UNIVERSITY OF TWENTE.

SPATIO-TEMPORAL WATER RESOURCE RESPONSES TO LAND USE LAND COVER CHANGE IN SEMI-ARID UPPER TEKEZE BASIN, NORTHERN ETHIOPIA

MEWCHA AMHA GEBREMEDHIN

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Presentation outlines

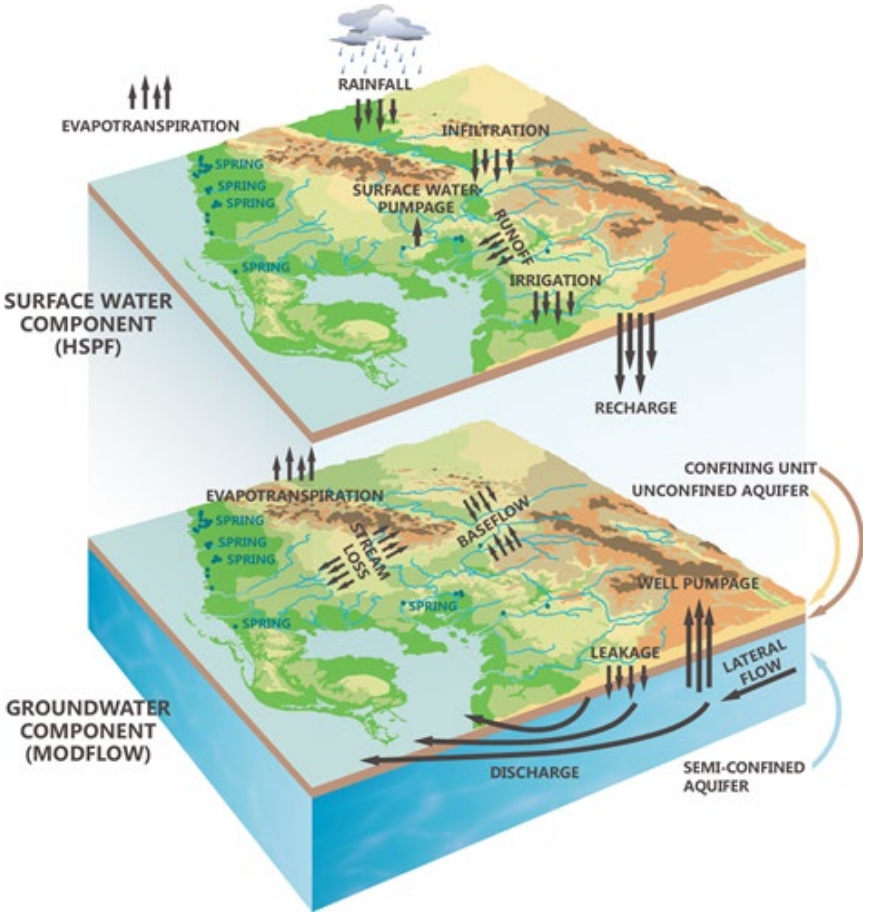
- Introduction
- Motivation
- Objectives
- Methodology
- Expected output
- Workplan

Introduction

- water availability is declining while population growth is increasing
  - seriously affecting the economic growth
- It is a critical problem in arid and semi-arid areas
  - different factors
- LULC change alter quantity and distribution SW-GW resources

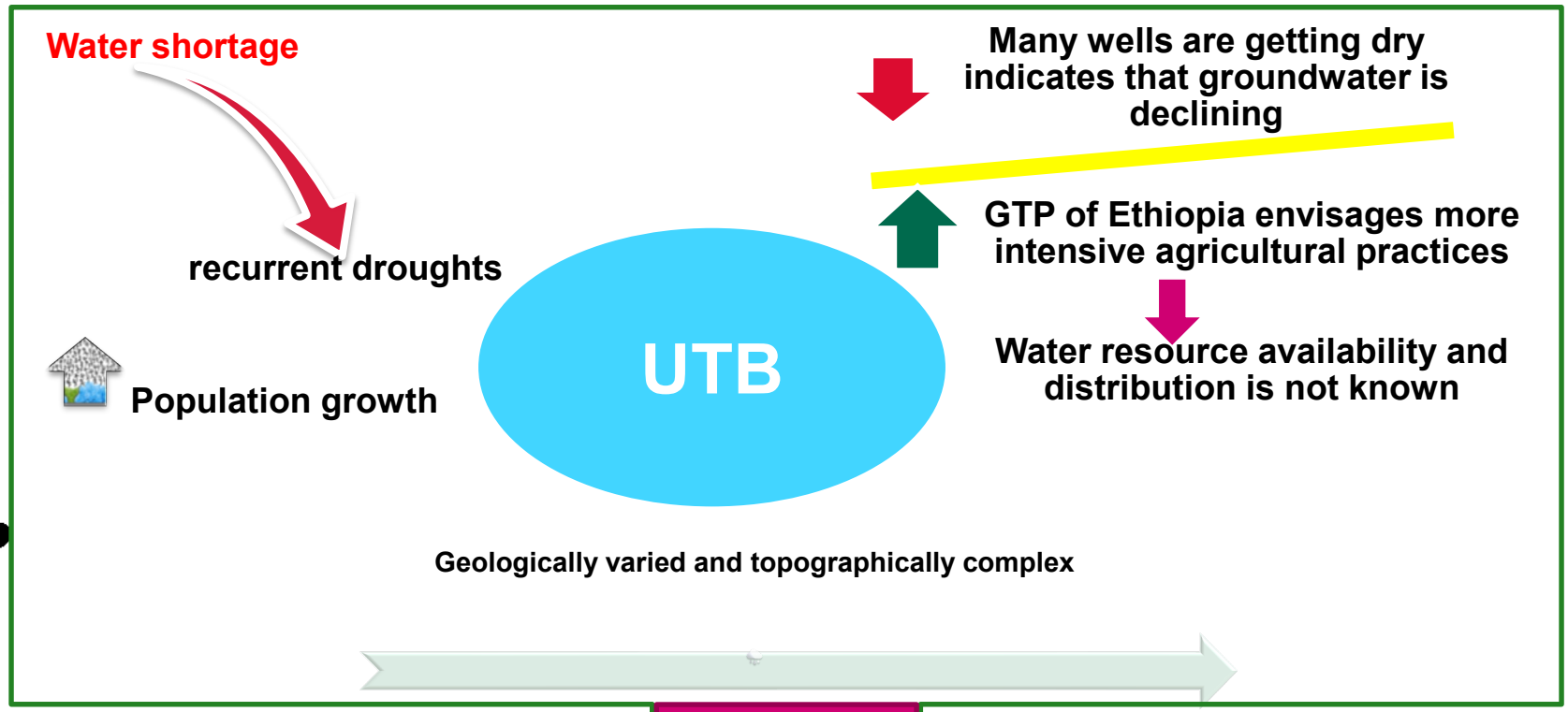
Introduction

- Investigating SW-GW interaction in space and time is growing field of research
  - sustainable water resources management
- IHM are playing key role in this field by integrating with geospatial data and geospatial technologies
  - simulate water flux and detail water balances



https://integratedhydrologicmodel.org/

Motivation



WRS?

Requires in depth investigations of the spatio-temporal surface-groundwater interactions and groundwater resources changes

Motivation

- The poor coverage of ground-based hydro-meteorological gauging stations is a challenge
  - RF and PET at reasonable resolution
  - state variable (groundwater level and stream flow) for validation
- Therefore integrating satellite products in data scarce of UTB is required

Objectives

The aim of this study is to conceptualize and quantify spatio-temporal water resources and their response to LULC in the semi-arid UTB, Northern Ethiopia

- Validate and merge daily satellite derived rainfall and potential evapotranspiration estimations with in-situ observations
- Setup and calibrate an integrated hydrologic model to quantify spatio-temporal surface-groundwater interactions and groundwater resources
- Predict future water resources changes in response to future LULC change

Study area

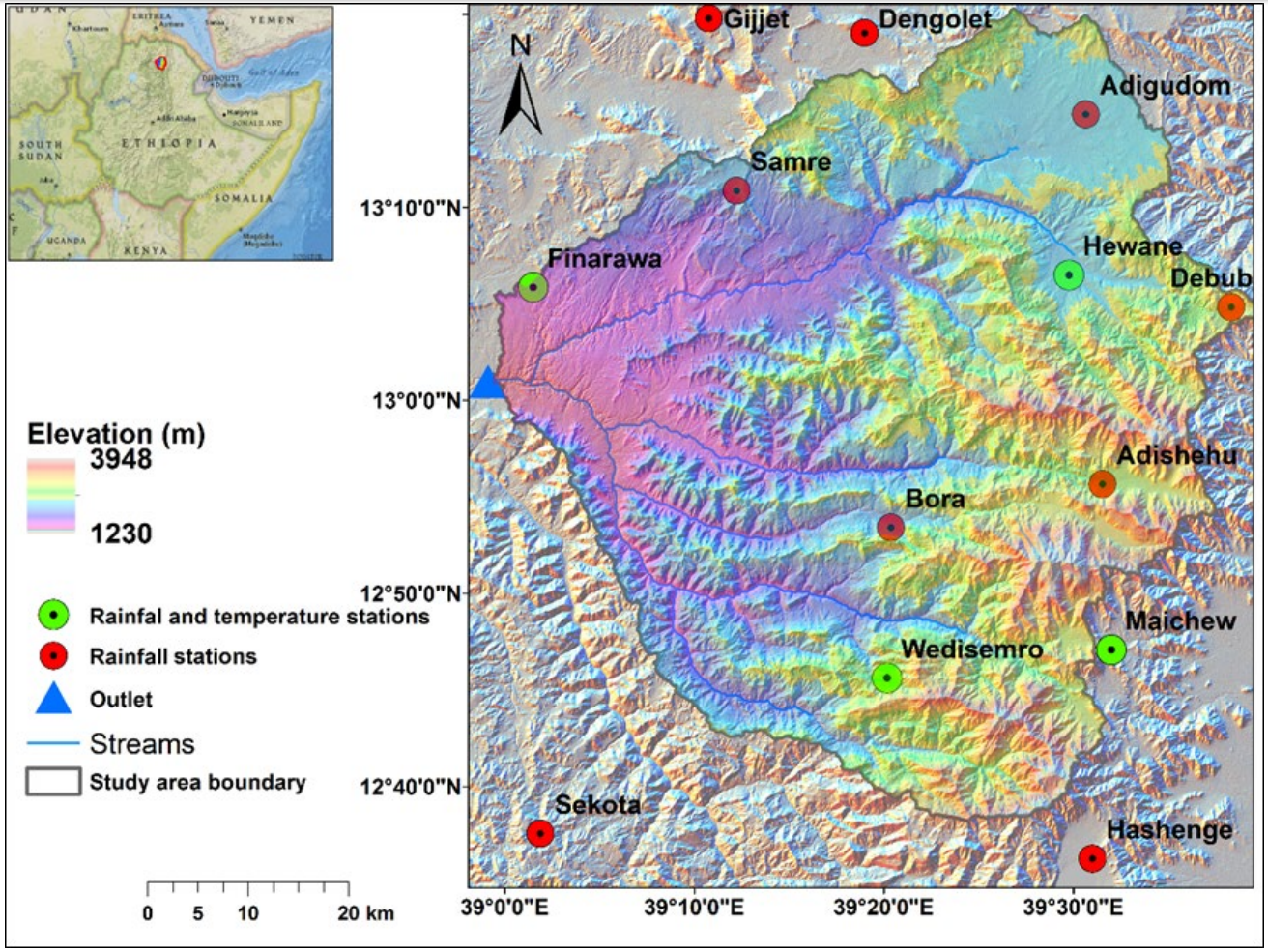


Figure 1: study area

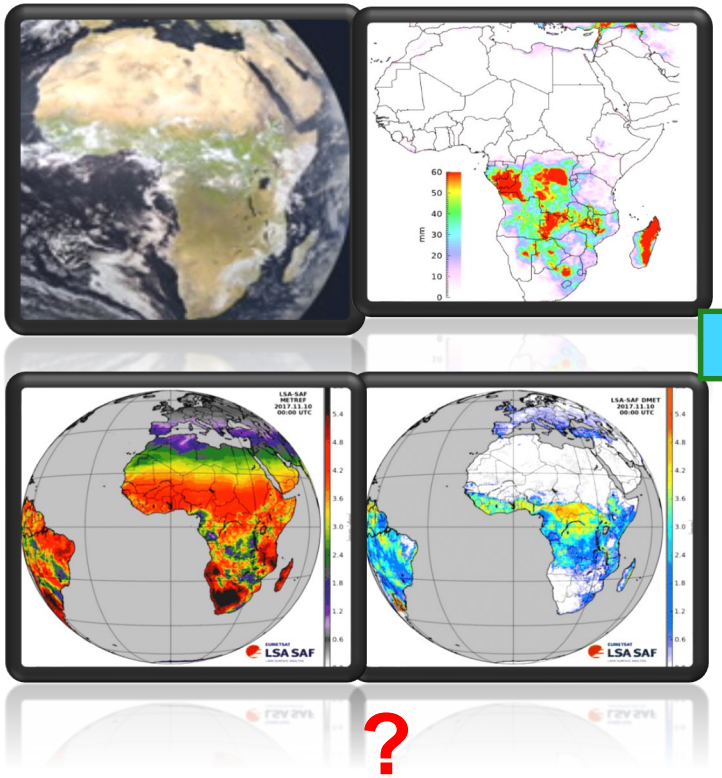
Validate and merge daily satellite derived rainfall and potential evapotranspiration estimations with in-situ observation– Objective-I

Research questions

- What is the temporal and spatial performance of satellite rainfall and potential evapotranspiration estimations in semi-arid area with complex topography?
- How can the satellite rainfall and potential evapotranspiration be integrated with in-situ observations for improved bias correction?
- What is the spatio-temporal variability of potential evapotranspiration?

Data acquisition – Objective-I

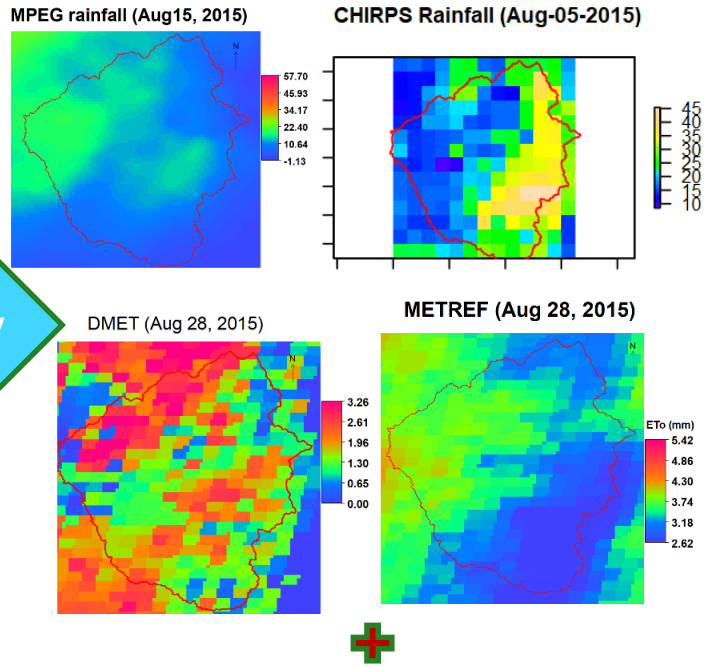
Satellite products



?

- **Relatively high spatio-temporal resolution**
- **Freely available**

Daily



Ground based

- Existing daily meteo →ENMA
- Additional weather station installation

Methodology- Rainfall

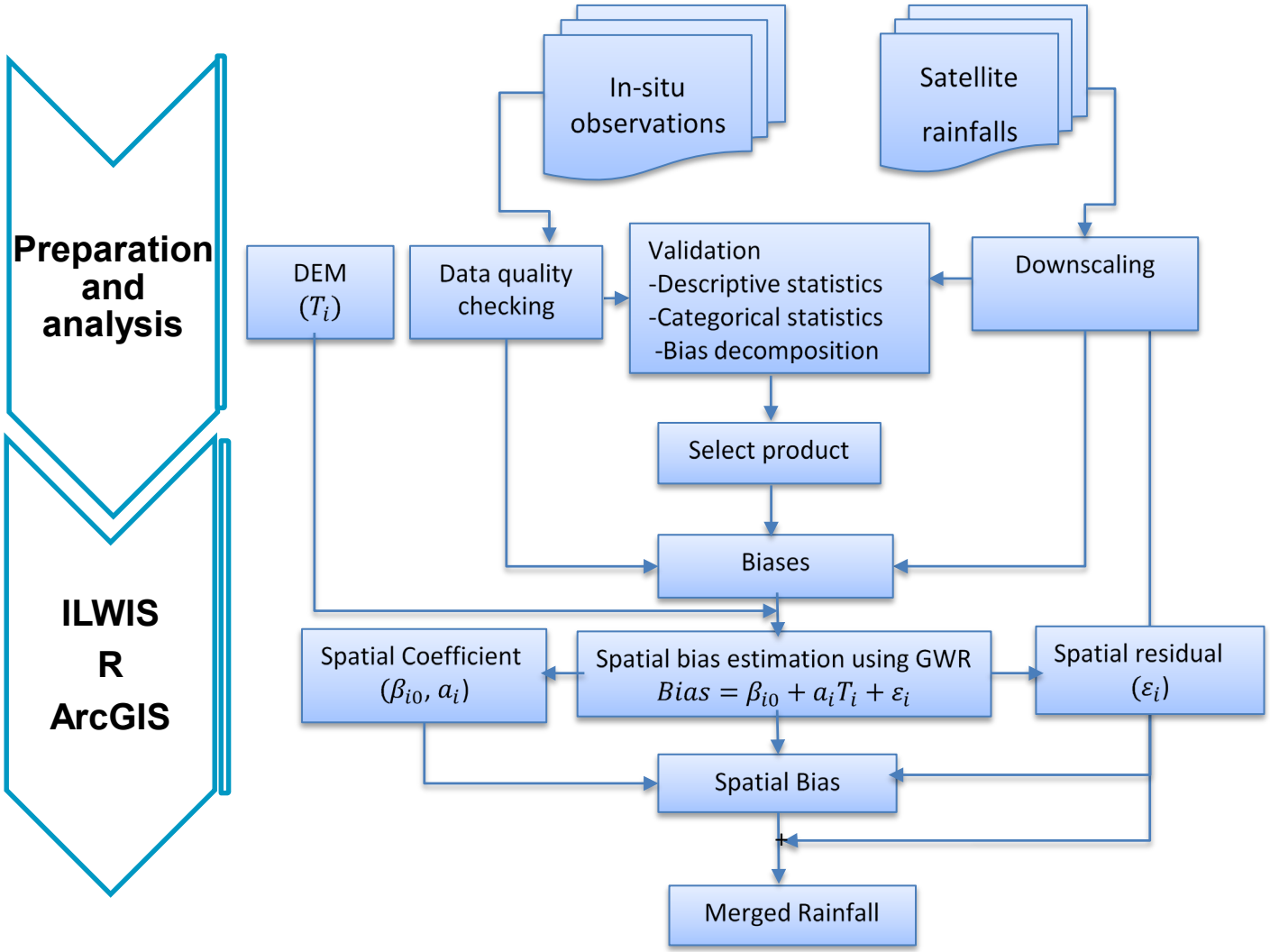
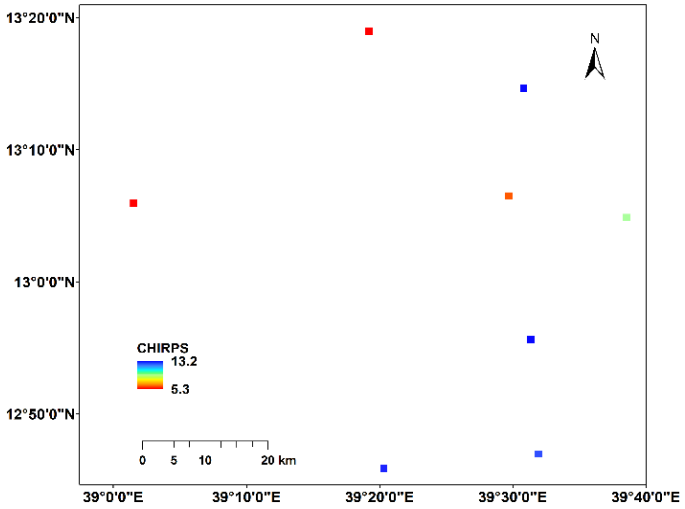
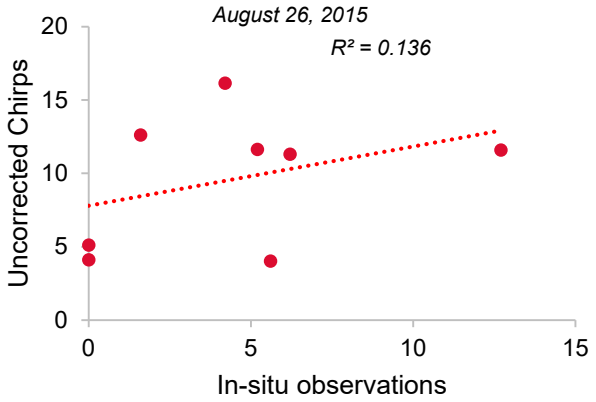
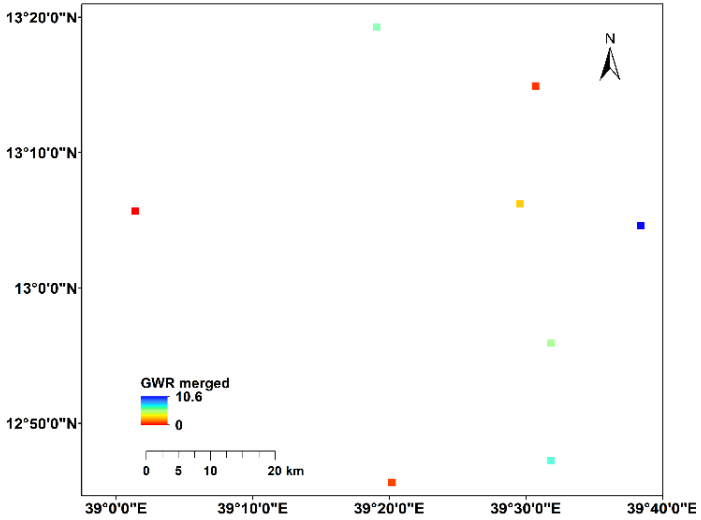


Figure 3: Flow chart of satellite rainfall evaluation and merging

Preliminary results- Rainfall







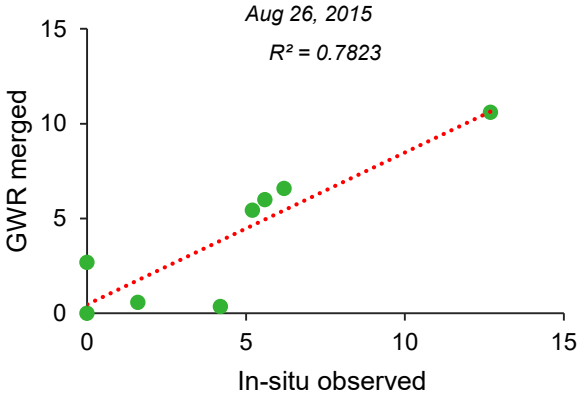


Figure 4: GWR merged and uncorrected CHIRPS in 8 stations in August 26, 2015

Methodology- DMETREF

PET analysis

ILWIS
R
ArcGIS

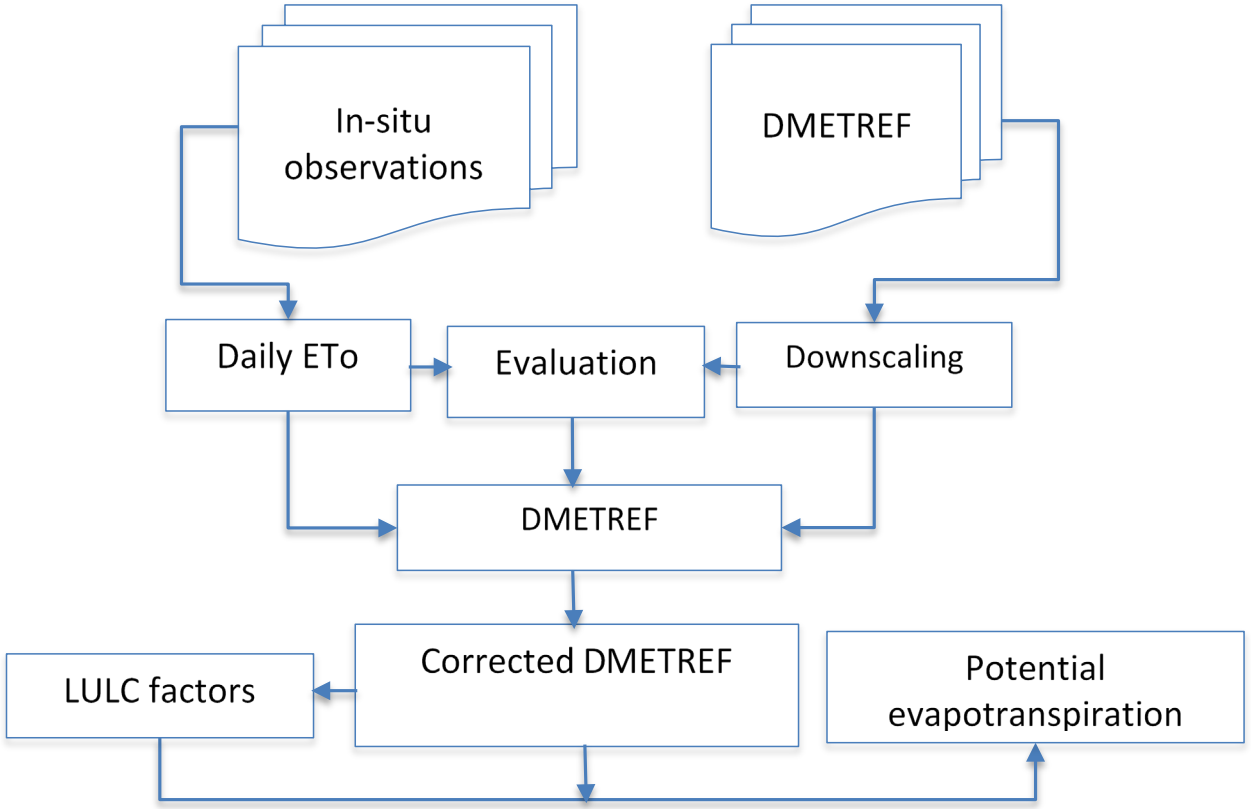


Figure 6: Flow chart of satellite reference evapotranspiration evaluation and conversion to potential evapotranspiration

Research questions

- What is the hydrogeological conceptual model to represent the surface-groundwater interaction?
- How surface-groundwater interactions and groundwater resources are characterized spatially and temporally with the timeline of model simulation?
- What is the spatio-temporal variability of net recharge and aquifer storage in response to different LULC?

Data acquisition – Objective-II

Satellite product

Improved RF and PET
- Objective-I

Satellite images
- http://earthexplorer.usgs.gov/

Vegetation density
- NDVI of satellite image

Ground based

River discharge
- MoWR
- Additional automatic data loggers

Groundwater level
- Monitoring

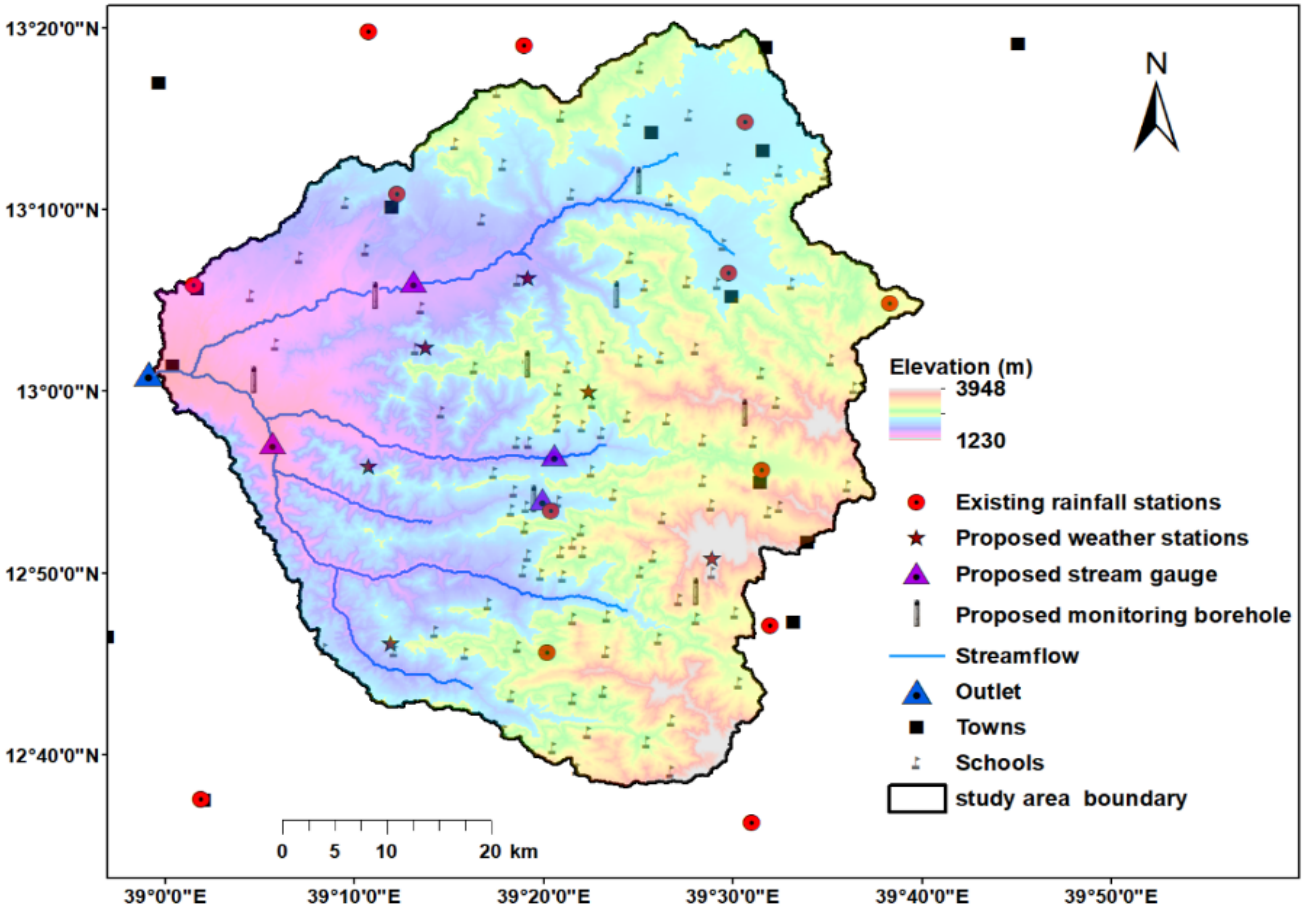
Soil data
- EthioSIS

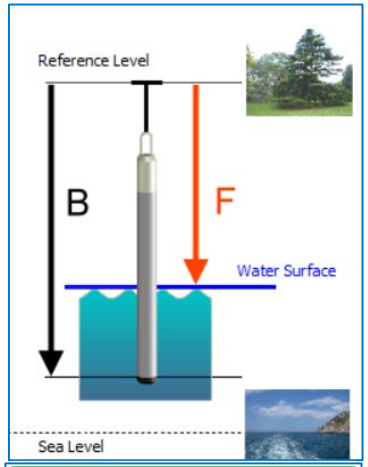
Geology and hydrogeology maps
- EGS

Borehole log information
- national and regional bureau of water resources

All data will be checked and re-projected/georeferenced to consistence coordinate system

Proposed instrument installation



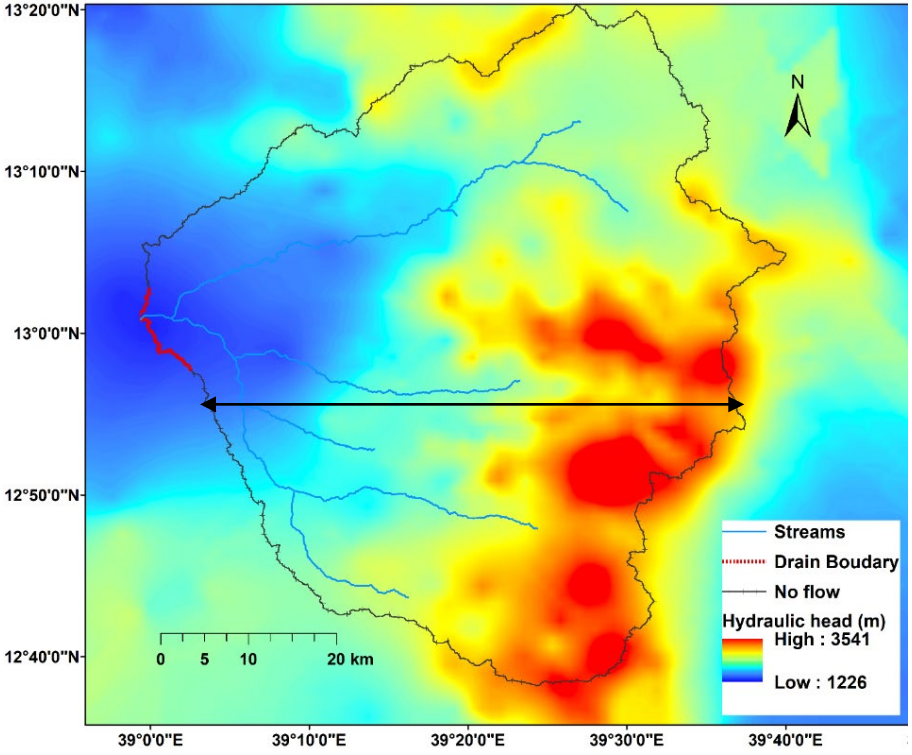


Logger programming

- *10 minute for river*
- *1 hour for GWL*

Figure 7: proposed borehole monitoring, weather station and stream gauge locations

Methodology



Conceptual model

Surface

- Watershed delineation

Sub-surface

- Define hydrostratigraphic units
- Determine boundary condition and flow direction
- Defining preliminary water balance

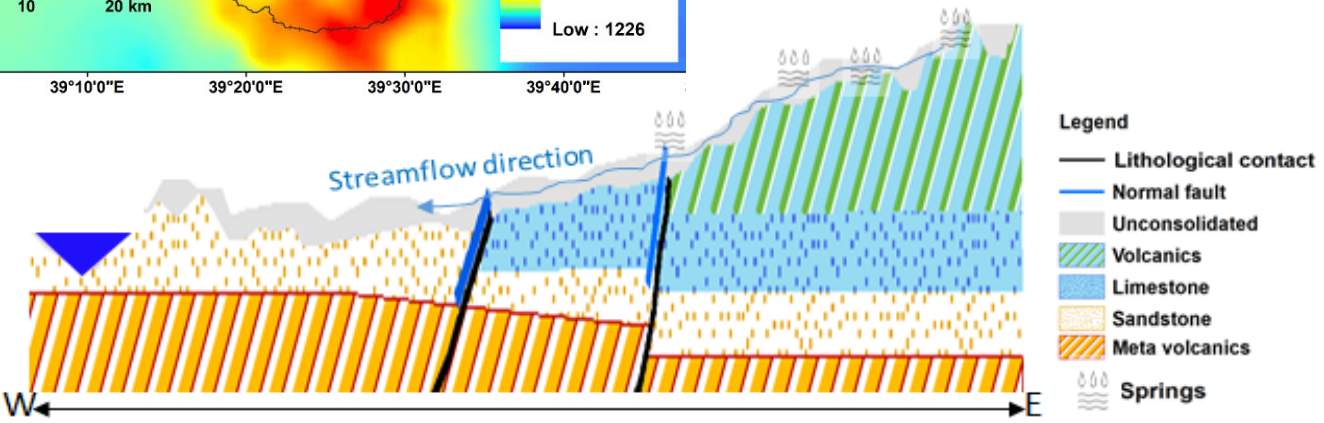


Figure 8: Conceptual model

Methodology

GSFLOW model will be use

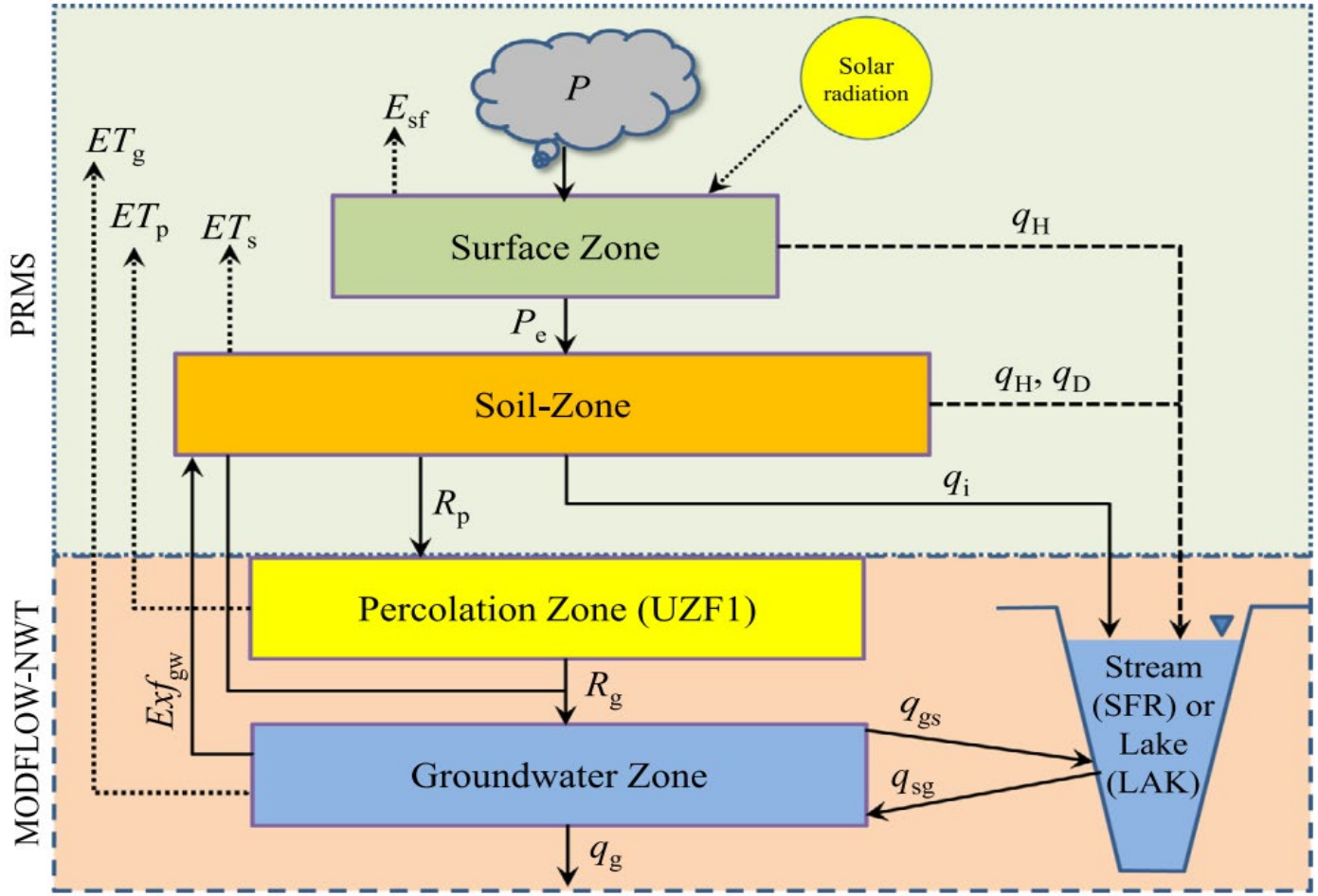


Figure 9: GSFLOW setup (Hassan et al., 2014)

Methodology

GSFLOW modeling

ArcGIS
ArcHydro
Paramtool
ModelMuse

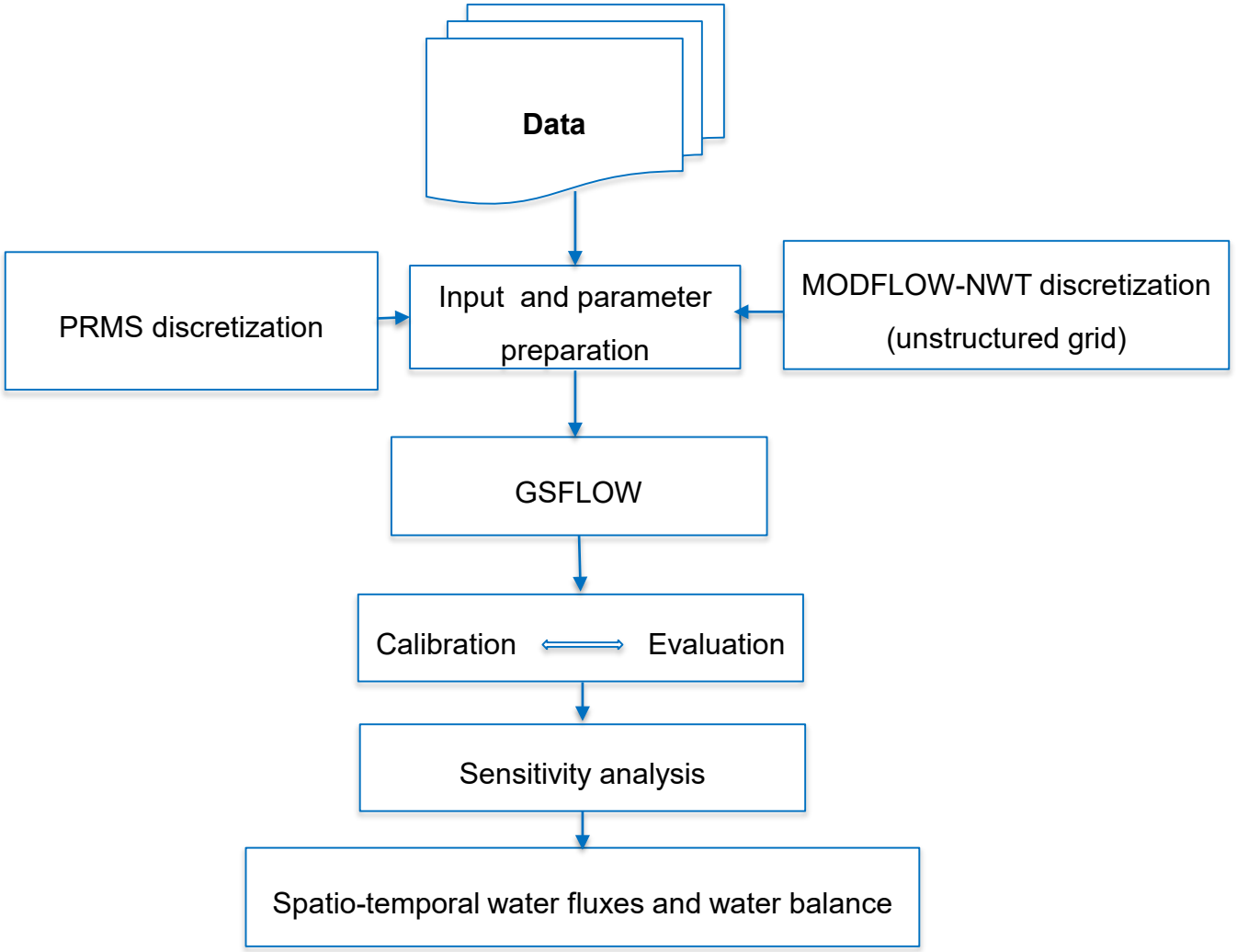


Figure 10: Methodology for GSFLOW modeling

Predict future water resources changes in response to future LULC change- Objective-III

Research questions

- What is the past trend in LULC change?
- What are the main driving factors for LULC change and how could be prioritized considering water impact?
- What is the predicted LULC change?
- How sensitive is the water resources change in response to future LULC change?

Data acquisition – Objective-III

Ground based data/ancillary data

- LULC factors
- GCP from ground

Remote sensing data

- Landsat images for 1990, 2000 and 2018
- Sentinel-2 for 2018
- DEM

Methodology

LULC analysis and prediction

ArcGIS
ERDAS
TerrSet

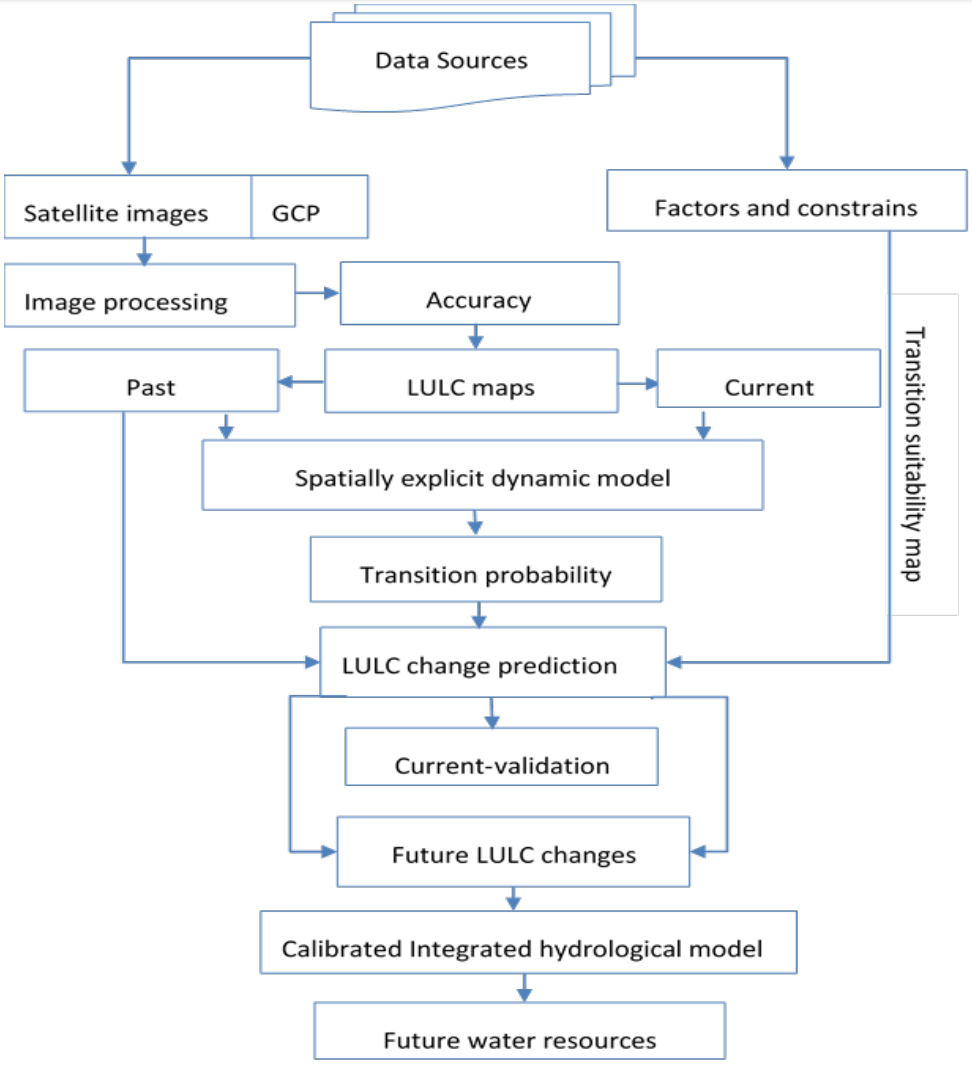


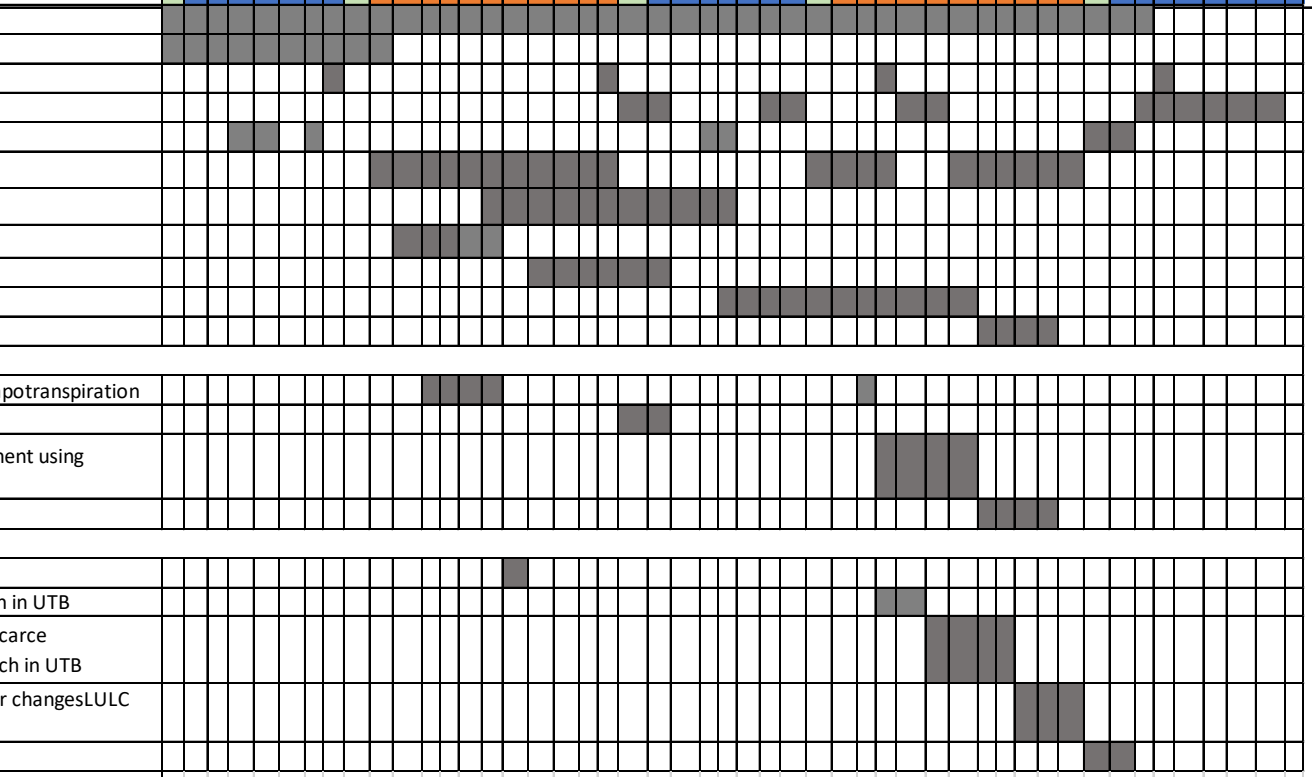
Figure 11: Methodology for future water resources changes in response to future LULC change

Expected outputs

- Provide quantified water fluxes and detailed water balance of the study area for effective water resource decision making
- Integrated hydrological modeling that can be scaled to other basins
- Four published papers in peer reviewed journals
  - Validating and improving satellite rainfall in UTB
  - Spatio-temporal variability of potential evapotranspiration in UTB
  - Assessment of surface-groundwater interaction in data scarce UTB using integrated hydrological modelling approach in UTB
  - Water resources changes under future land use land cover changes in UTB

Work plan

No	Activities
1	**Literature review**
2	**Proposal development**
3	**Progress report**
4	**Seminars and workshopes**
5	**Course work**
6	**Fieldwork and data collection**
7	**MSc students supervision**
8	**Satellite rainfall and potential evapotranspiration analysis**
9	**Hydro-geological conceptual model development**
10	**Integrated hydrological modeling developemnt**
11	**LULC change analysis and prediction**
12	**Result analysis and writeup**
	i. Validating and improving satellite rainfall and potential evapotranspiration
	ii. Hydro-geological conceptual model
	iii. Surface-groundwater interaction in data scarce environment using integrated hydrological modelling
	iv. Water resources changes under futre LULC changes
13	**Manuscript preparation and send to Journal publication**
	i. Validating and improving satellite rainfall
	ii. Spatio-temporal variability of potential evapotranspiration in UTB
	iii. Assessment of surface-groundwater interaction in data scarce environment using integrated hydrological modelling approach in UTB
	iv. Water resources changes under future land use land cover changesLULC changes
14	Thesis submission



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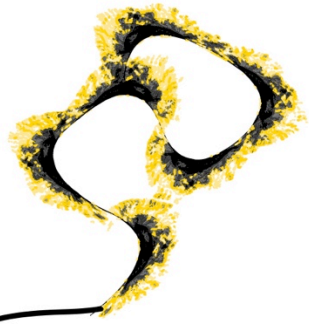
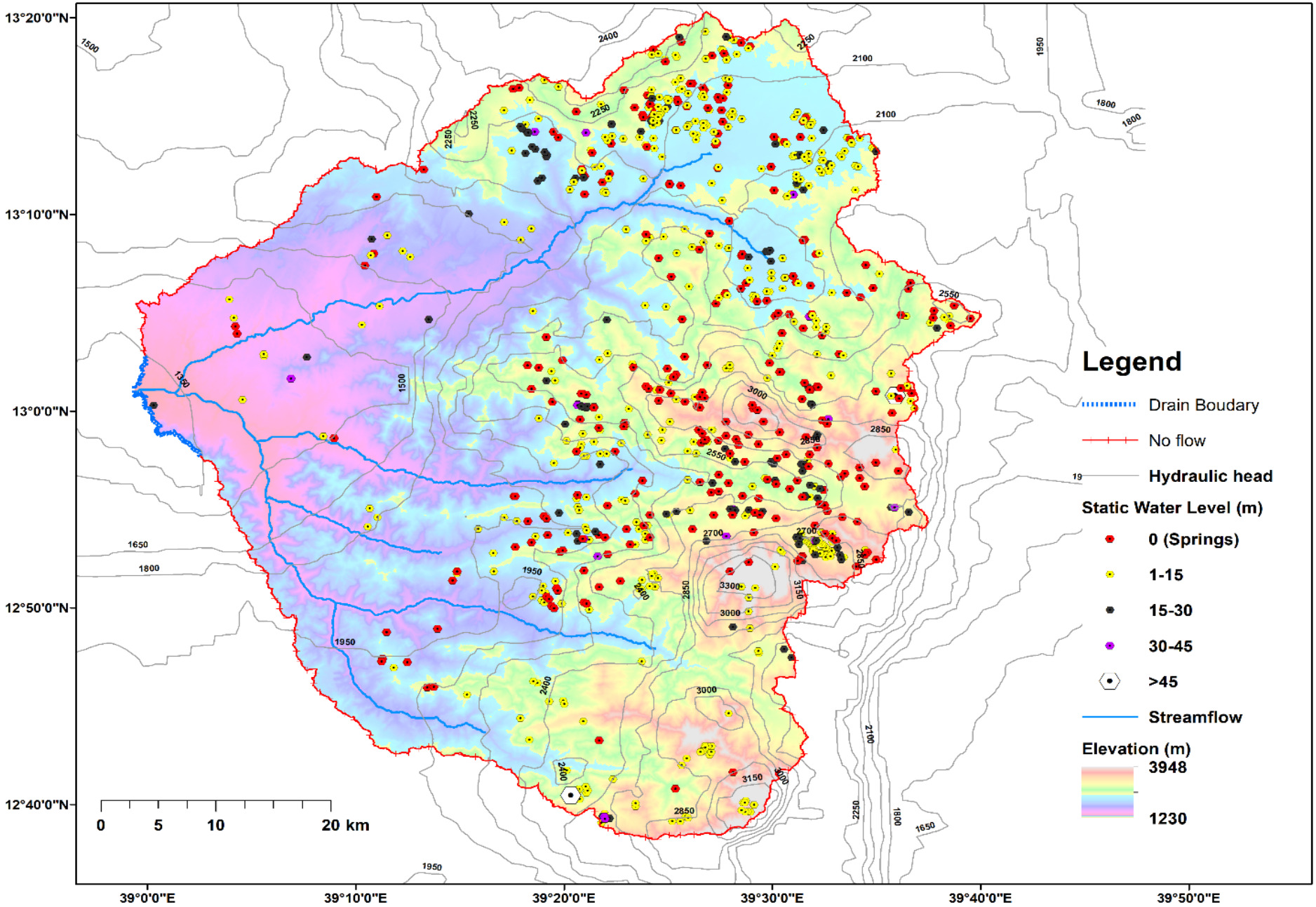
THANK YOU!

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39°0'0"E
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39°20'0"E
39°30'0"E
39°40'0"E
39°50'0"E
0 5 10 20 km
Legend
Drain Boudary
No flow
Hydraulic head
Static Water Level (m)
0 (Springs)
1-15
15-30
30-45
>45
Streamflow
Elevation (m)
3948
1230