

Watershed Boundary

Elevation
High : 1952 m

Low : 4.80 m

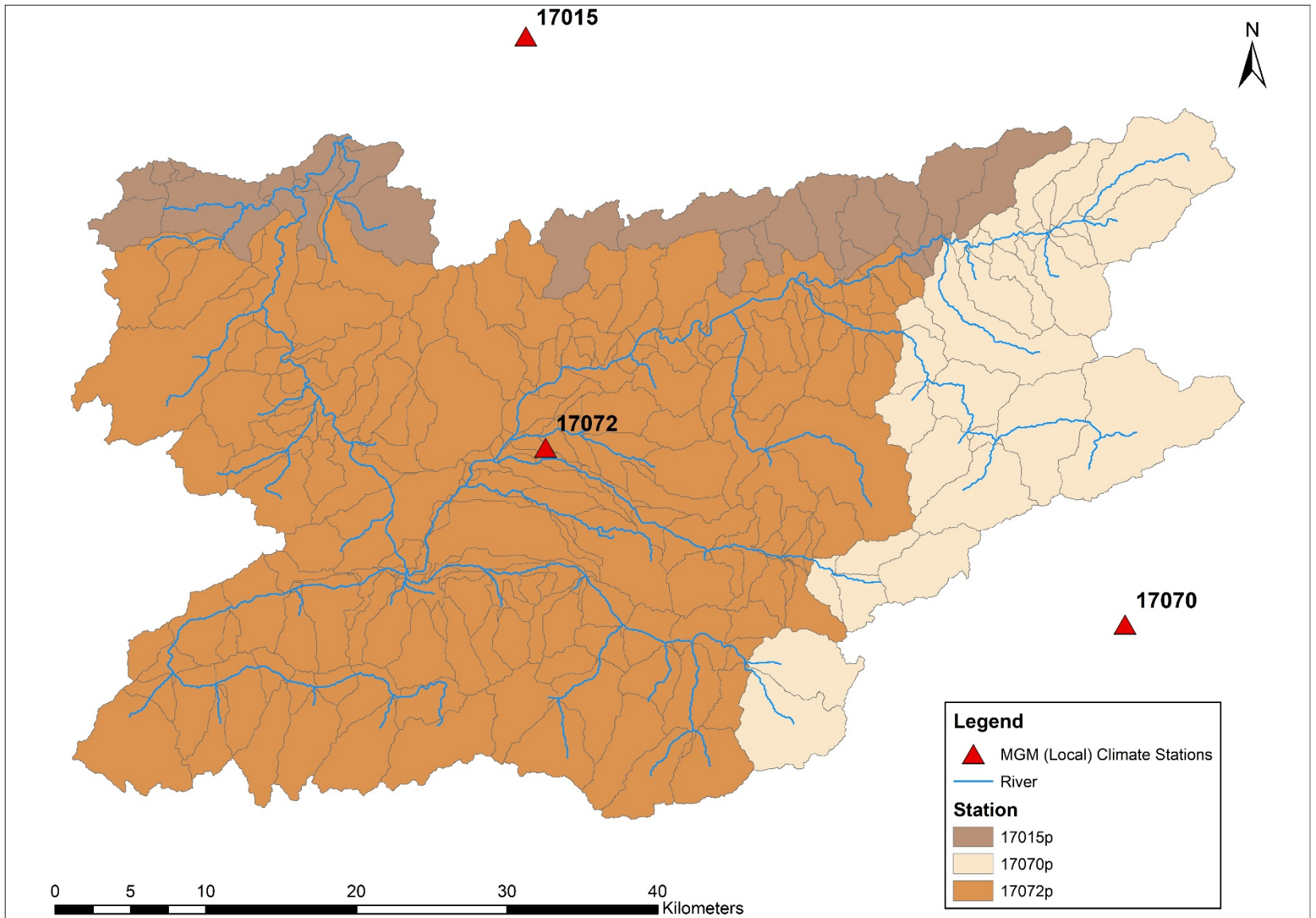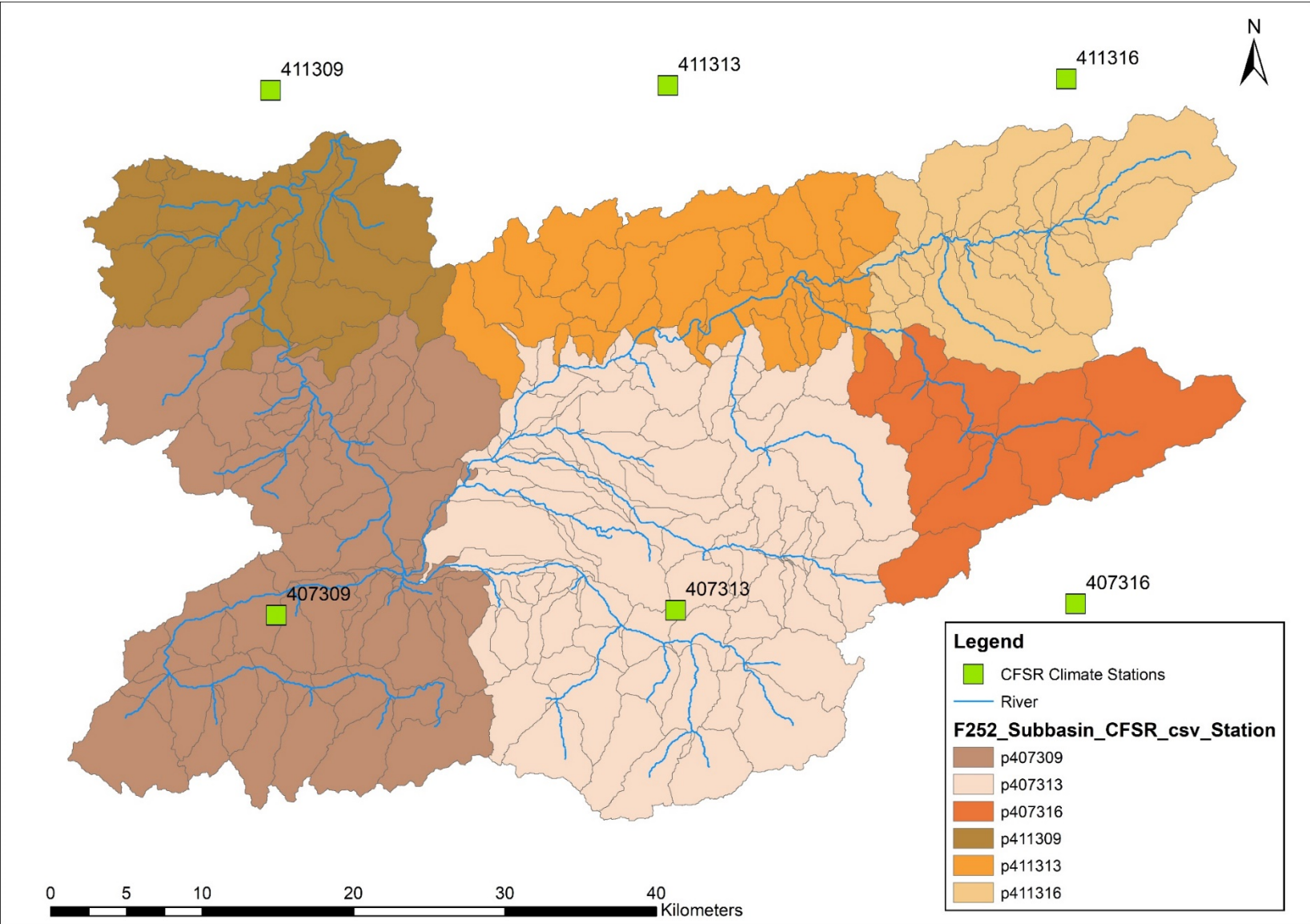0   5   10   20   30   40
Kilometers
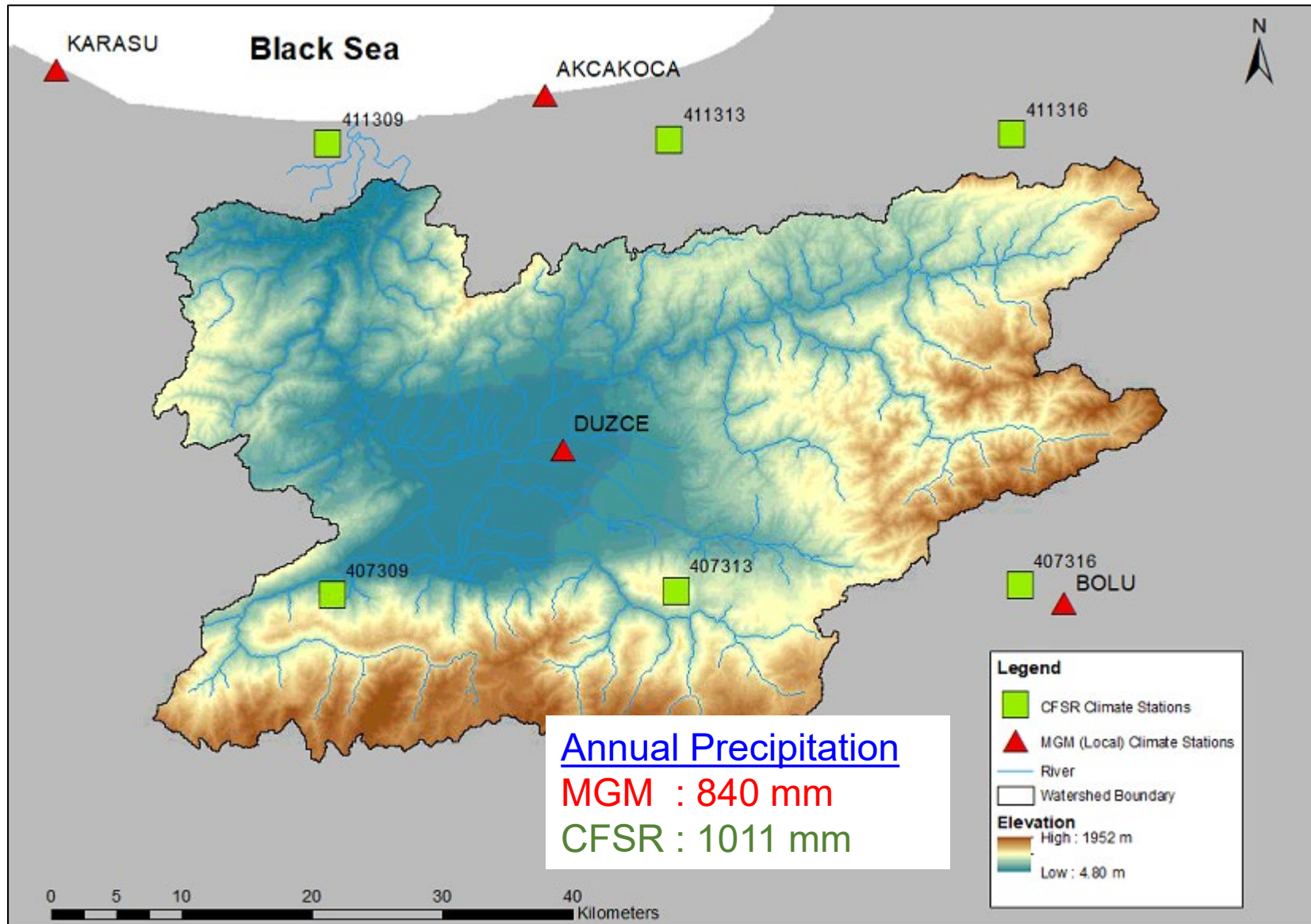
Subbasin No vs. Climate Data

Subbasin No vs. Climate Data

Model Configuration Setup

Subbasin Number

Landuse Dataset

Climate Dataset

7   50   252

Corine   Landsat   Statip
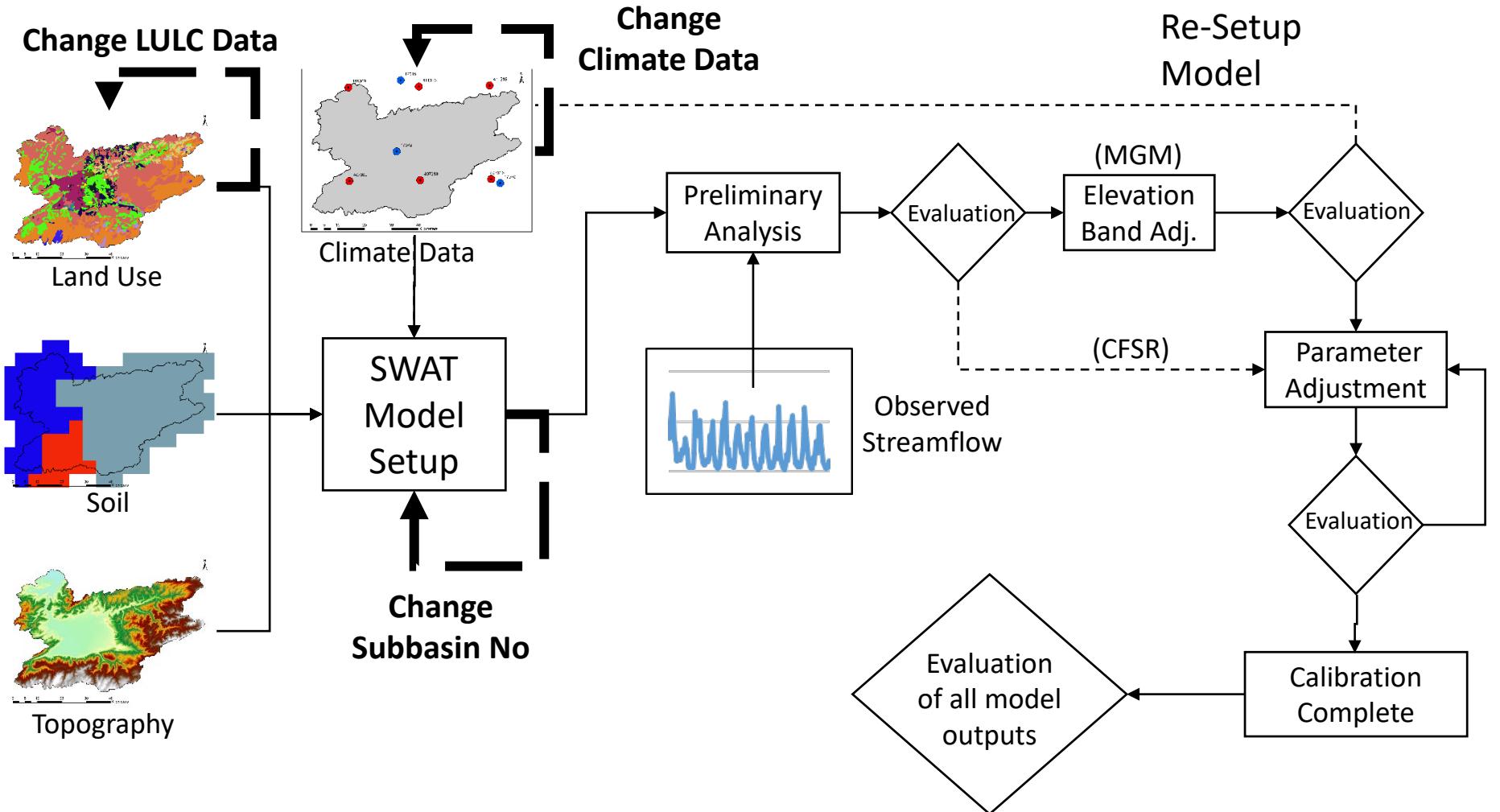
CFSR   MGM
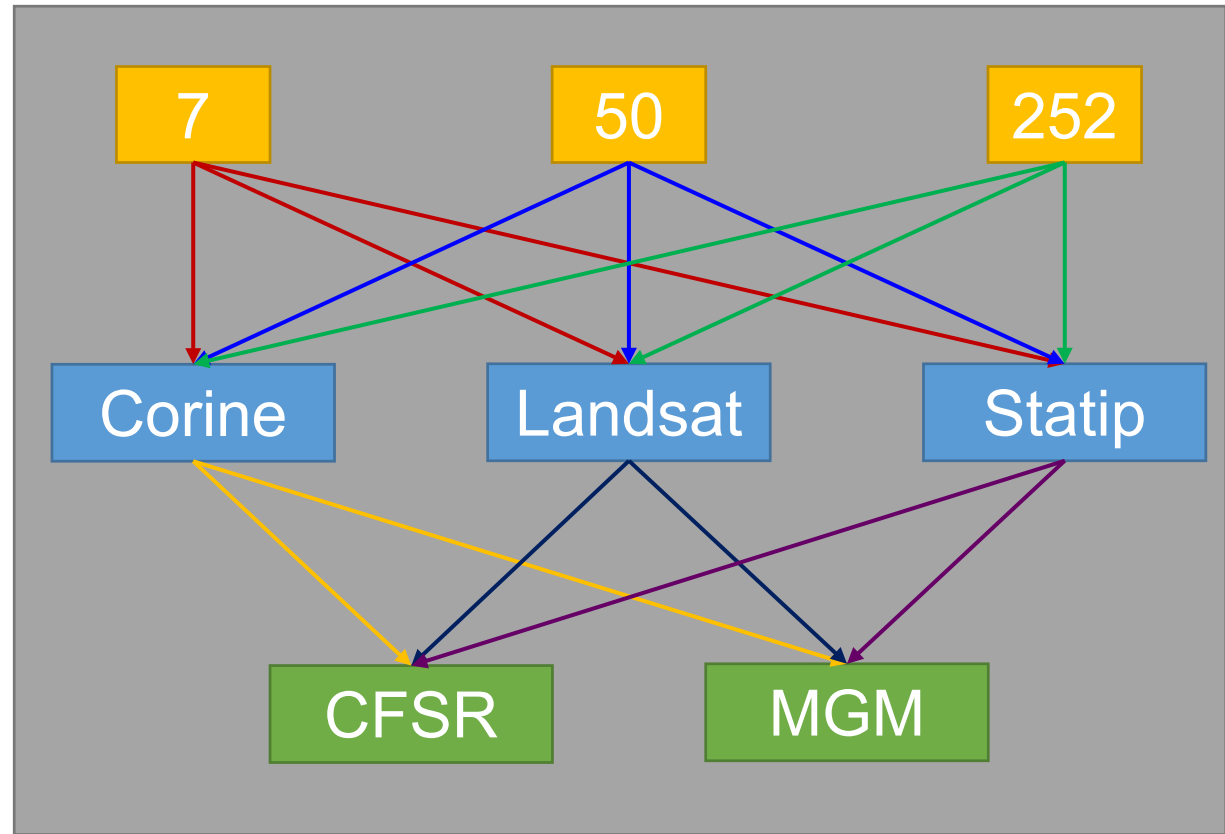
- **18 Different Model Setup**

SubbasinNo_Landuse_Climate
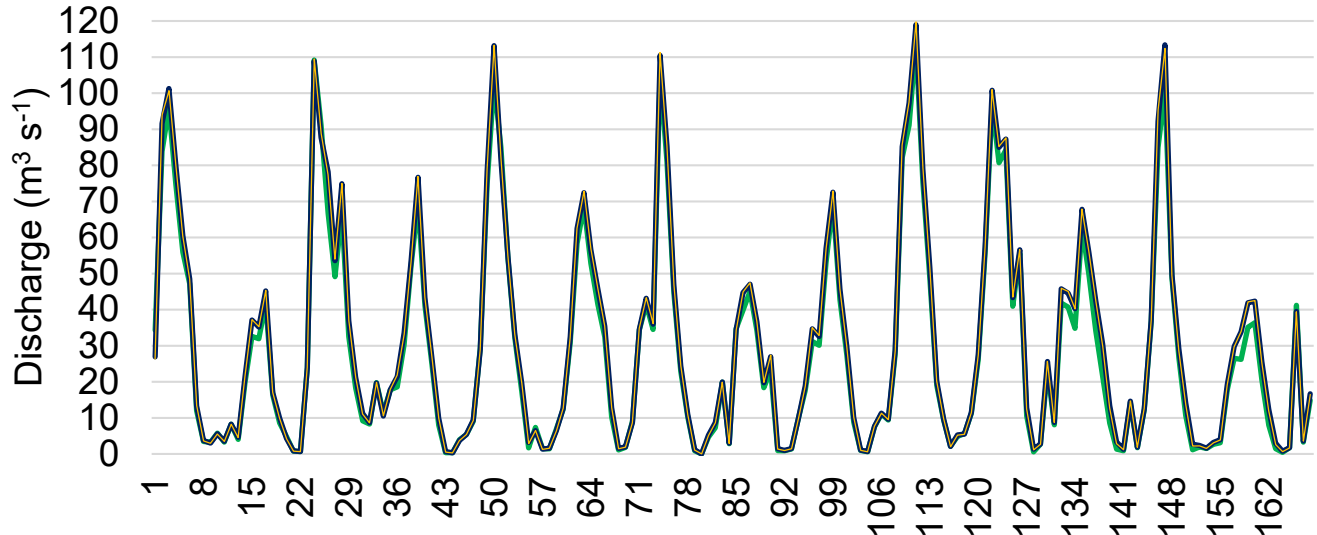
7_COR_CFSR

252_LAND_MGM
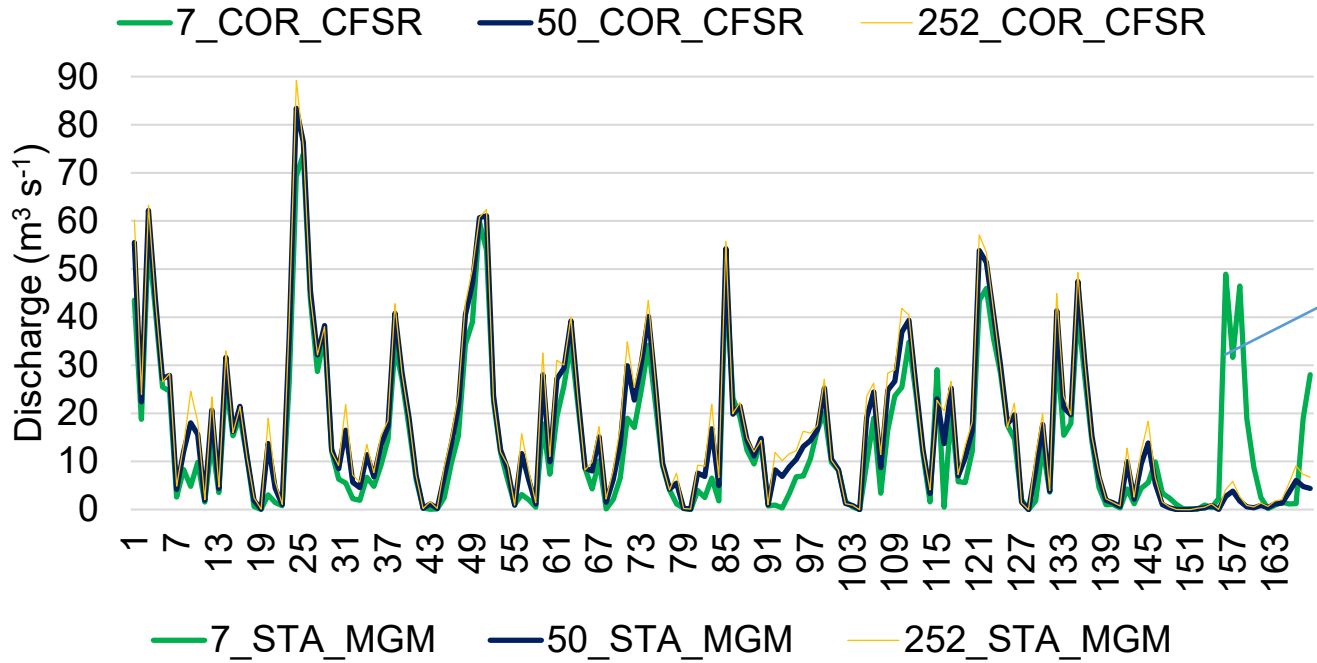
50_STA_MGM

Methodology

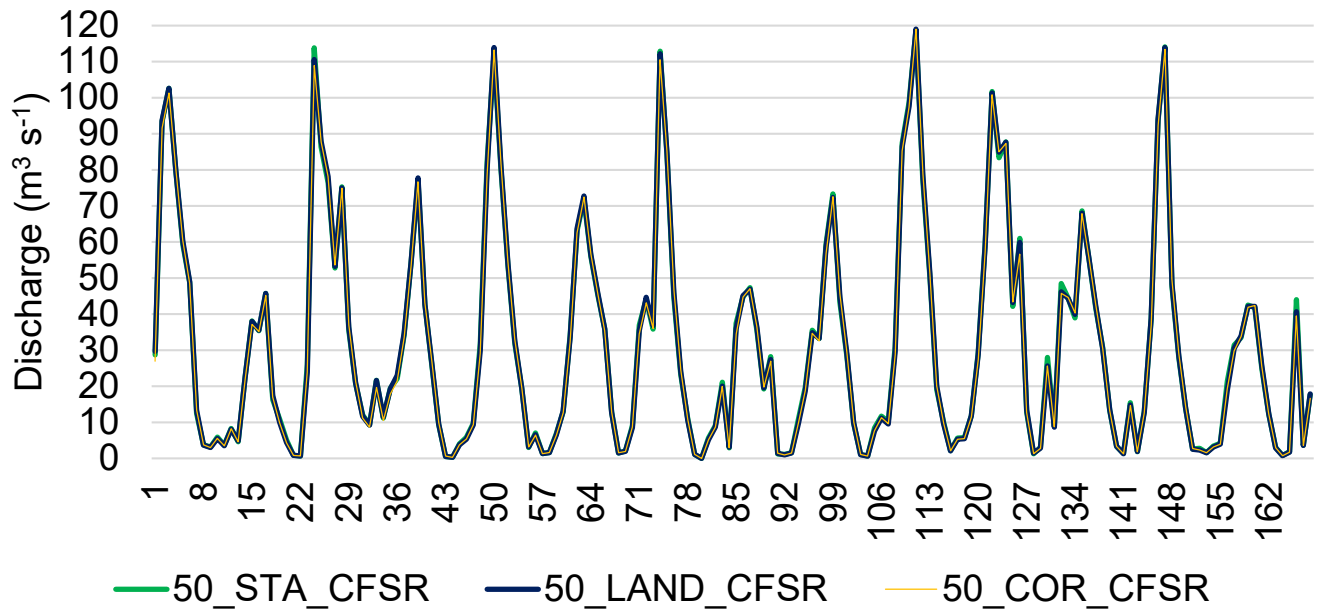# Comparison of Subbasin No.

- First Simulations before calibration
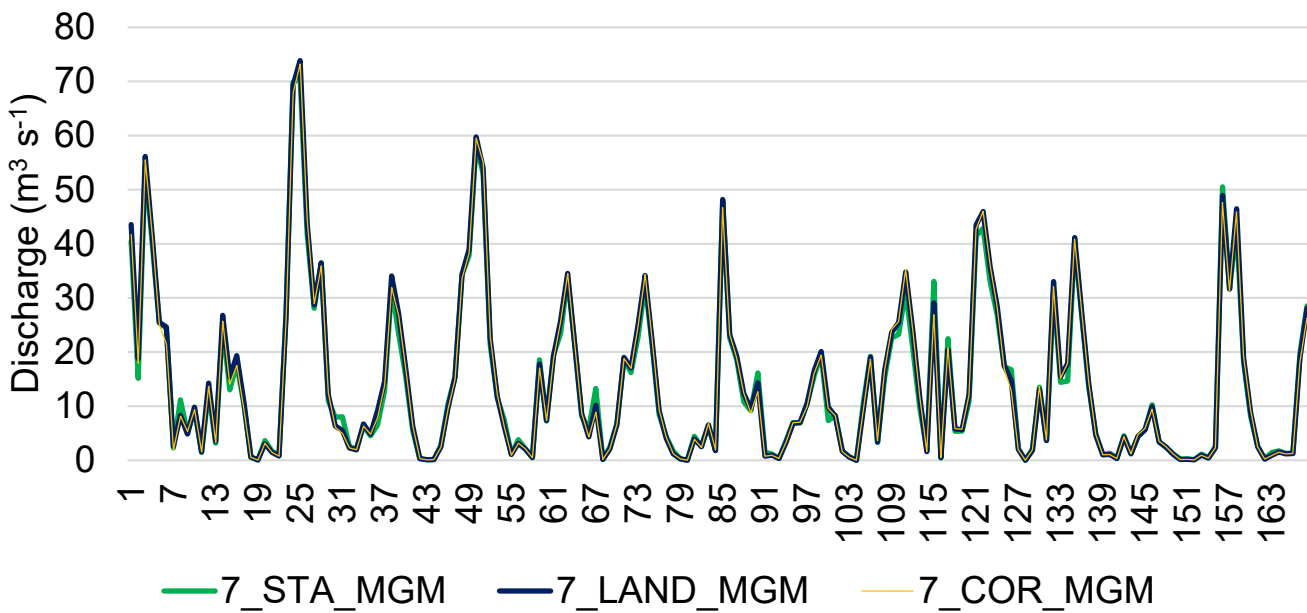- In order to compare effects of subbasin number
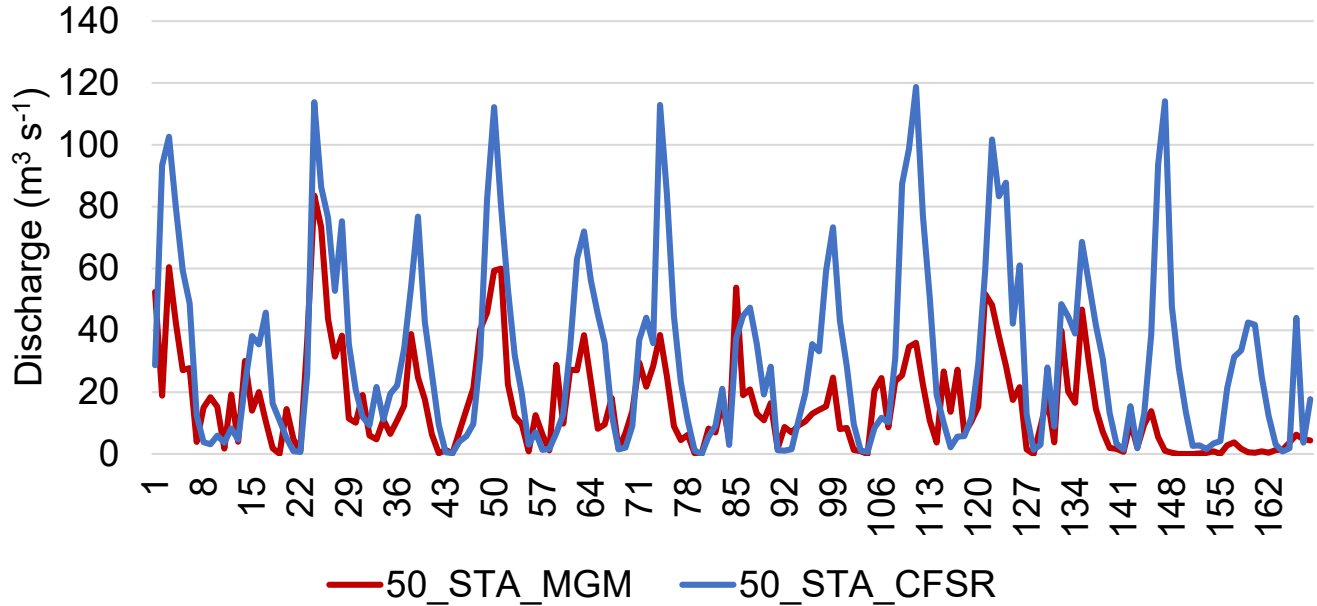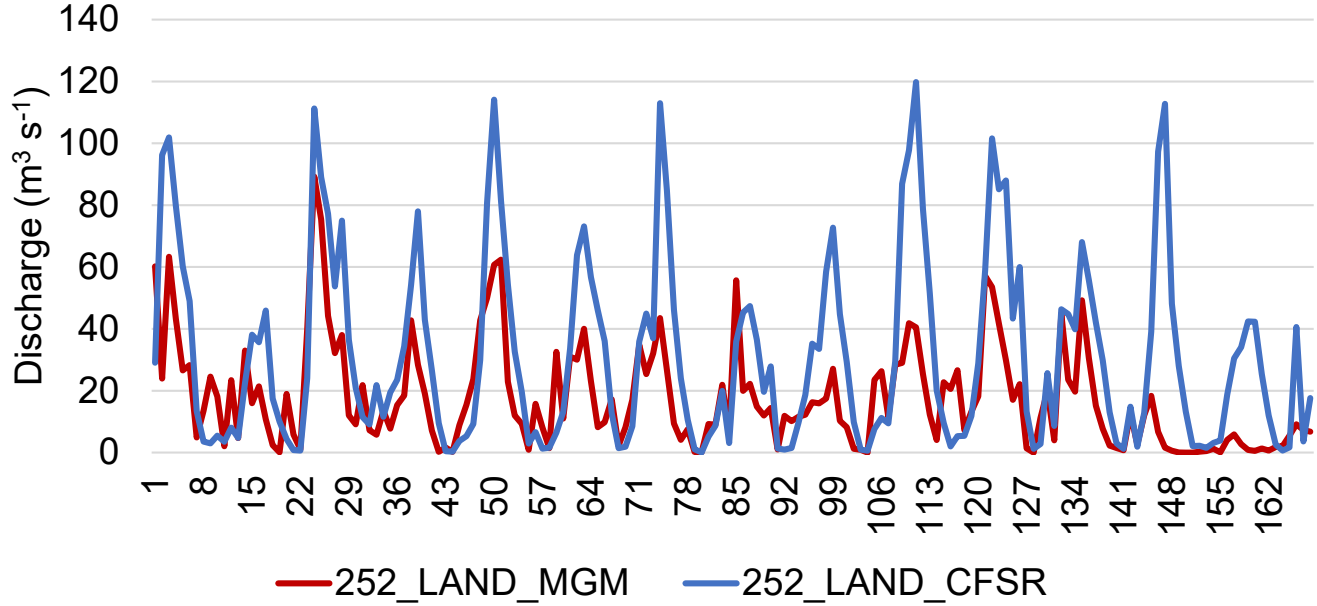- No obs. data

Subbasin Config.

Comparison of Landuse Data

- First Simulations before calibration
- In order to compare effects of landuse datasets
- No obs. data

Comparison of Climate Data

- First Simulations before calibration
- In order to compare effects of climate data
- No obs. data

Perfomance Criteria for First Sim.

Model Name	R2	bR2	NS	BPIAS
7_COR_CFSR	0.79	0.5594	0.63	31.6
7_COR_MGM	0.52	0.1602	-0.22	67.1
7_STA_CFSR	0.78	0.5574	0.64	31
7_STA_MGM	0.48	0.1404	-0.25	67.4
7_LAND_CFSR	0.78	0.5588	0.64	31
7_LAND_MGM	0.51	0.1576	-0.21	66.6
50_COR_CFSR	0.78	0.5843	0.68	26.9
50_COR_MGM	0.48	0.1546	-0.13	62.3
50_STA_CFSR	0.78	0.5842	0.68	26.1
50_STA_MGM	0.45	0.1375	-0.16	62.5
50_LAND_CFSR	0.78	0.5845	0.68	26.3
50_LAND_MGM	0.48	0.1533	-0.12	61.7
252_COR_CFSR	0.78	0.5853	0.67	26.8
252_COR_MGM	0.46	0.1455	-0.09	59.1
252_STA_CFSR	0.78	0.5852	0.68	26
252_STA_MGM	0.43	0.1294	-0.12	59.2
252_LAND_CFSR	0.78	0.5857	0.68	26.2
252_LAND_MGM	0.45	0.1439	-0.08	58.6

Flow Duration Curve

Flow Duration curve for the first simulations of all 18 models
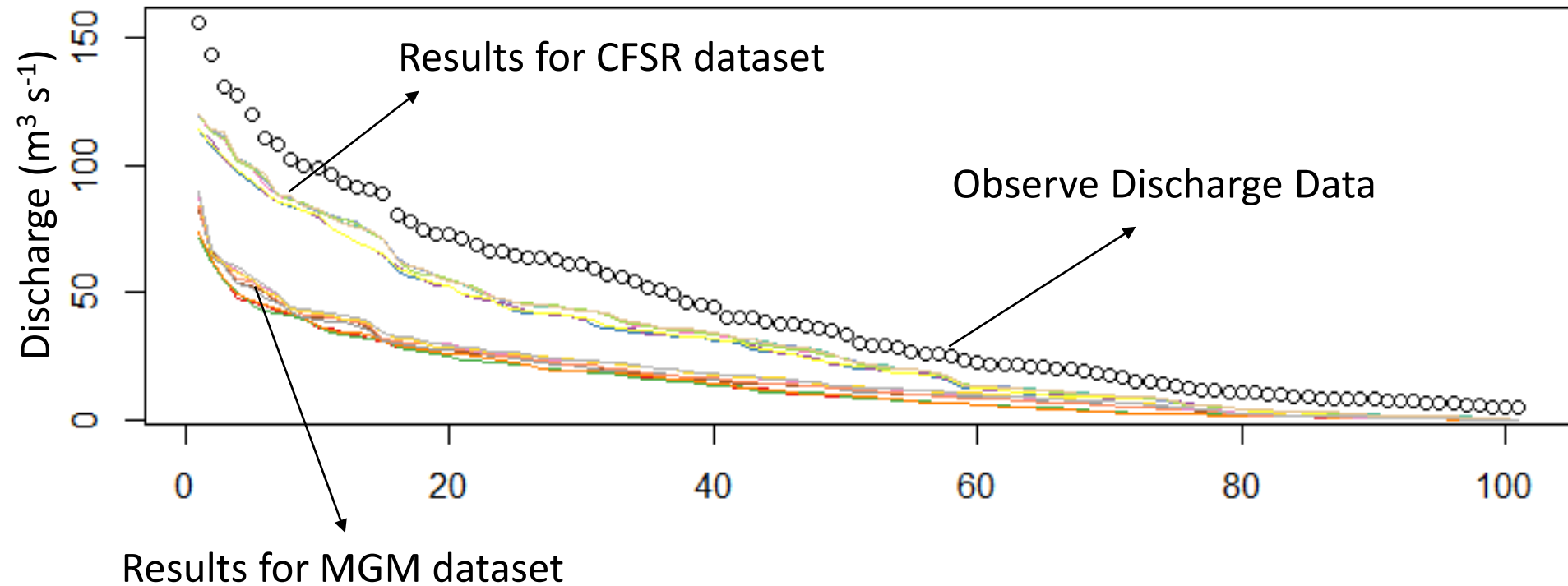
Ex. time series for first simulation
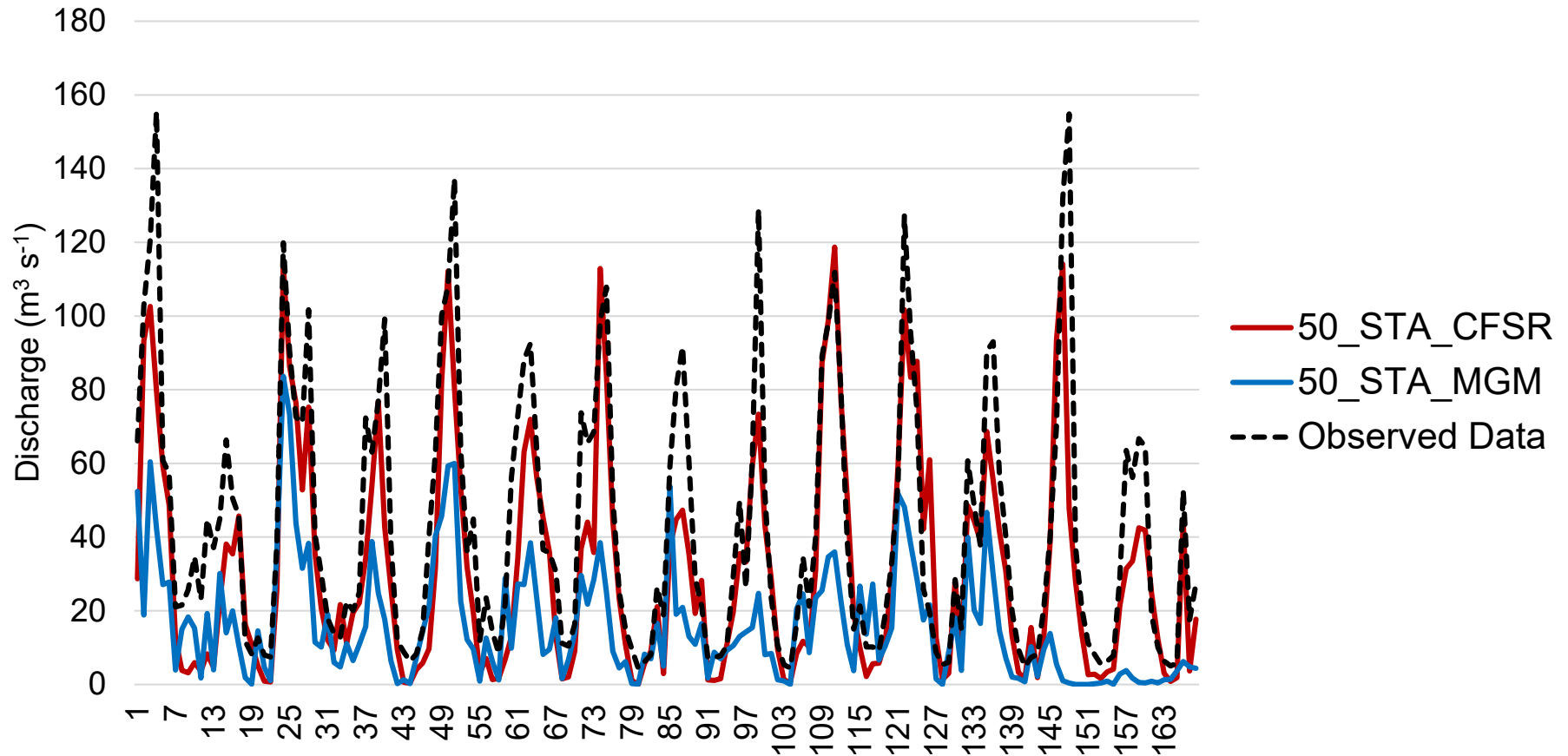
| Model Name	R2	bR2	NS	BPIAS
50_STA_CFSR	0.78	0.5842	0.68	26.1
50_STA_MGM	0.45	0.1375	-0.16	62.5

SWAT Model Parameters

- **SWAT-CUP** used for model calibration/validation

SWAT Parameters	Initial Range
r__CN2.mgt	-0.5 to 0.5
r__GWQMN.gw	-0.5 to 0.5
r__GW_REVAP.gw	-0.5 to 0.5
r__SOL_AWC().sol	-0.5 to 0.5
r__REVAPMN.gw	-0.5 to 0.5
r__ESCO.hru	-0.2 to 0.2
r__ALPHA_BF.gw	-0.5 to 0.5
r__SOL_K().sol	-0.5 to 0.5
r__SOL_BD().sol	-0.5 to 0.5

- **Plapse Rate** is chosen as 600mm/km
(Cuceloglu and Ozturk, 2017)

480 simulations has been done for each model
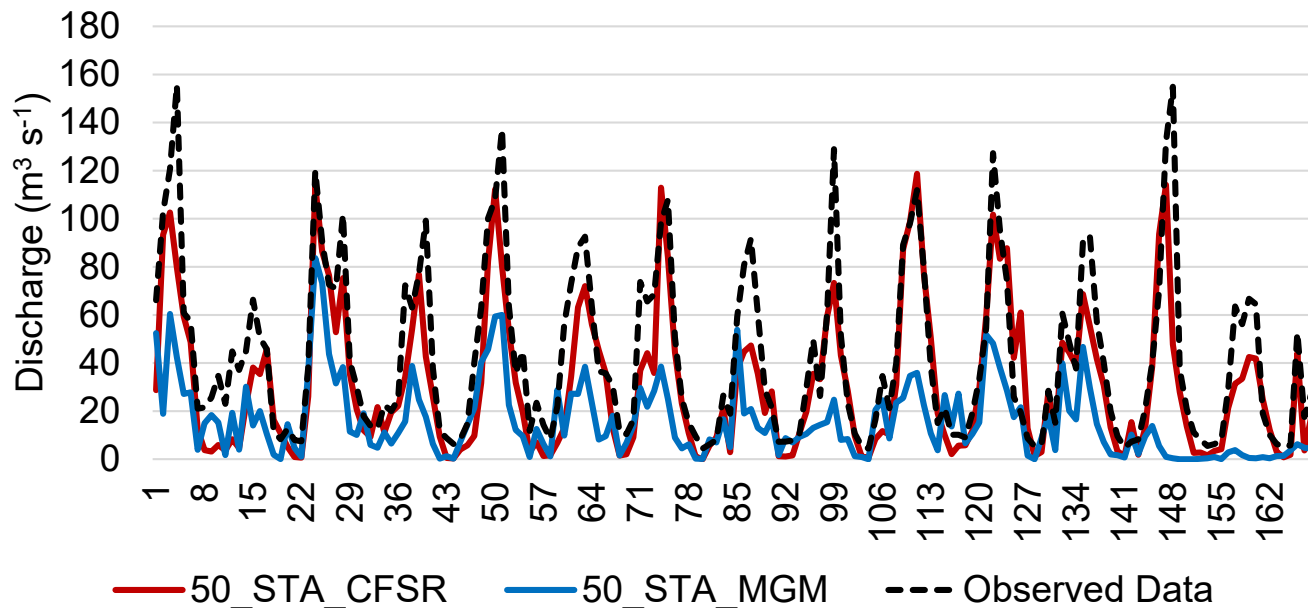
First Simulation
(Before Calibration)
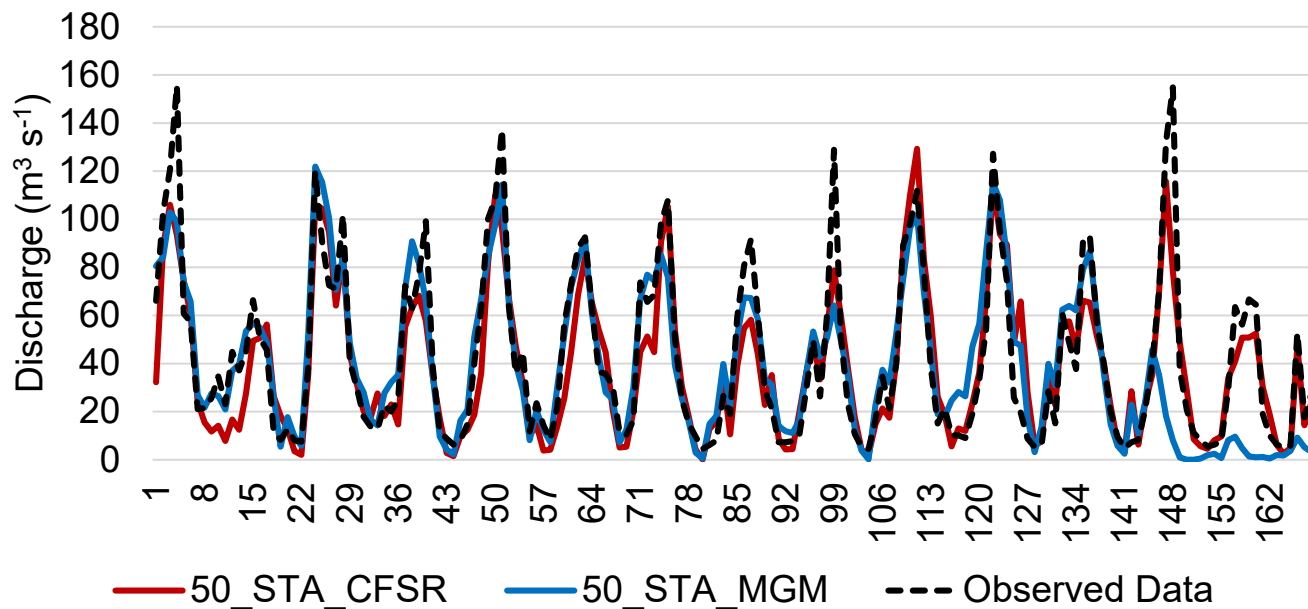
Best Simulations
(After Calibration)

Model Performance/Flow Duration Curve

Best Simulations
(After Calibration)

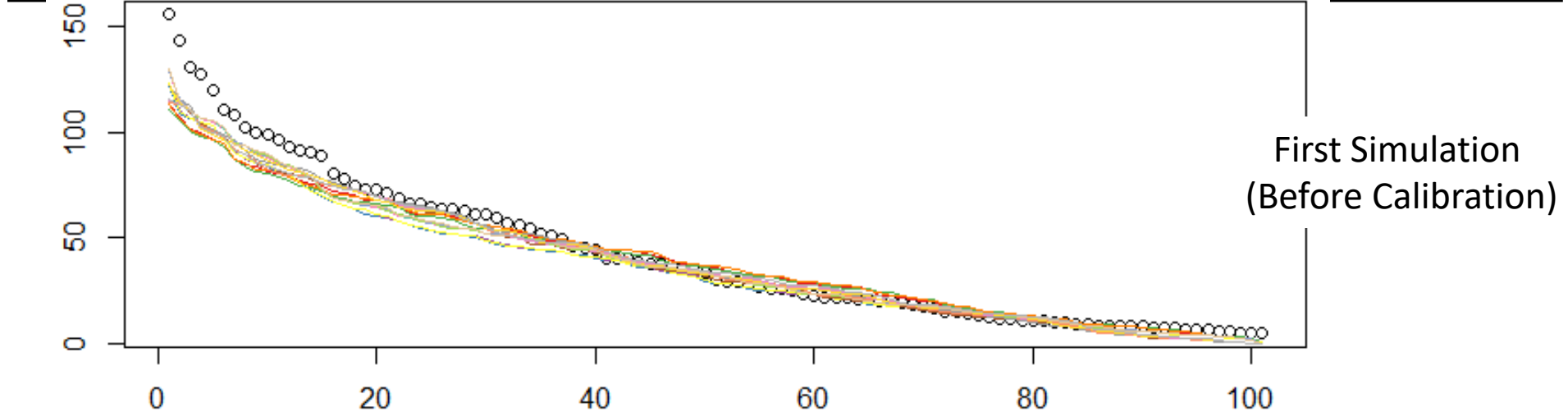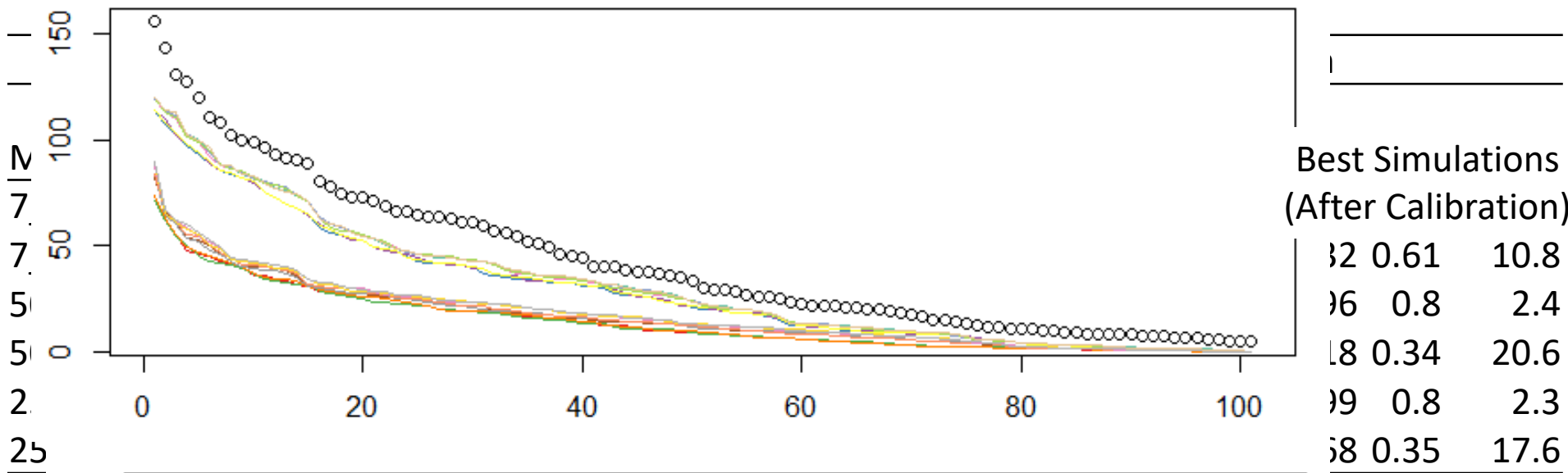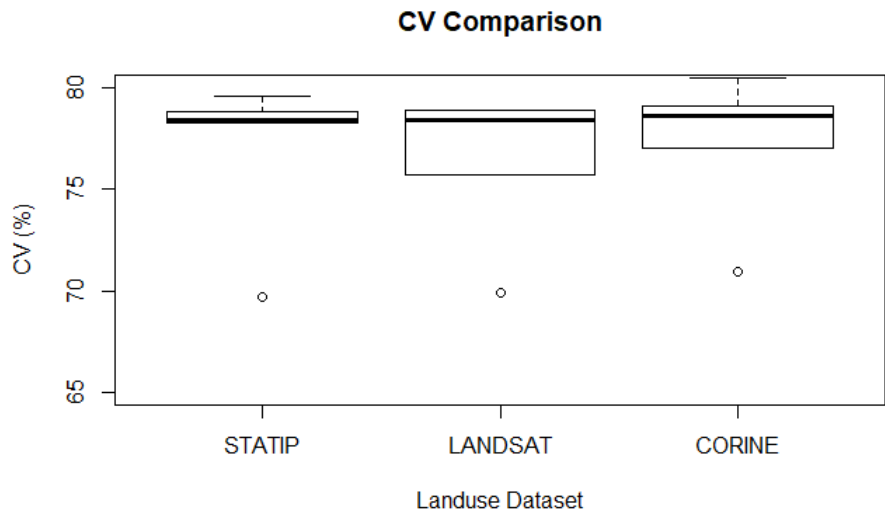|		
32	0.61	10.8
96	0.8	2.4
18	0.34	20.6
99	0.8	2.3
58	0.35	17.6

First Simulation
(Before Calibration)

CV Value for Streamflow
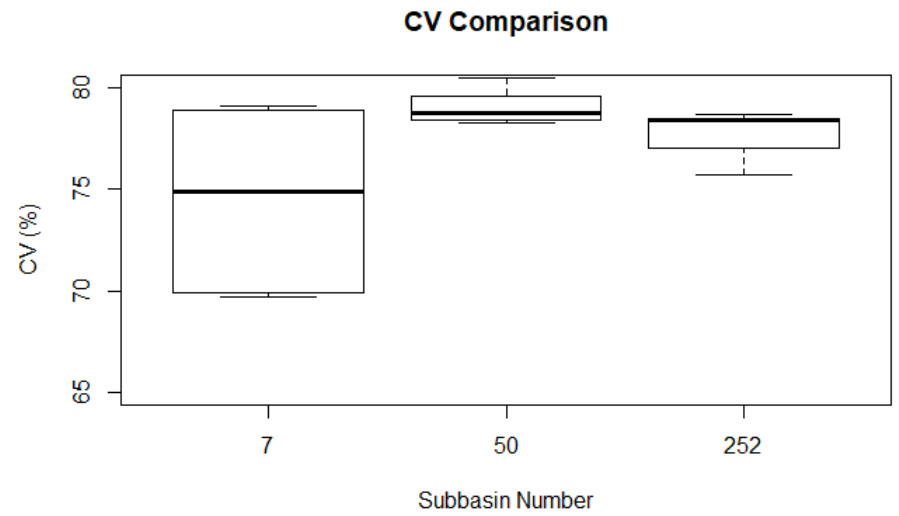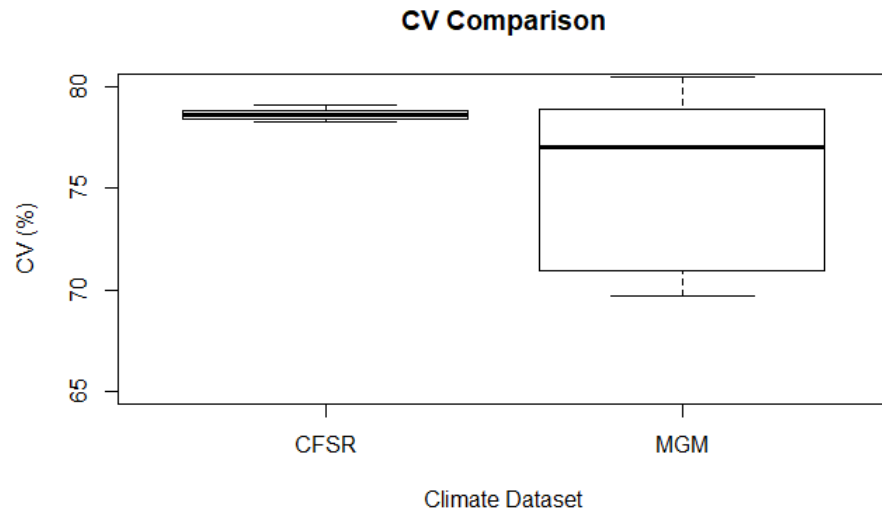
Results Discussion

- The study shows the climate data set is the most influencial dataset and has a larger uncertainity in our study area.

- Global climate dataset (reanalysis data) represents better than the local data.

- The Corine LULC dataset (freely available) yield quite similar results as the local landuse datasets. Detailed local dataset (STATIP) has the smallest uncertainty.

- Subbasin number has no significant effect on the monthly calibrated discharge data but it is important to evaluate relation between the subbasin and climate data.

- Using elevation band is quite efficient (if the available dataset catches the dynamic of the system)

Conclusion

- Effects of different input data and subbasin configuration are investigated in Melen Watershed, Turkey

- SWAT model has been succesfully applied to the region.

- Hydrological simulations could be significantly different for different model setup configurations and could cause large uncertainity.

- Multisite and daily calibration are also important to investigate

- Nowadays it is easy (relatively) to find multiple datasets therefore modeler should take different these datasets into consideration. It is strongly recommend to use different input datasets for modelling studies.

Thanks for your attention...