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Application of the SWAT Model to assess climate change impacts on water balances and crop yields in the West Seti River Basin

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Outline of the Presentation

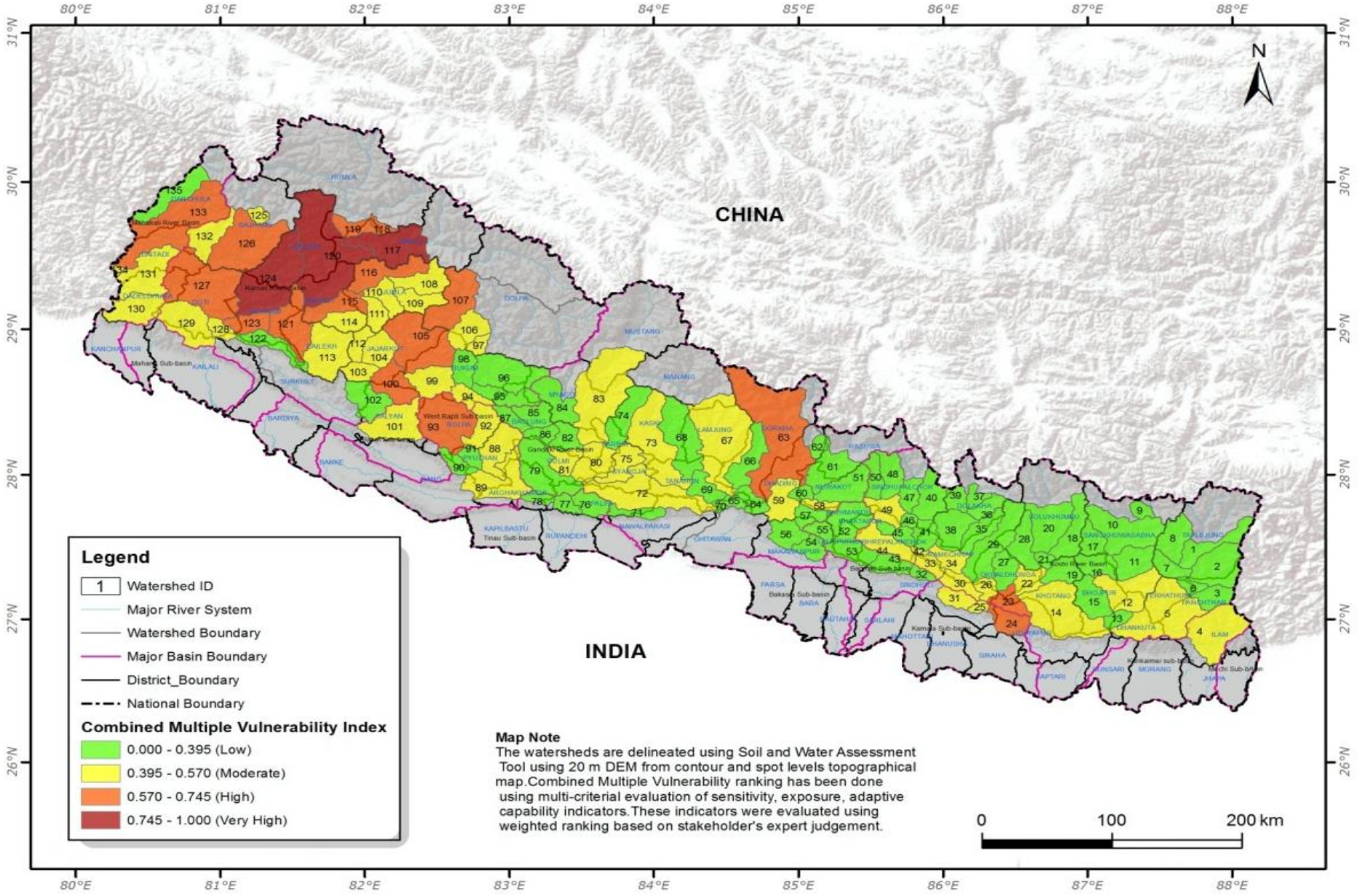
1. Introduction/Background
2. Study Area
3. Method
4. Input Data
5. Result
6. Conclusion

Introduction/Background

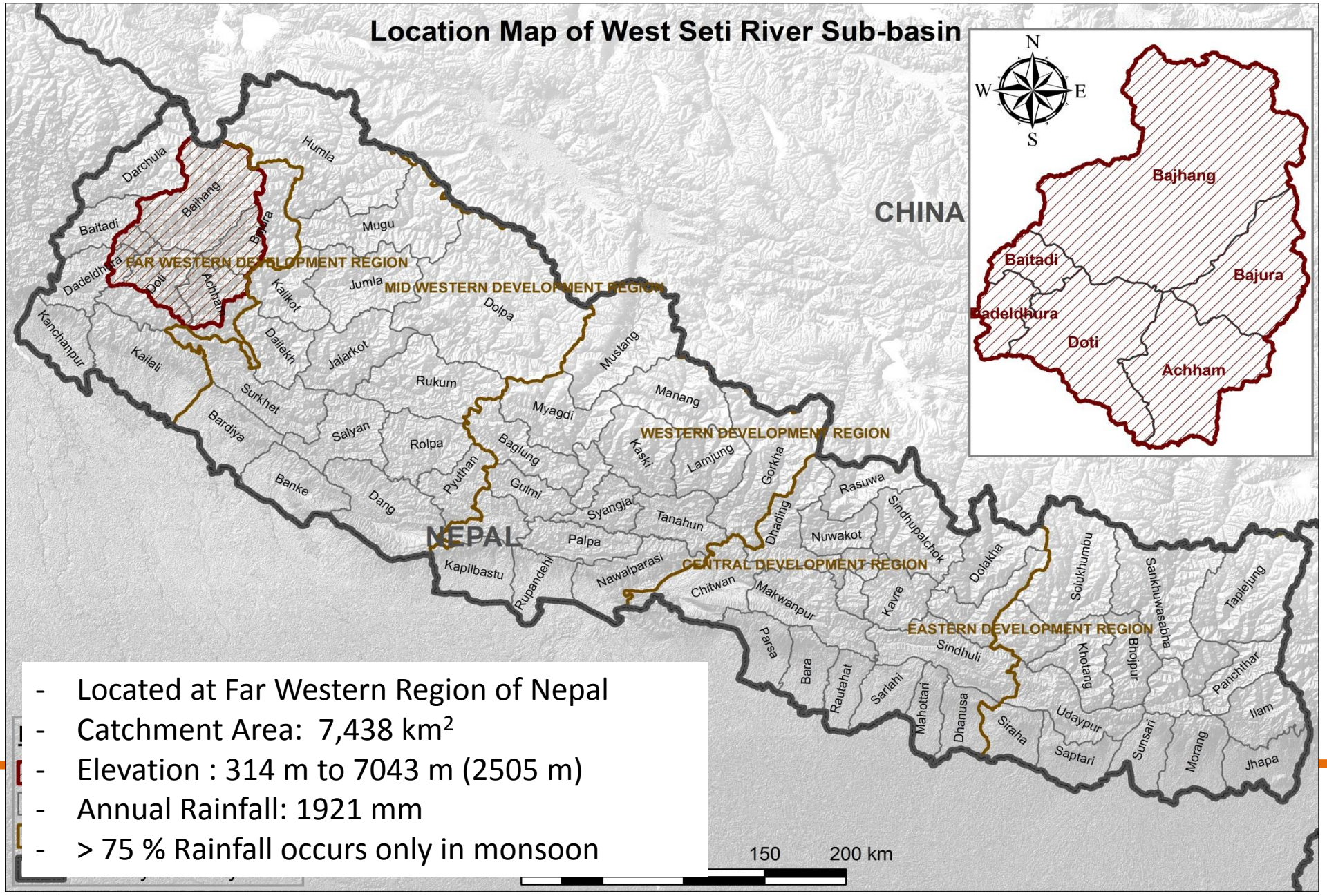
1. Himalayan region is considered sensitive to climate change (CC), and developing countries, such as Nepal, are more vulnerable to CC because they have limited capacity to adapt to it.
2. Between 1977-2000, the maximum temperature of Nepal increased by 0.06°C per year.
3. Most of the agriculture land in the hills and middle mountains depends on the direct rainfall and only few lands have irrigation access from local streams.
4. Irrigation water management should be balanced with soil fertility management to increase crop yields.
5. Agricultural production depends on the water availability; and water availability depends on the climate.

Therefore, the central idea of this study is to evaluate the impact of climate change on the soil water balance in the agricultural lands and subsequently to measure change in the yields of cereal crops.

Combined/Multiple Vulnerability Map of Watershed in Middle and High Mountain Regions

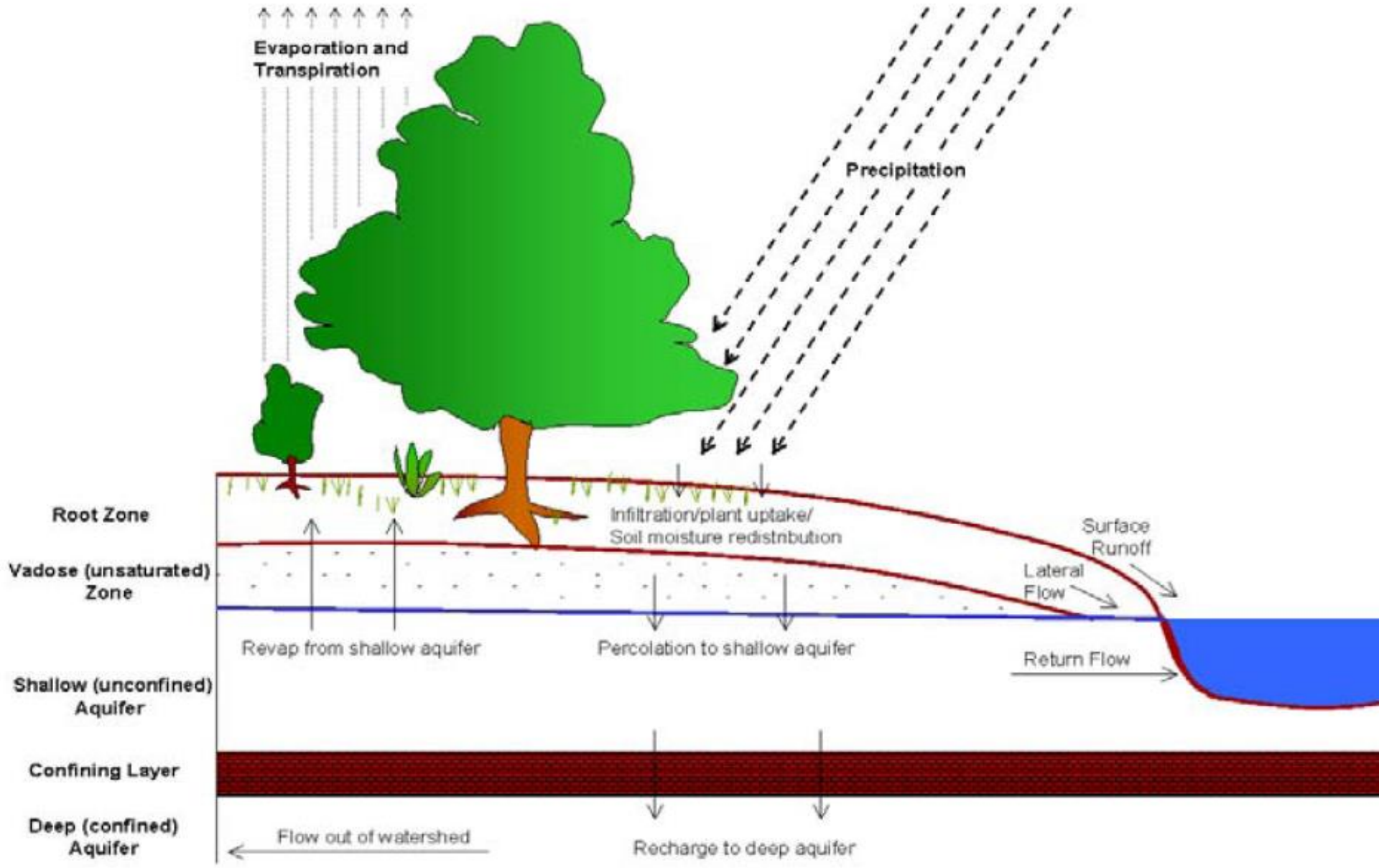


Study Area: The West Seti River Sub-basin



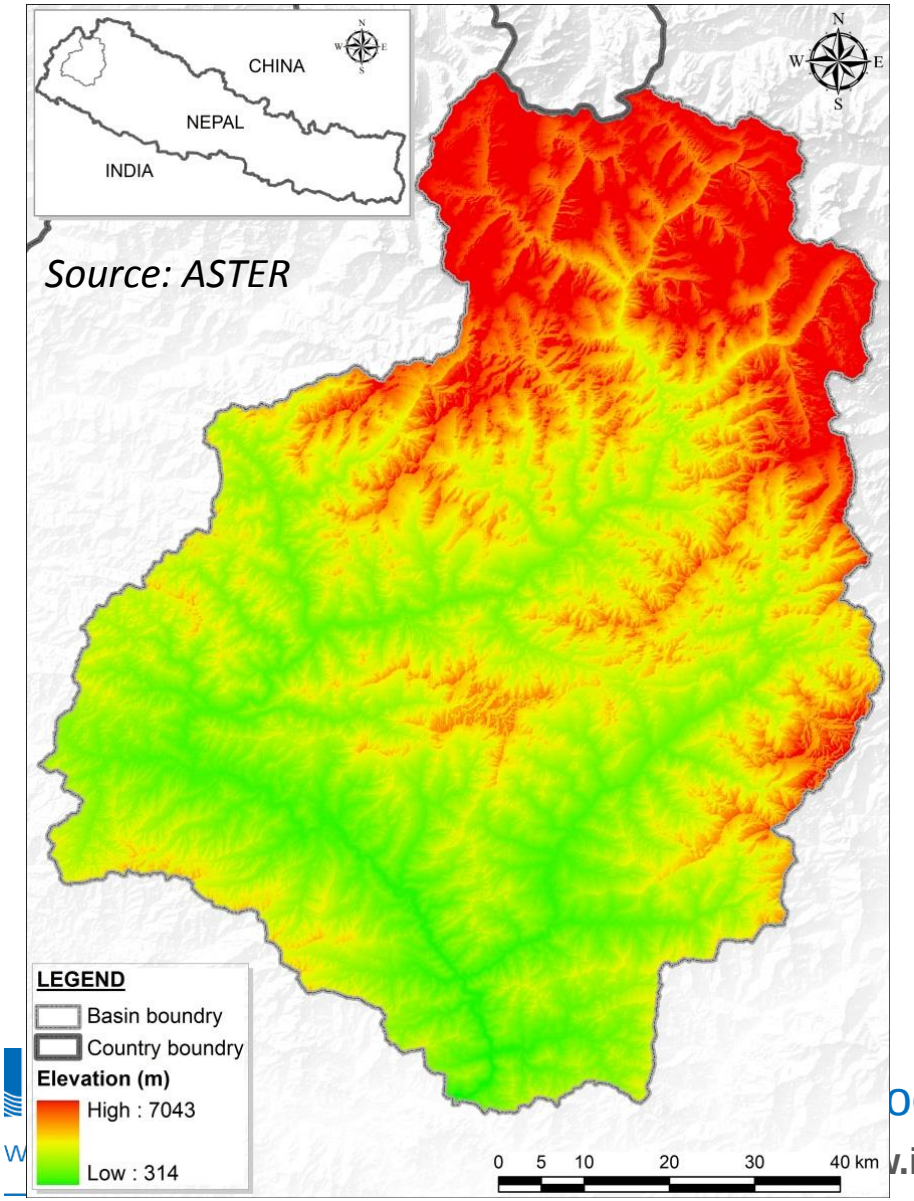
- Located at Far Western Region of Nepal
- Catchment Area: 7,438 km^2
- Elevation : 314 m to 7043 m (2505 m)
- Annual Rainfall: 1921 mm
- > 75 % Rainfall occurs only in monsoon

Method: SWAT Model

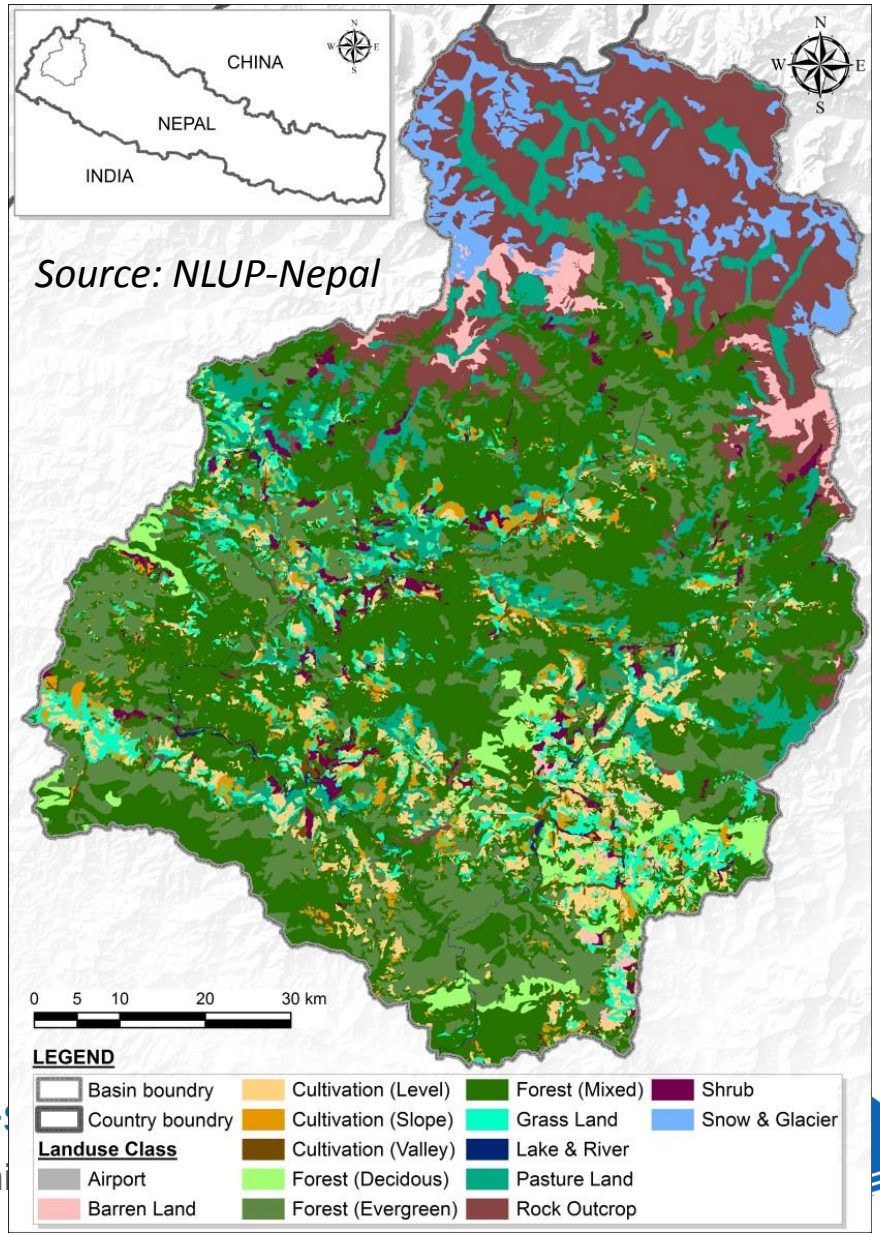


Input Data: Spatial

Digital Elevation Map (DEM):

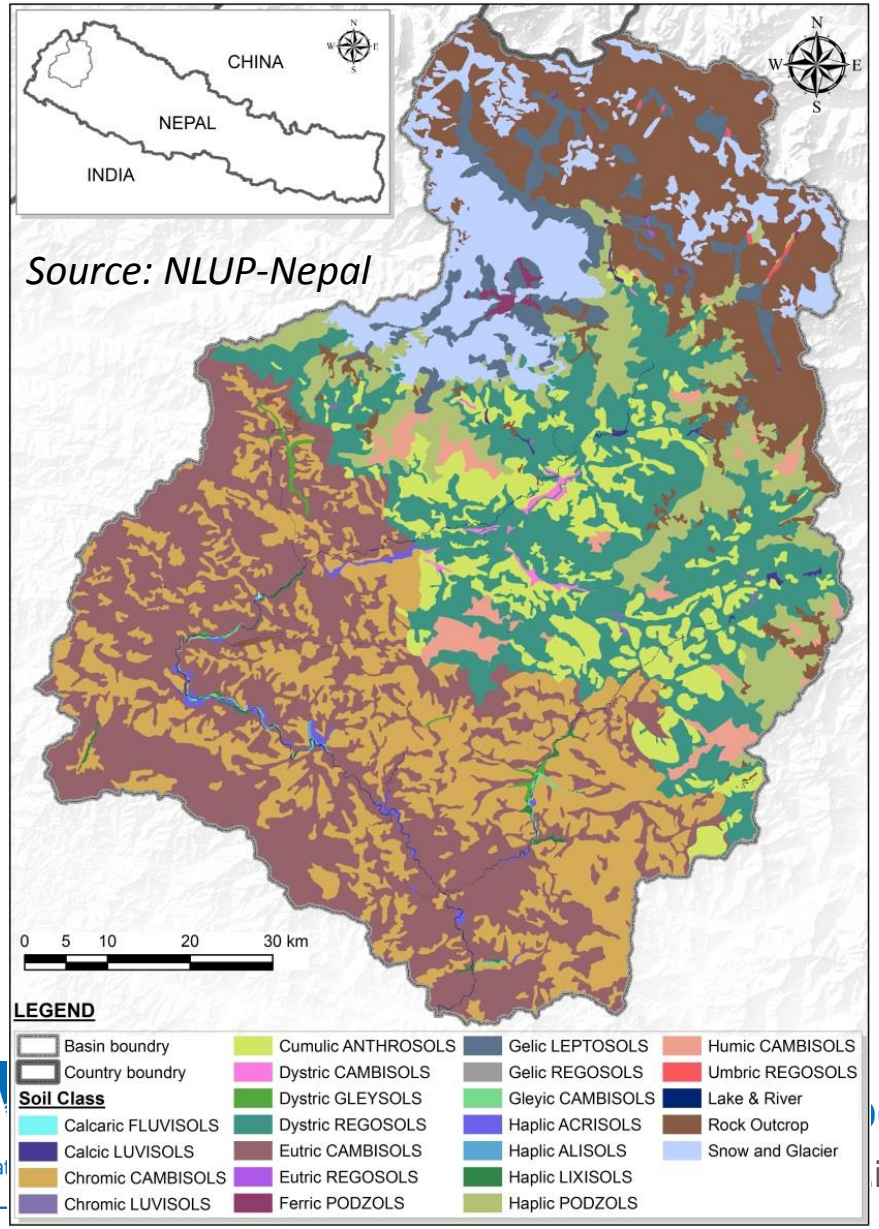


Landuse Map:



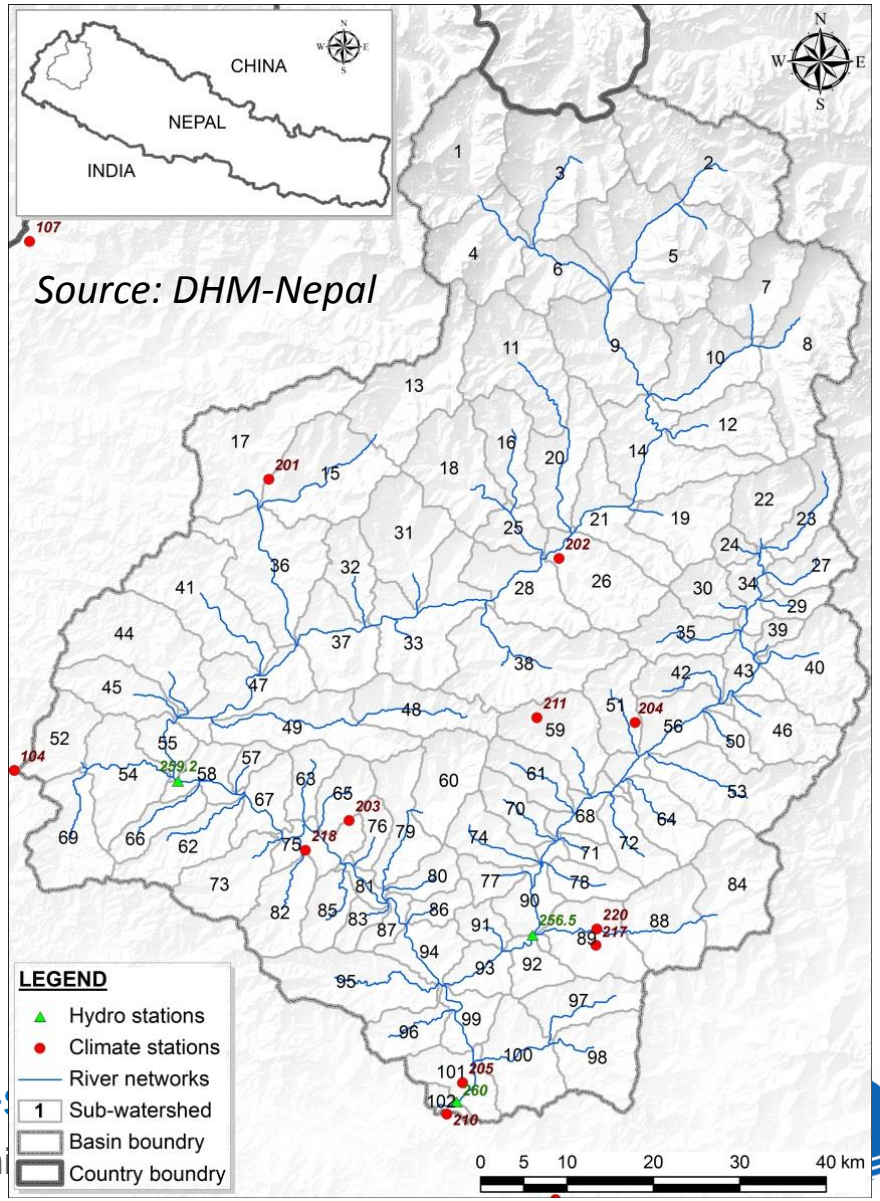
Input Data: Spatial

Soil Map:



Input Data: Time Series

Stations and Sub-watersheds:



Input Data: Agricultural and Projected Climate

Agricultural Data:

- Source: Ministry of Agriculture and Co-operatives (MoAC), Nepal

Projected Climate Data:

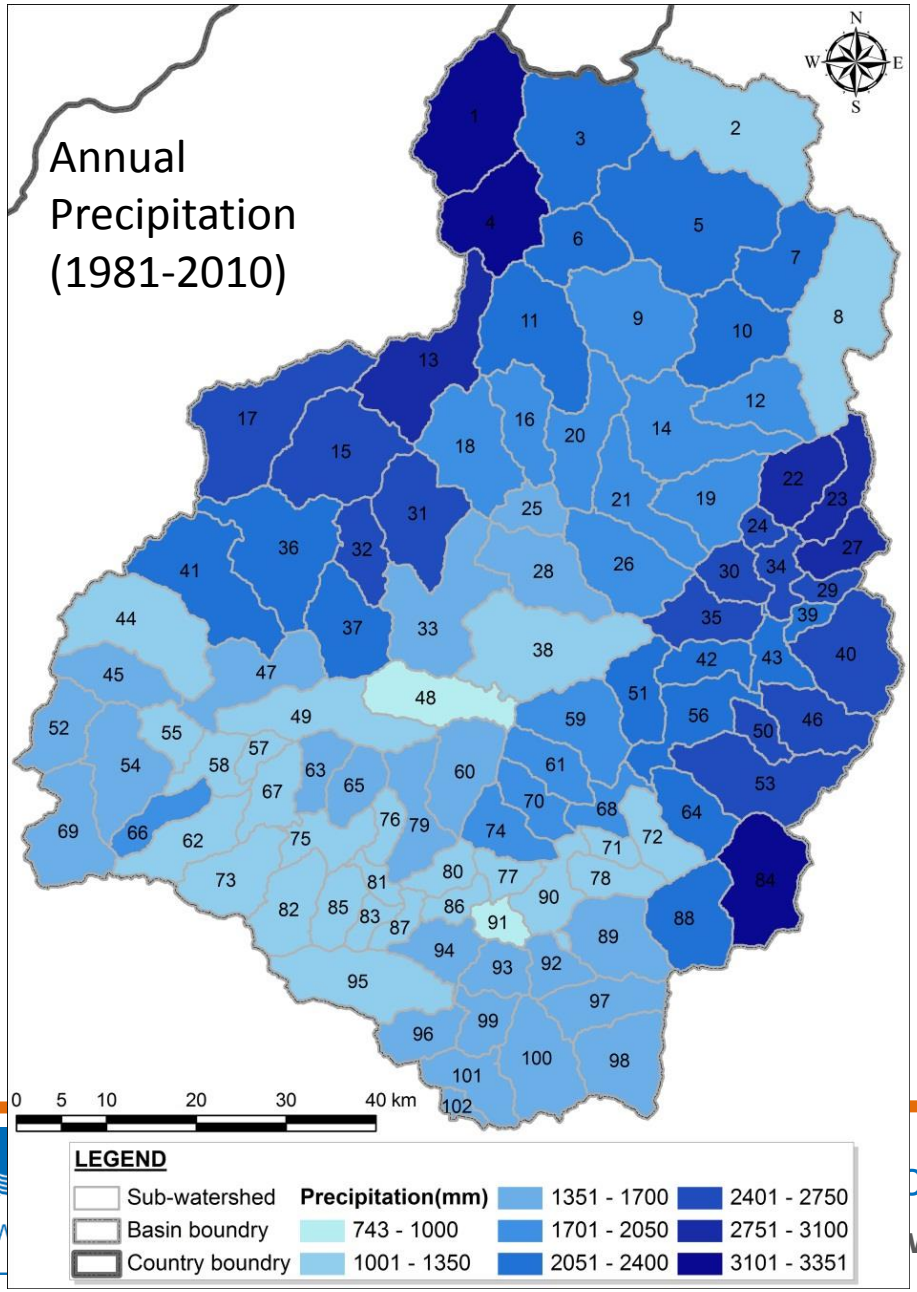
- Source: **DHM-Nepal** and **ADPC**
- **Average** of RCM: **PRECIS** and **WRF**
- **PRECIS**: Downscaled from **GCMs** (ECHam5 and HadCM3)
- **WRF**: Downscaled from **GCMs** (Era40, CCSM, ECHam5, GFDL and HadCM3)
- AR4-SRES: **BL**, **A1B**
- Period: **1971-2000** for **BL** and **2031-2060** for **Future**
- Variable: Rainfall, Temperature (Max & Min), Solar Radiation, Wind Speed and Relative Humidity

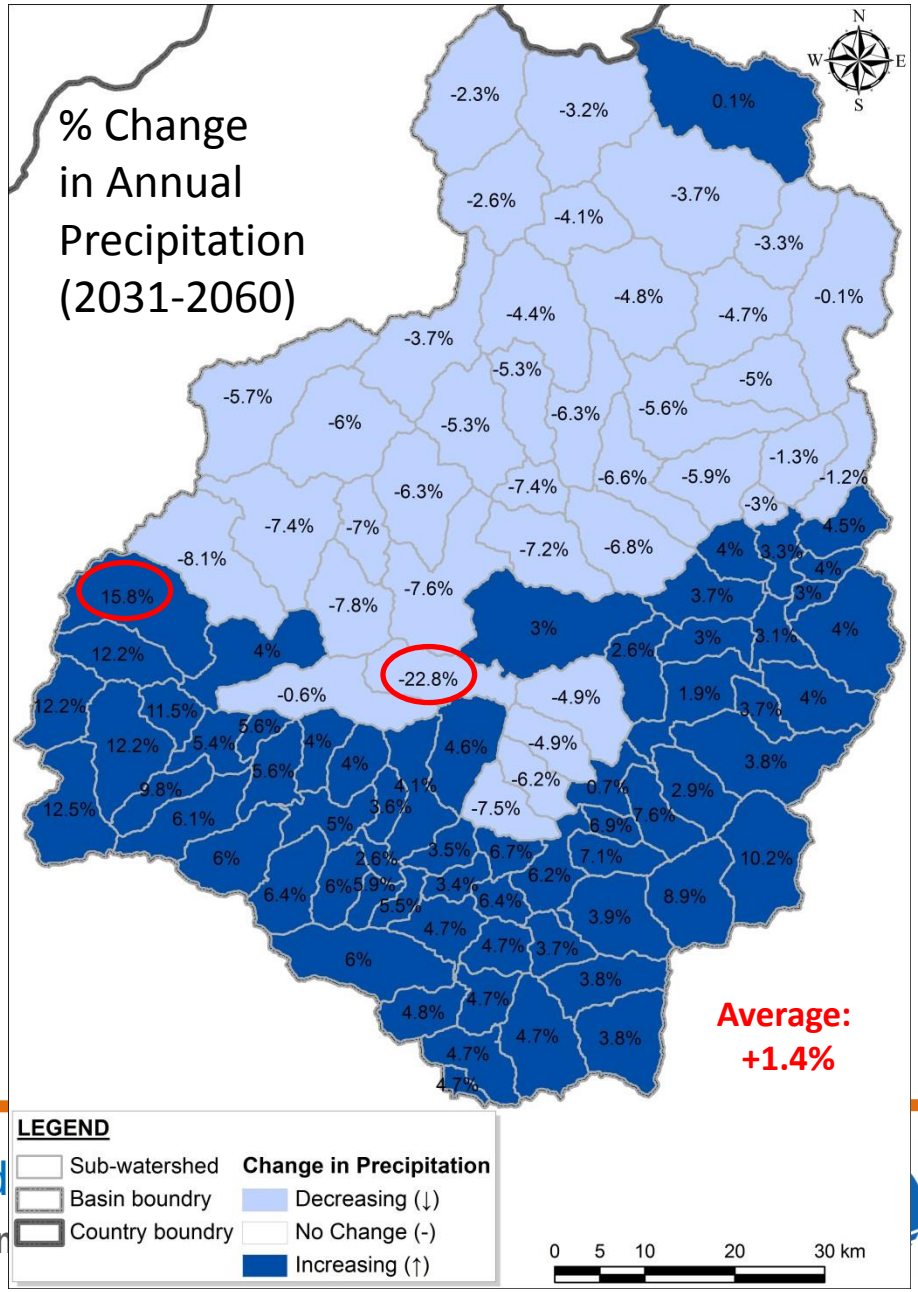
Result: Model Calibration and Validation

Hydrological Stations in the West Seti River Sub-basin and Model Performance

Station	Period		Nash Sutcliffe Efficiency (NSE) (%)			
	Calibration	Validation	Calibration		Validation	
			Daily	Monthly	Daily	Monthly
Budhi Ganga, Chitreghat	2001-2003	2004-2006	73	90	60	78
Seti River, Gopaghat	1986-1990	1991-1995	67	86	54	90
West Seti, Banga	1981-1985	1986-1990	74	93	68	85

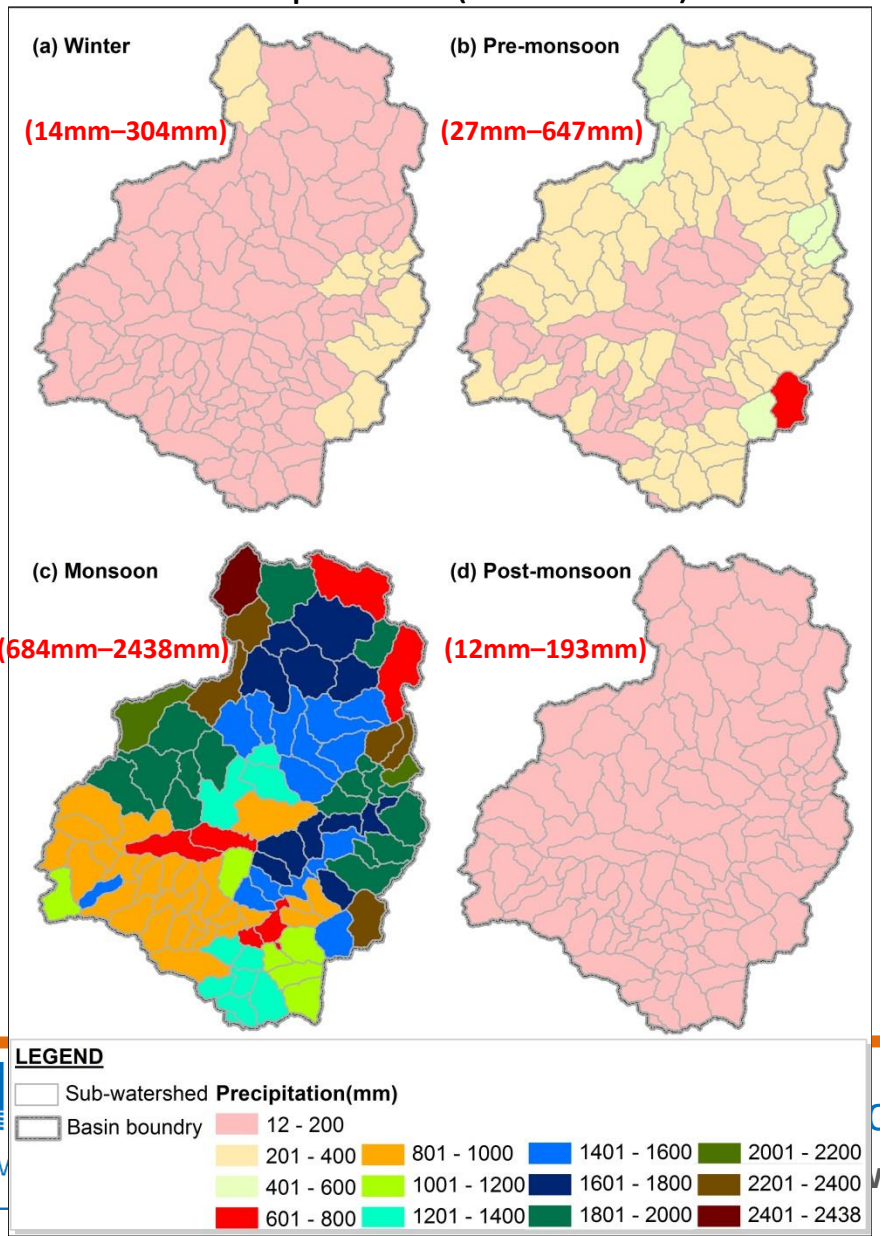
Result: Distribution of Precipitation



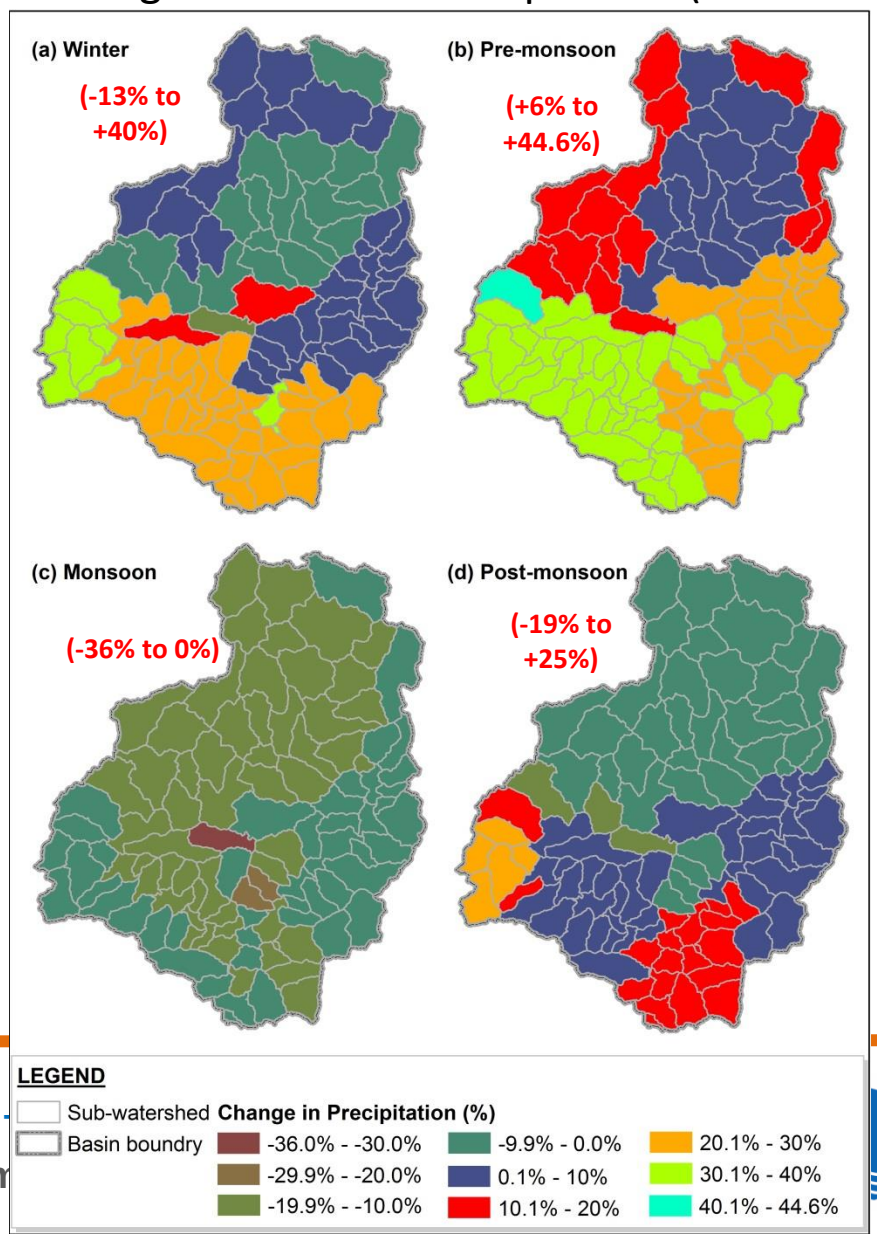


Result: Distribution of Precipitation

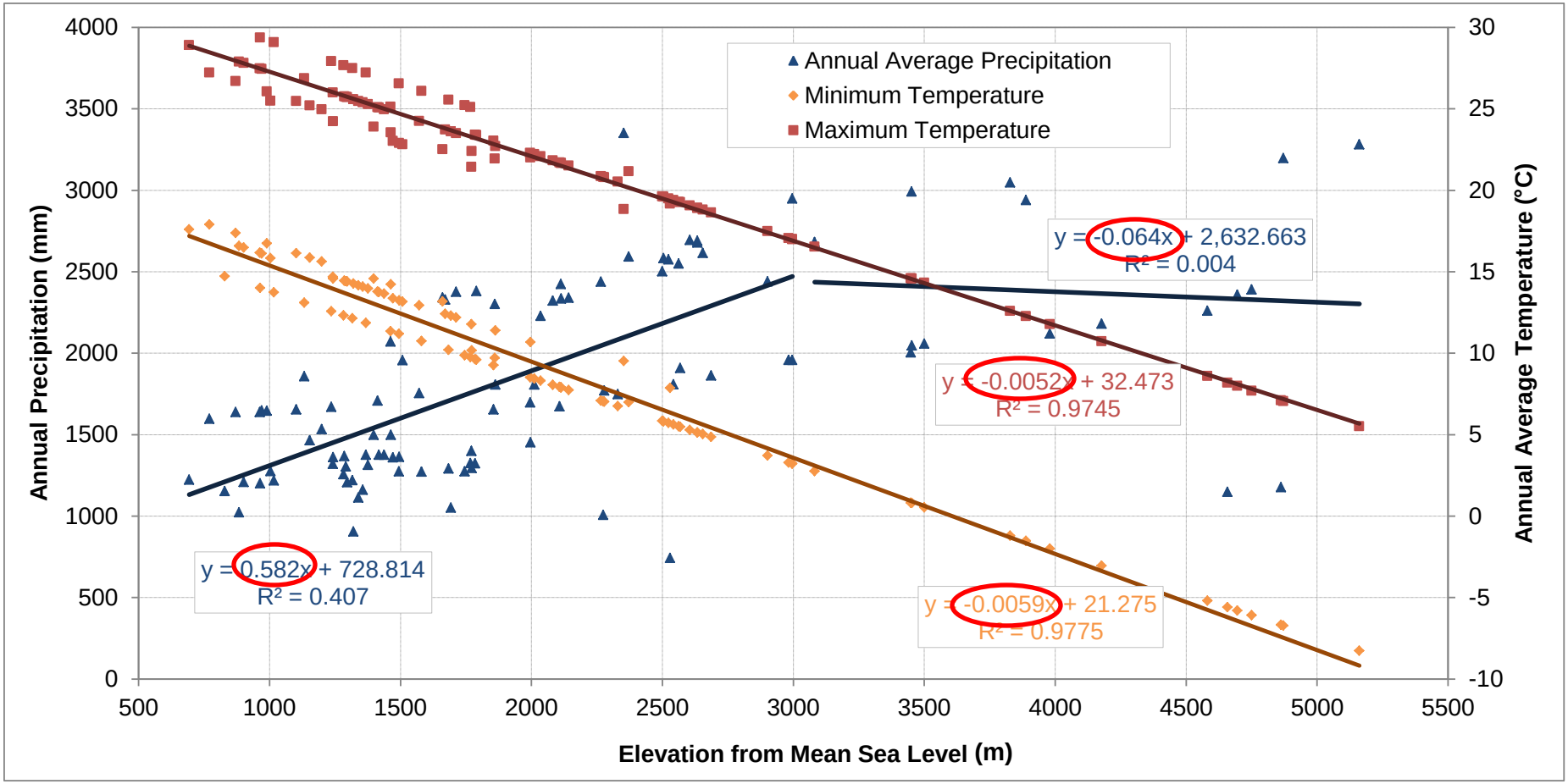
Seasonal Precipitation (1981-2010)



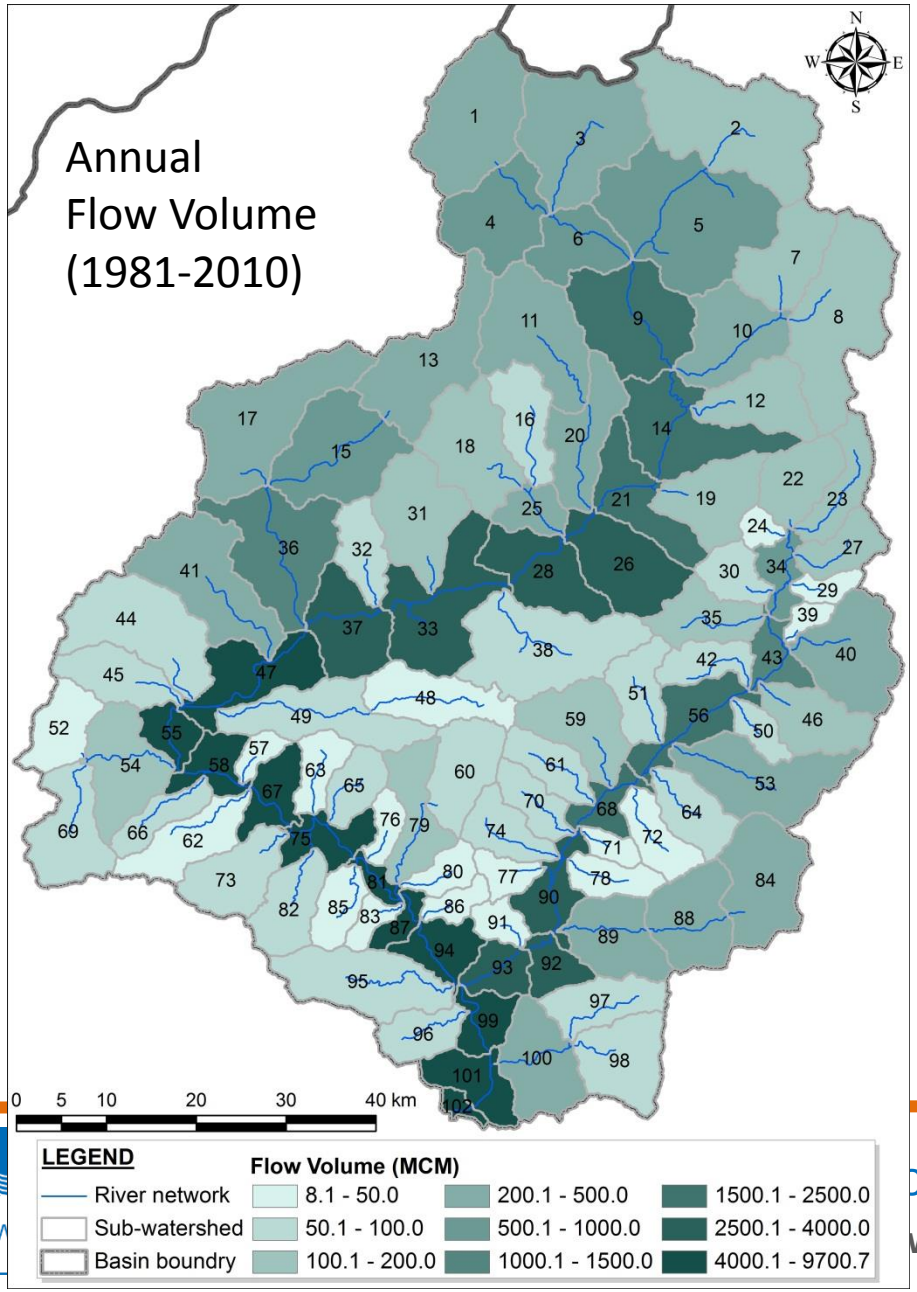
% Change in Seasonal Precipitation (2031-2060)

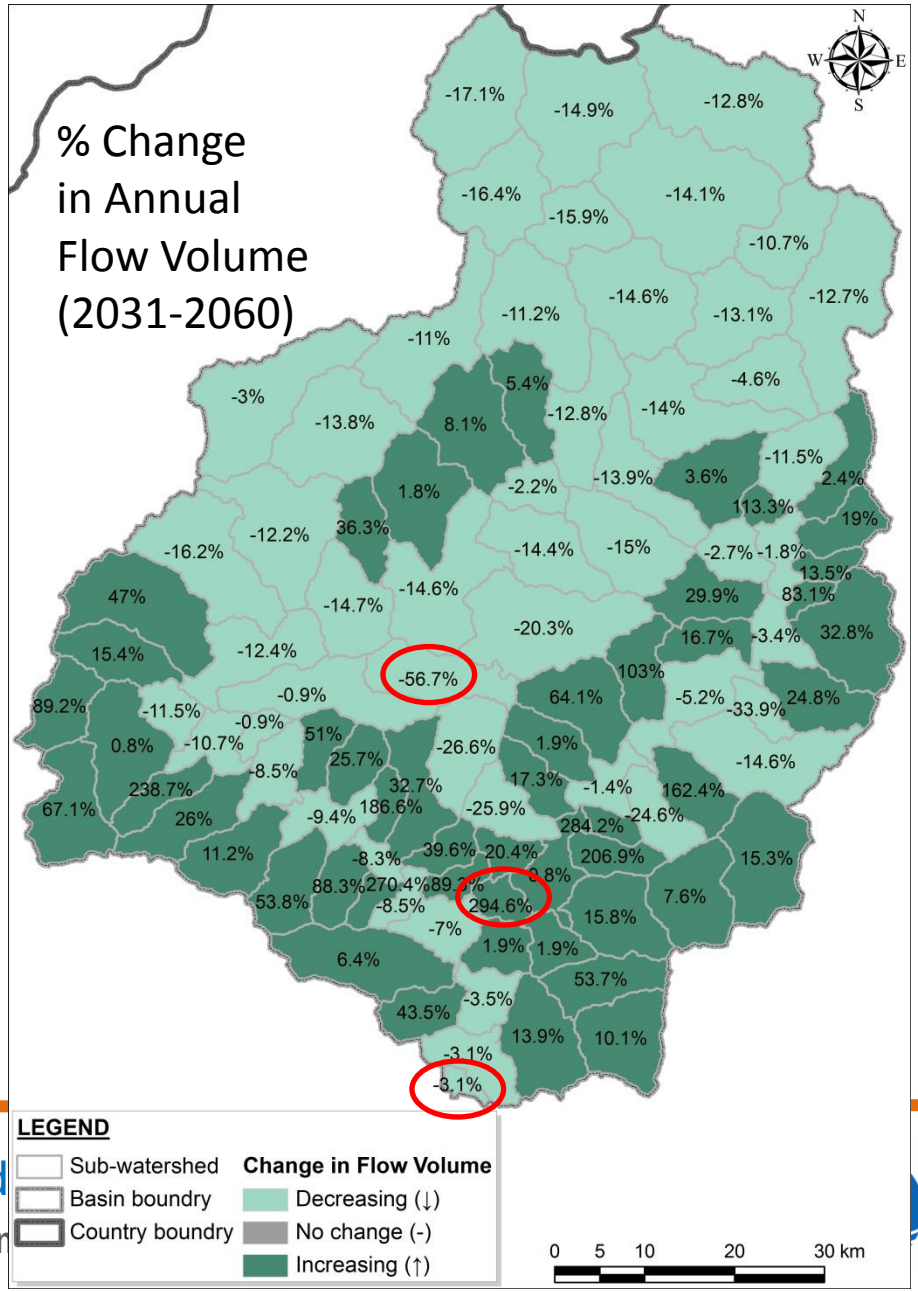


Result: Trend of Annual Precipitation and Annual Average Minimum and Maximum Temperature



Result: Distribution of Flow Volume





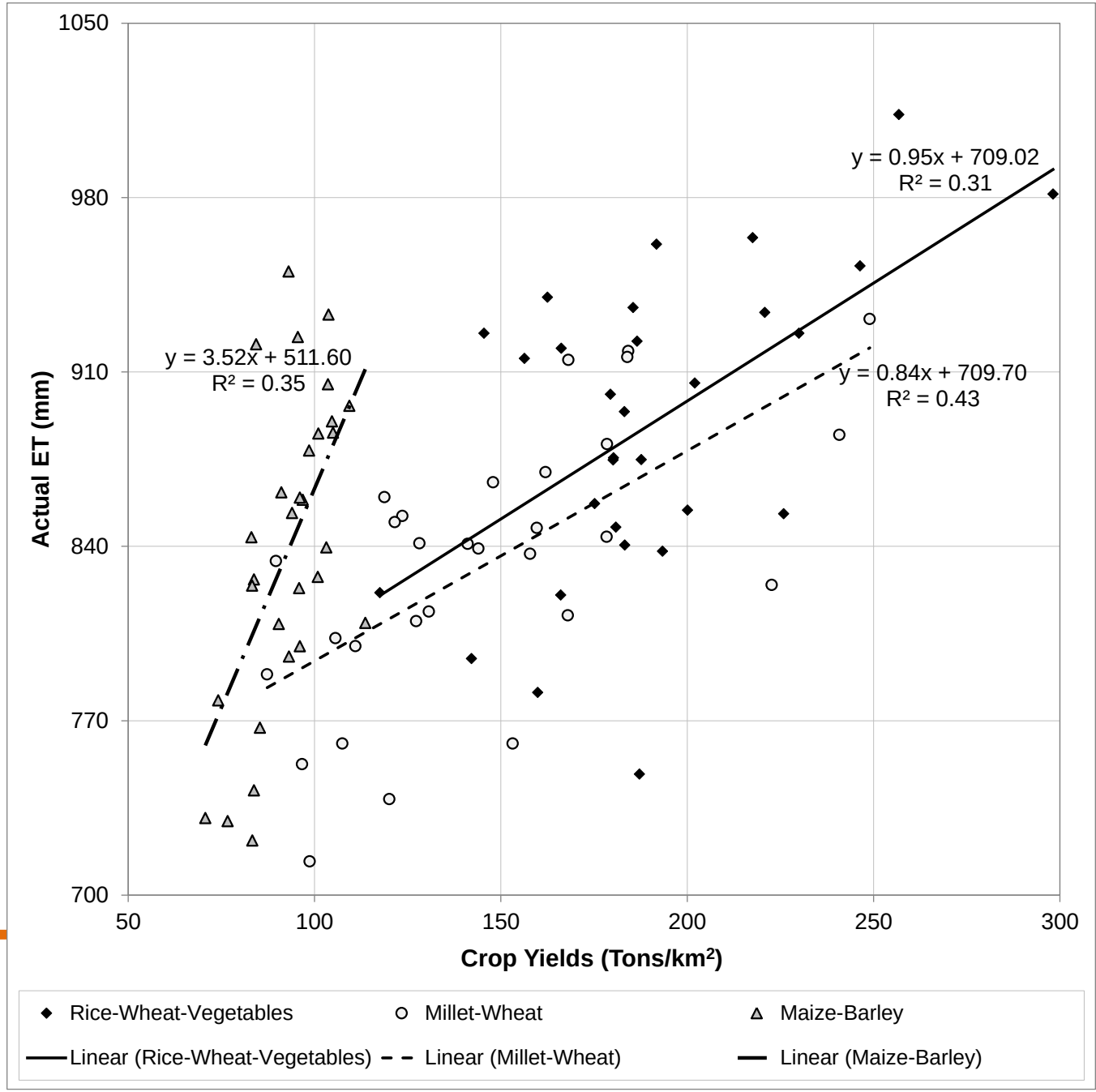
Result: Trend of Annual Actual ET and Crop Yields (1981-2010)

Rotation Scenario:

a) Rice-Wheat-Vegetables;

b) Millet-Wheat; and,

c) Maize-Barley



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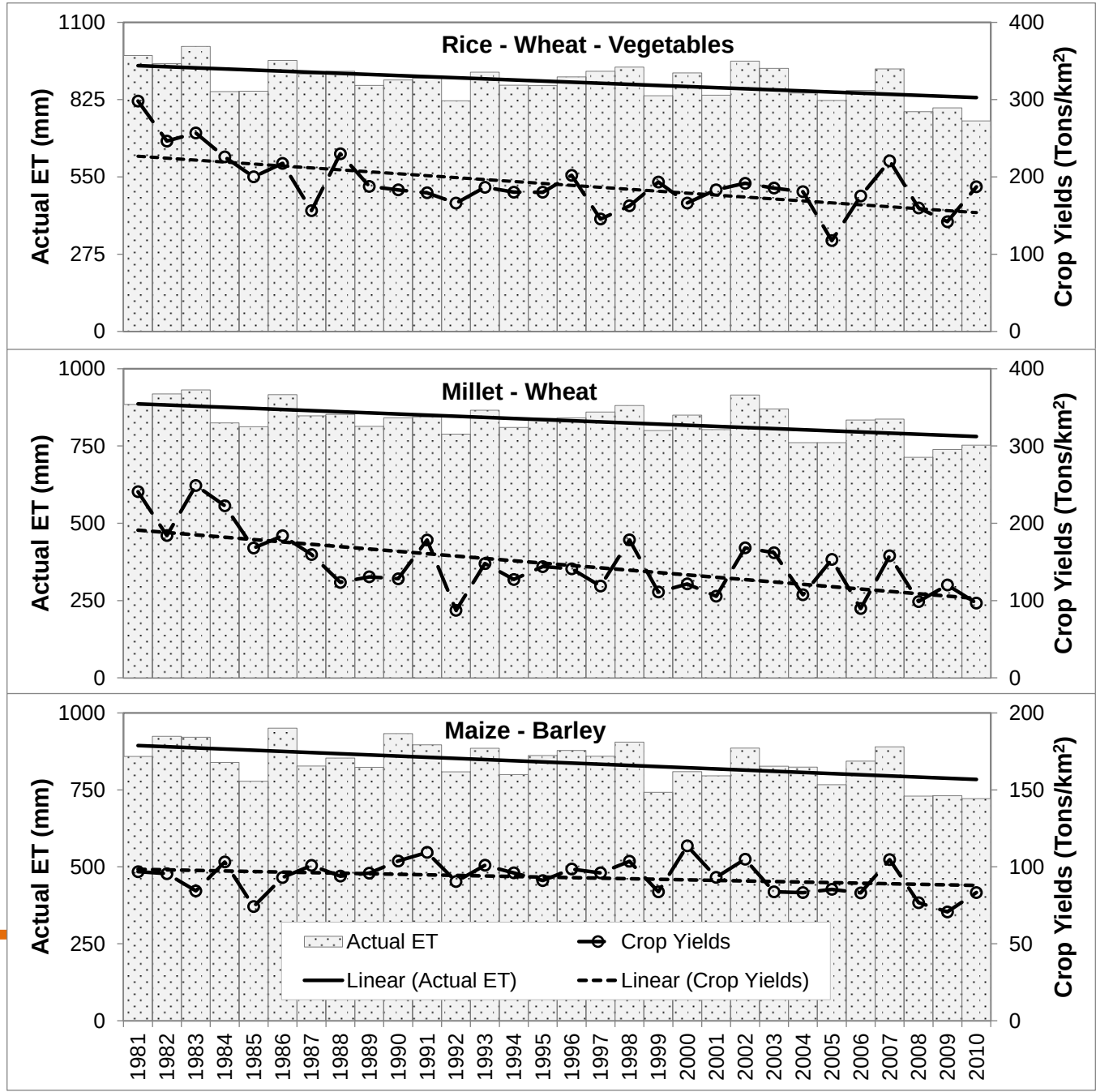


Result: Impact of Climate Change on Water Balance and Crop Yields

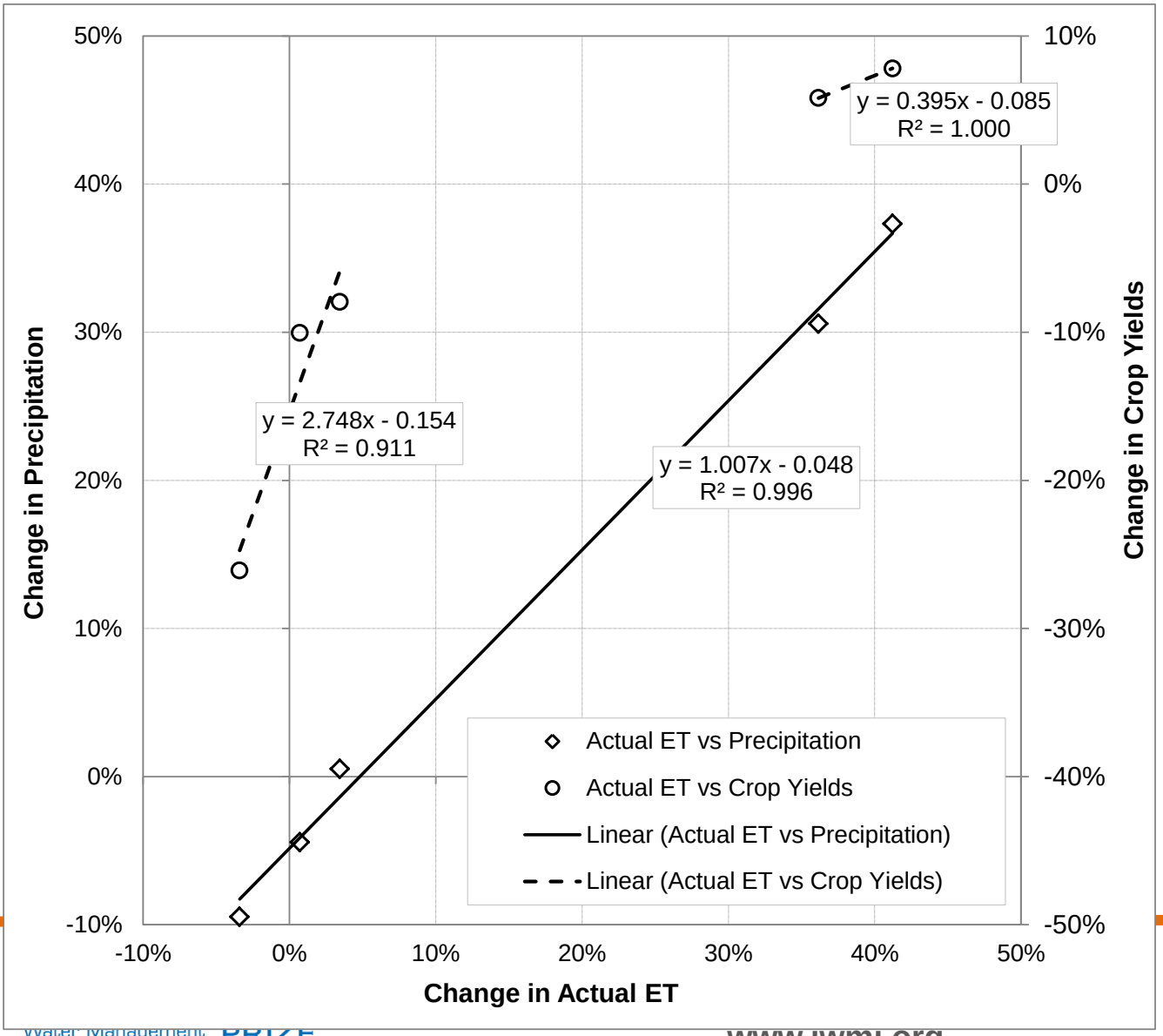
Simulated Water Balance and Crop Yields under Current Climate (1981-2010):

Variables	Summer Crop			Winter Crop	
	Rice	Maize	Millet	Wheat	Barley
Precipitation (mm)	1002	818	788	186	169
Actual ET (mm)	534	452	322	138	177
Surface Runoff (mm)	235	175	170	7	10
Crop Yields (Tons/km^2)	54	83	15	45	29

Percentage Change in Simulated Water Balance and Crop Yields under Future Climate (2031-2060):

Variables	Summer Crop			Winter Crop	
	Rice	Maize	Millet	Wheat	Barley
Precipitation	-4.4%	+0.5%	-9.5%	+37.3%	+30.6%
Actual ET	+0.7%	+3.4%	-3.4%	+41.2%	+36.2%
Surface Runoff	-12.6%	-6.3%	-16.9%	+21.9%	+18.1%
Crop Yields	-10.0%	-7.9%	-26.1%	+7.8%	+5.8%

Result: Impact of Climate Change on Water Balance and Crop Yields



Assumptions in Crop Yields evaluation:

a) Harvest and kill operation

b) Auto-irrigation

c) Not validated

d) Simulated under default parameters of crop yields (Standard parameter)

Conclusion

Under Current Climate:

1. Declining trends of annual actual ET and crop yields

Under Future Climate:

1. Precipitation will decrease on the summer crops fields except on the maize; and will increase on the winter crops
2. Actual ET will increase for all crops except in millet under future climate projection
3. Summer crop yields will decrease and winter crop yields will increase

However, there is large degree of uncertainty in the simulated results due to disagreement among the projected future climate scenarios.


Thank you