The Impact of Future Urban Expansion on Streamflow in Brazos County, Texas USA

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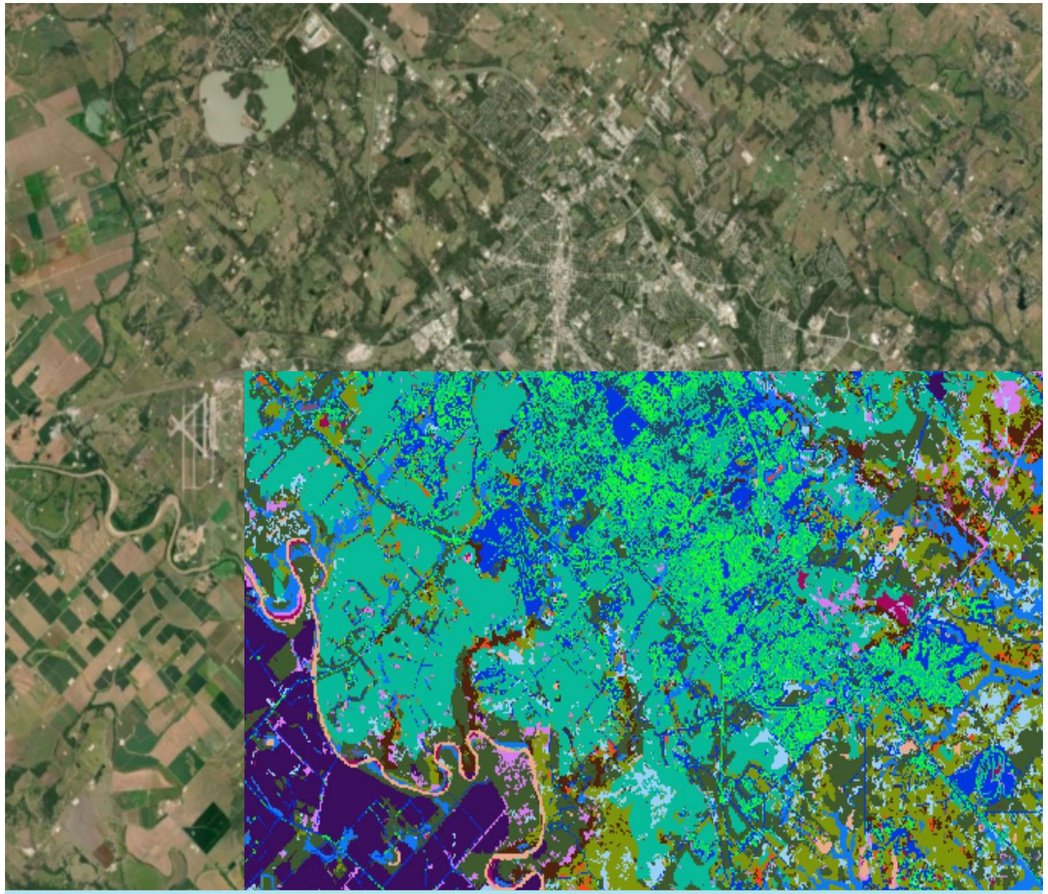
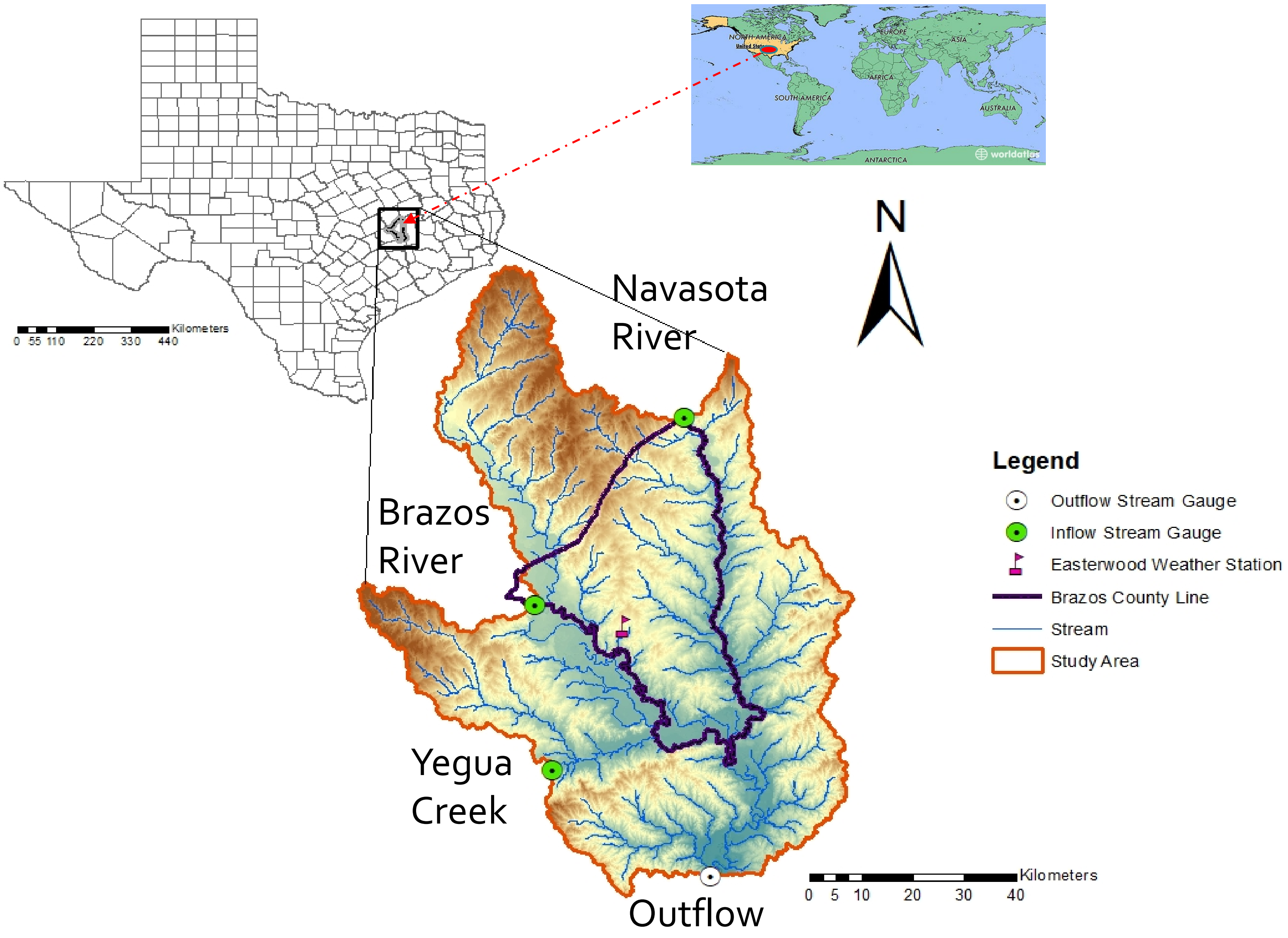
Why Perform This Study?

- Global Climate Change
  - Warmer and wetter conditions expected in study area
- Increase in Urban Area
  - Increase in impervious surfaces
  - Decrease in agriculture and forest land
- Future Streamflow and Water Yield
  - Determining trends for future scenarios



Aerial View of College Station, Texas USA and overlay of predicted Land Use/Land Cover for the year 2050

Study Area



NORTH AMERICA
EUROPE
ASIA
AFRICA
SOUTH AMERICA
AUSTRALIA
ANTARCTICA
worldatlas
Kilometers
0 55 110 220 330 440
Navasota River
Brazos River
Yegua Creek
Outflow
N
Legend
Outflow Stream Gauge
Inflow Stream Gauge
Easterwood Weather Station
Brazos County Line
Stream
Study Area
Kilometers
0 5 10 20 30 40

Inflows and Outflow in Watershed

Three Inflows

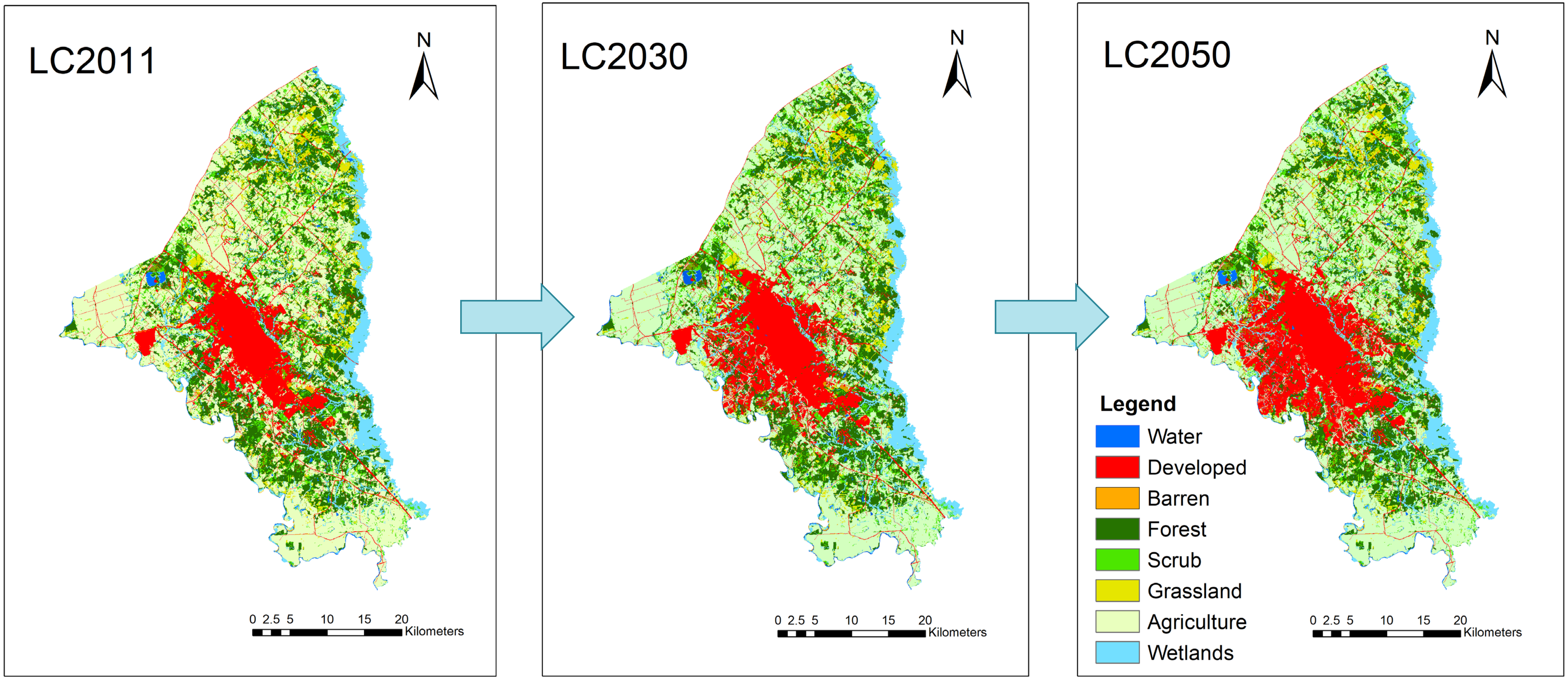
- USGS 08110800
  - "Navasota Rv at Old San Antonio Rd nr Bryan, TX"
- USGS 08108700
  - "Brazos Rv at SH 21 nr Bryan, TX
- USGS 08110000
  - "Yegua Ck nr Somerville, TX"

Single Outflow

- USGS 08111500
  - "Brazos rv nr Hempstead, TX"

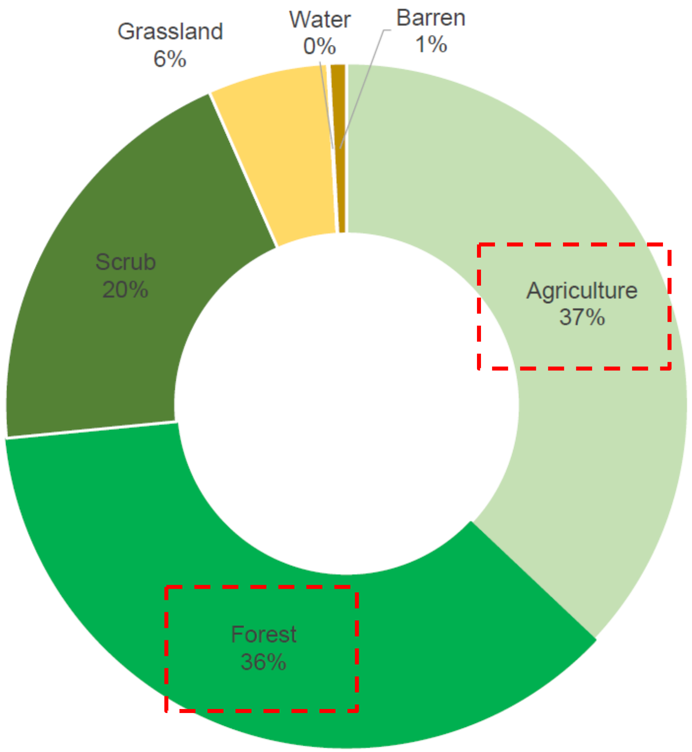
USGS 08110000 "Yegua Ck nr Somerville, TX". Data from this point is one of three streamflow inputs for the SWAT Model.

Urbanization

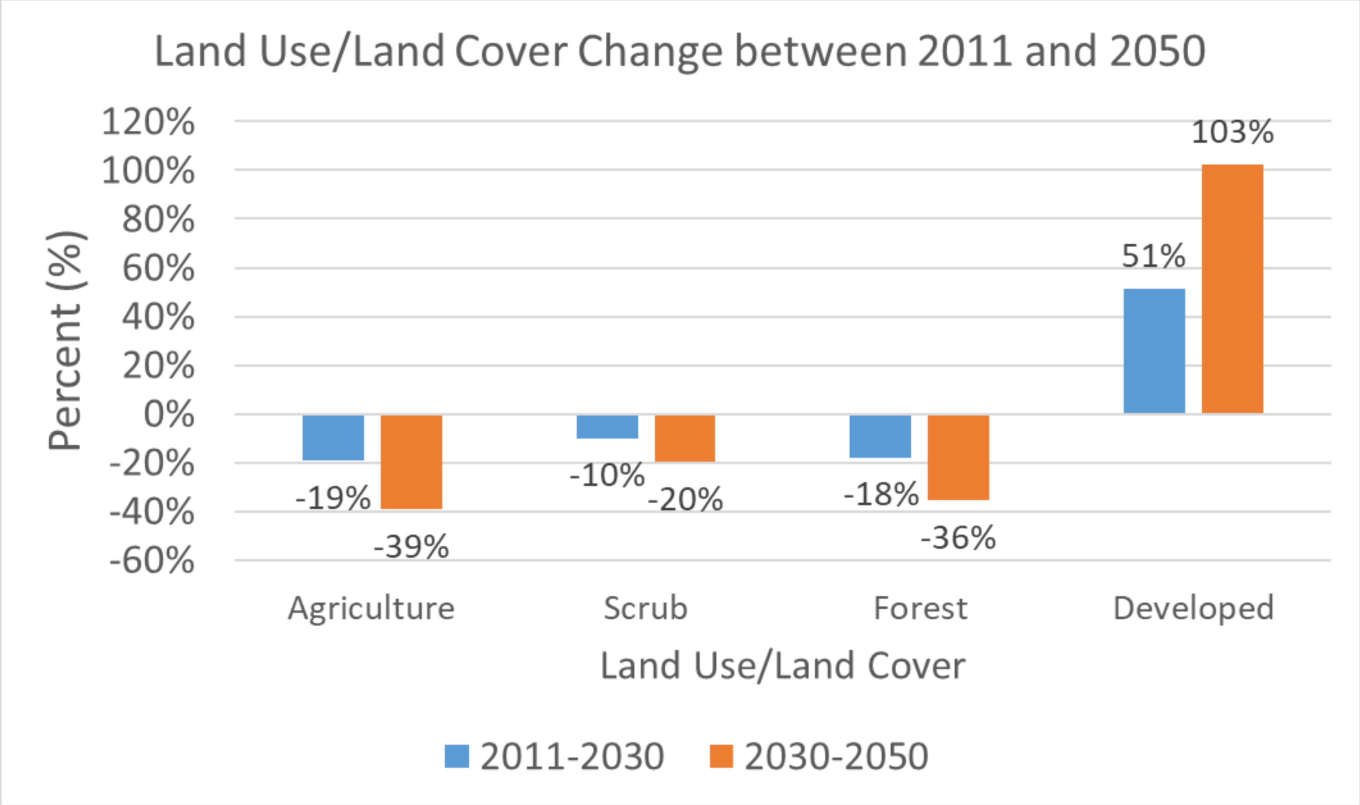


Predicted Land Use/Land Cover for the year 2030 and 2050 in Brazos County, Texas USA compared with Land Use/Land Cover from 2011. The future maps: LC2030 and LC2050 are created by the Multi-layer Perceptron.

Land Use/Land Cover Changes



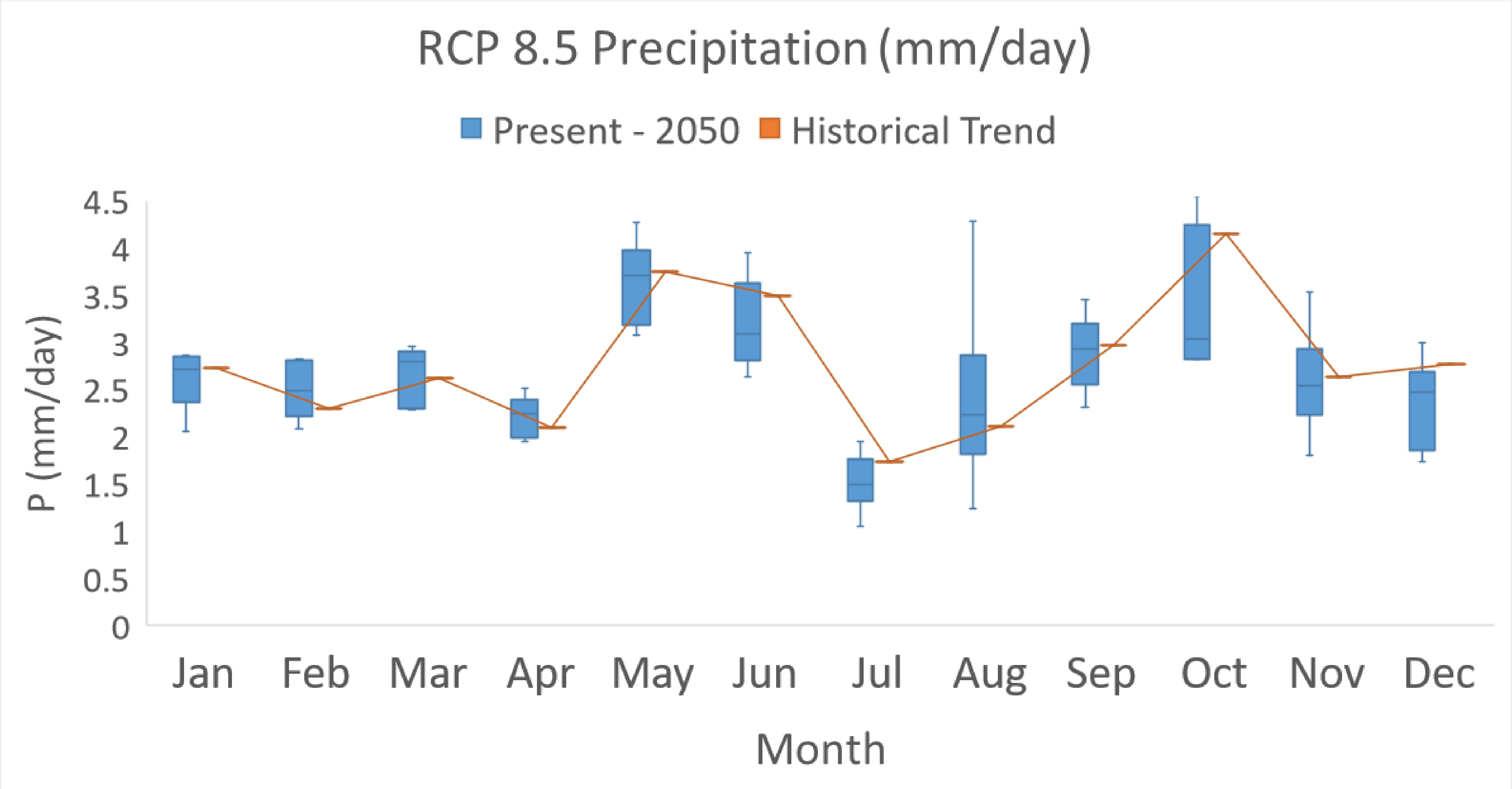
Contributions to developed areas



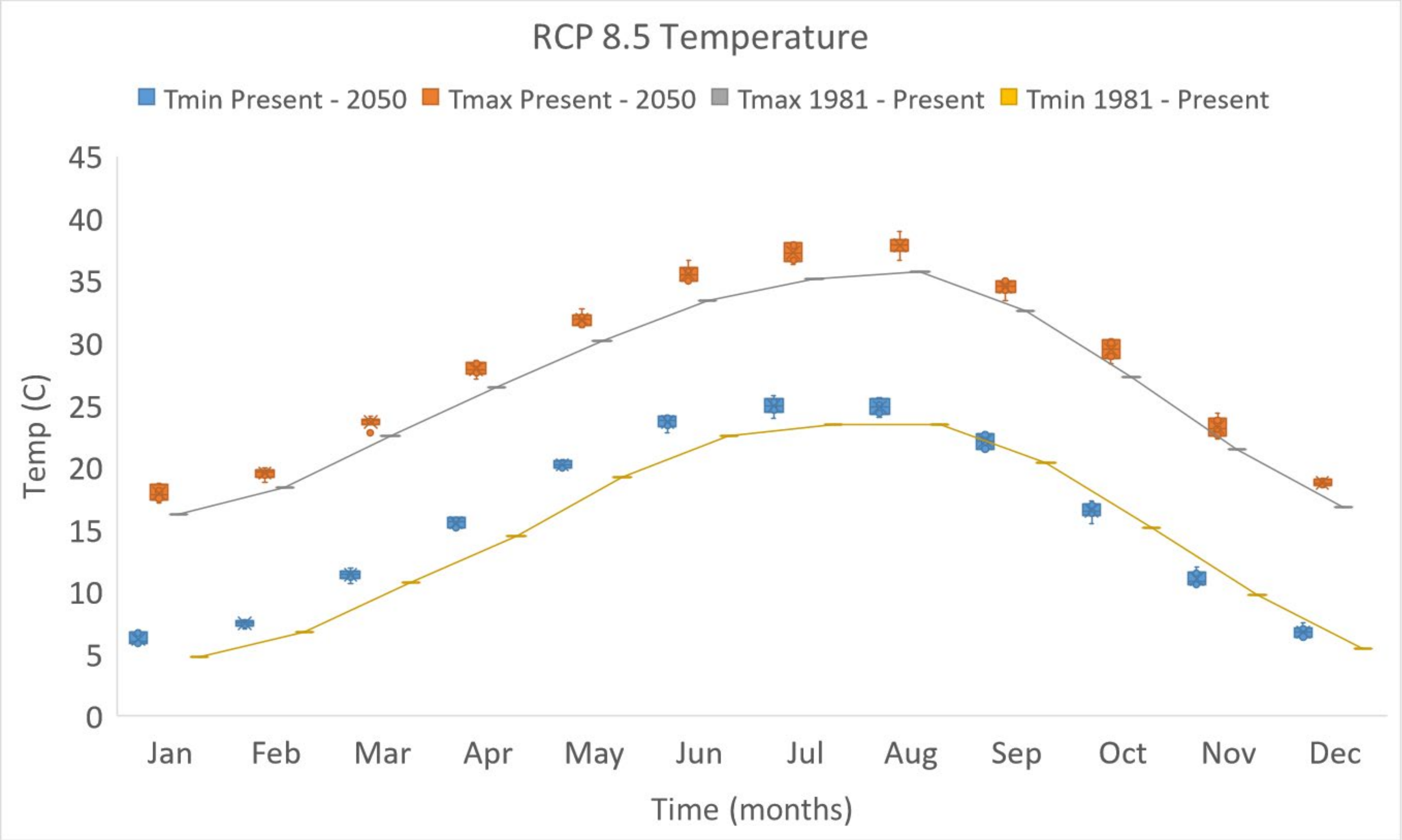
Global Climate Models

Description of the six GCMs used for scenario inputs.

Model	Name	Counrty	Spatial Resolution
BCC-CSM 1.1-m	Beijing Climate Center, China Meteorological Administration Model	China	1.9^o x 1.9^o
CCSM4	Community Climate System Model National Center for Atmospheric Research	USA	0.94^o x 1.25^o
CNRM-CM5	Centre National de Recherches Meteorologiques Climate Model	France	1.4^o x 1.4^o
HadGEM2-ES365	Hadley Global Environment Model 2 - Earth System	United Kingdom	1.25^o x 1.88^o
IPSL-CM5A-MR	Institut Pierre-Simon Laplace Climate Model 5 Medium Resolution	France	1.25^o x 2.5^o
MIROC5	Model for Interdicipinary Research on Climate version 5	Japan	1.4^o x 1.4^o



Historical rainfall in mm/day compared with expected range of future rainfall from six Global Climate Models.



Historical Temperature in °C compared with expected range of future precipitation from six Global Climate Models.

Methods

- Model Set-Up
  - Calibration/Validation
- Baseline Scenario
  - No Streamflow input
  - Water Yield
  - Streamflow
- Future Scenario
  - Six GCMs Used
  - Two Land Use/Land Cover dates
  - Twelve scenarios

NOAA and USGS data were used as inputs for the SWAT model

Manual Calibration

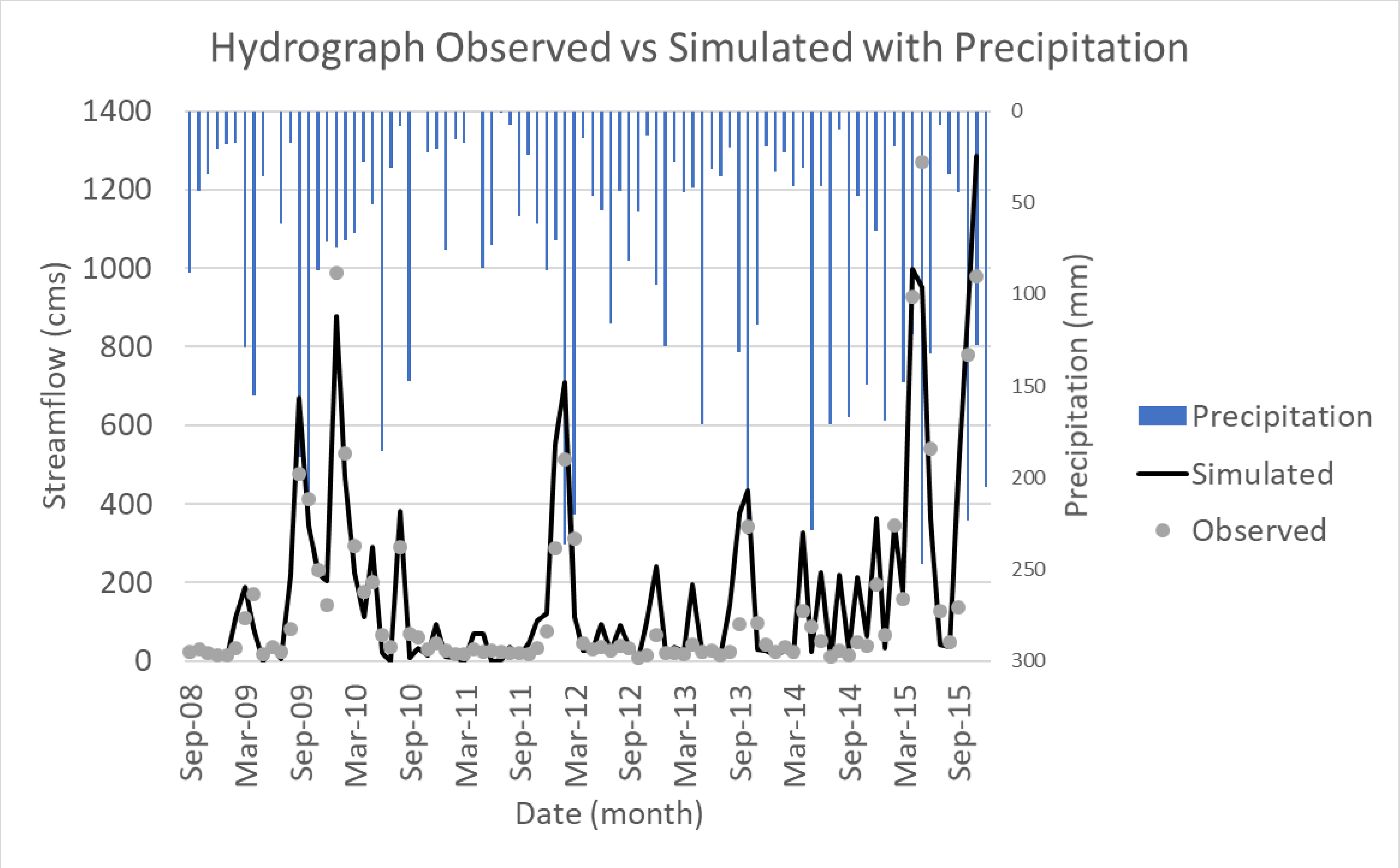
- Initial simulation – No Calibration!
  - NSE: 0.74
- Three parameters Calibrated
  - CN, ESCO and SOL_AWC
- Baseline Simulation
  - NSE: 0.83

Calibration and Validation Statistics 2008 - 2015

	NSE	Pbias	R^2
Calibrate (2008 - 2011)	0.89	3.6%	0.90
Validate (2011 - 2015)	0.84	18.98%	0.87

Final Values of Calibrated Parameters

Model Parameter	Final Value
CN	80
SOL_AWC	0.09
ESCO	0.7



Hydrograph at study area outlet (USGS 08111500).

Results

- Impact of Climate Change and Urbanization
  - Two factors considered together
- Streamflow will increase
  - Increased annual maximum and average streamflow
- Water Yield will decrease
  - Decrease average water yield

Streamflow

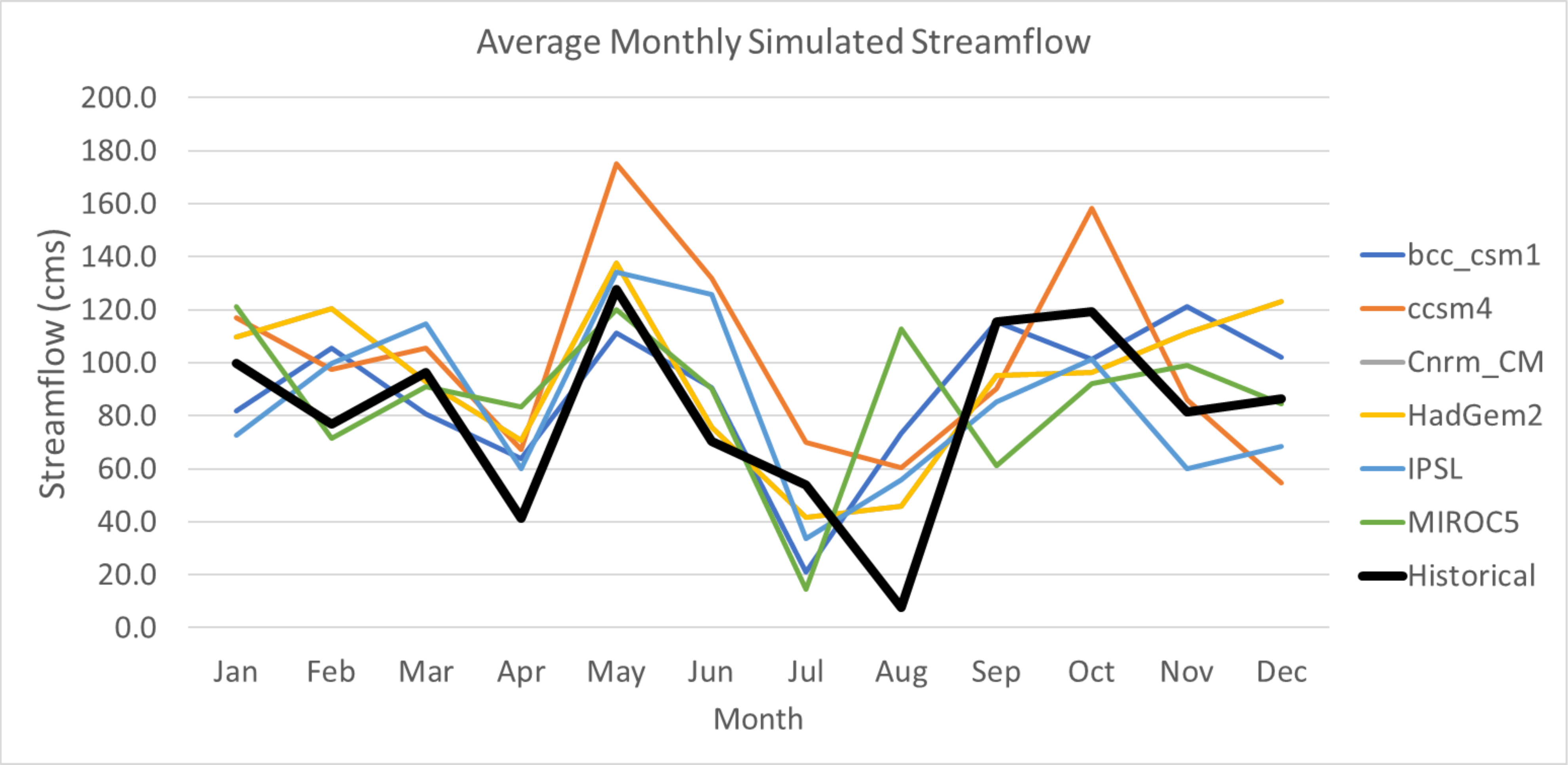
- Comparison of Monthly Average
  - Streamflow expected to increase in 7 out of 12 months
  - Monthly average increase expected to be about 7%
  - Streamflow will rise at an increasing rate with time.

Representative comparison of three GCMs with Baseline Streamflow scenario

	Monthly Average Streamflow (cms)			
Month	Baseline	CCSM4	HadGem2	MIROC5
1	99.7	117.1	109.8	121.3
2	76.8	97.5	120.5	71.5
3	96.4	105.6	92.9	90.8
4	41.3	67.3	70.7	83.4
5	127.7	175.1	137.5	119.9
6	70.2	131.9	75.6	90.3
7	53.9	69.9	41.6	14.7
8	7.8	60.2	45.8	112.7
9	115.5	90.3	95.3	61.2
10	119.1	158.1	96.3	91.9
11	81.3	86.1	111.2	98.9
12	86.4	54.7	123.2	84.6

= Decrease

= Increase


Average Monthly Simulated Streamflow
Streamflow (cms)
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
bcc_csm1
ccsm4
Cnrm_CM
HadGem2
IPSL
MIROC5
Historical

Water Yield

- Comparison of Monthly Average
  - Water Yield expected to decrease in 6 out of 12 months
  - Monthly Average will decrease by 10% across the study area

Representative comparison of three GCMs with Baseline Water Yield scenario

	Monthly Average Water Yield (mm)			
Month	Baseline	CCSM4	HadGem2	MIROC5
1	47.7	49.7	46.7	51.5
2	35.2	37.1	45.5	27.5
3	49.4	45.7	40.5	39.5
4	23.7	29.1	30.3	35.5
5	66.1	75.3	59.6	52.0
6	37.9	55.5	32.5	38.3
7	30.3	31.2	19.1	7.6
8	7.3	26.9	20.6	48.7
9	55.0	38.3	39.9	26.3
10	58.1	67.5	41.7	39.8
11	39.5	35.8	46.1	41.1
12	41.5	23.6	52.3	36.2

= Decrease

= Increase

Conclusion

- Streamflow will increase
  - Historical Max Average: 295 cms
  - 2030 Max Average: 298 cms
  - 2050 Max Average 306 cms

- Water Yield will decrease
  - Simulated Monthly Average: 44 mm
  - 2030 and 2050 Monthly Average: 38 mm

Soil & Water Assessment Tool SWAT

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