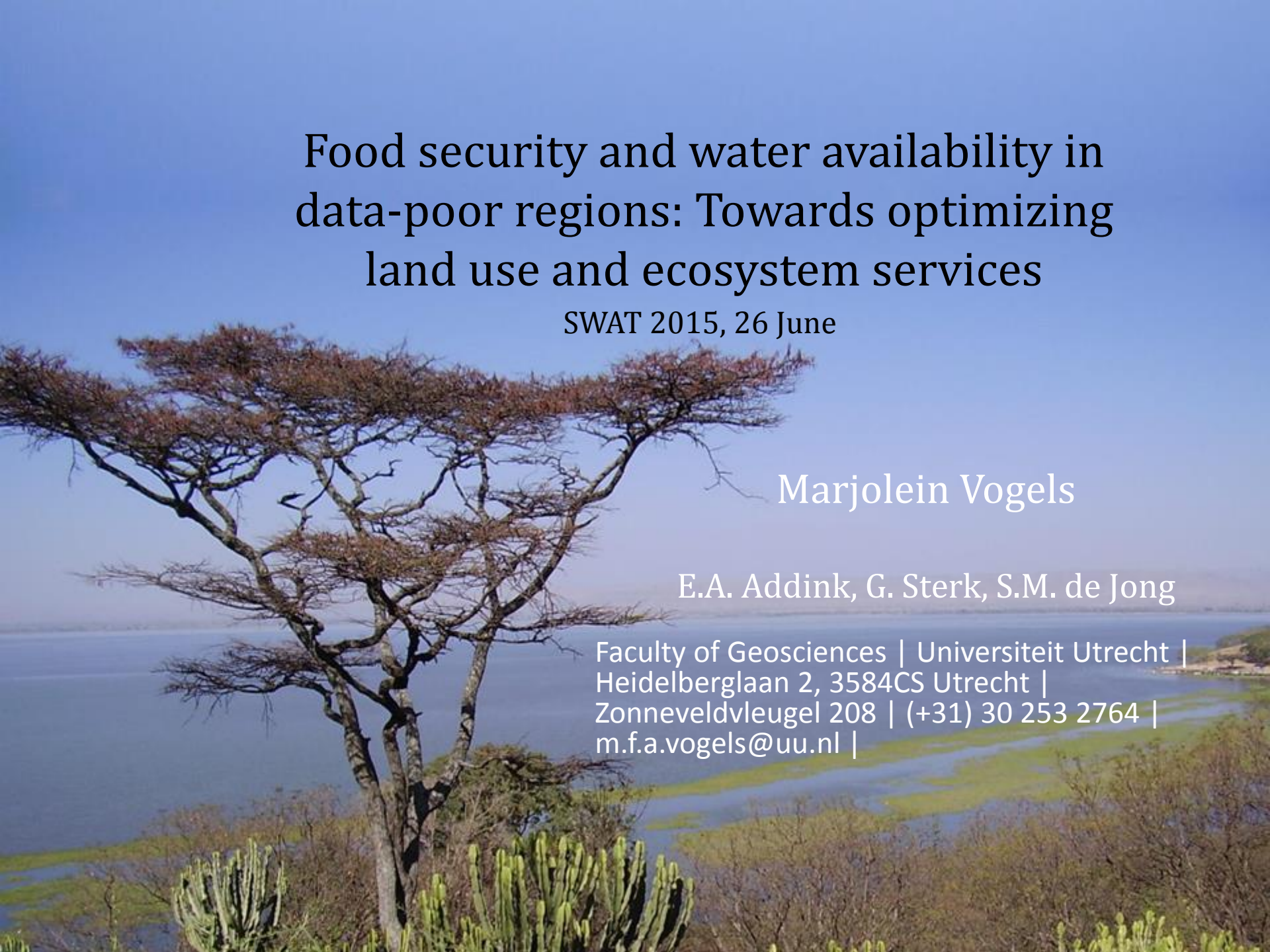
Food security and water availability in data-poor regions: Towards optimizing land use and ecosystem services

SWAT 2015, 26 June



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This presentation

- Framework of this research project
- The current land degradation problem in Ethiopia
- Knowledge gap and research focus of this project
- Preliminary results of the Tikur Woha catchment
- SWAT and data assembly

Framework of this research project

- The project is funded by the European programme of Climate-KIC
- Collaboration with Hawassa University and the Wondo Genet College of Forestry and Natural Resources, Ethiopia
- Conducted at Utrecht University at the Department of Physical Geography, Geosciences, the Netherlands

Dryland regions: Ethiopia

- The ‘water tower’ of Eastern Africa
- Alternation of periods of severe drought and heavy flooding
- Land use and land cover (LULC) is affected by growing population and economy
- Most dominant land cover change is the increase of cropland at the expense of forest
- Less infiltration and more surface runoff : threatening food supply and access to water

Agricultural sector: water scarcity and soil erosion

- Traditional agricultural practices are highly unsustainable for the environment

- Also further land degradation may result from anticipated climate change within the next decades, affecting both annual precipitation and its seasonality

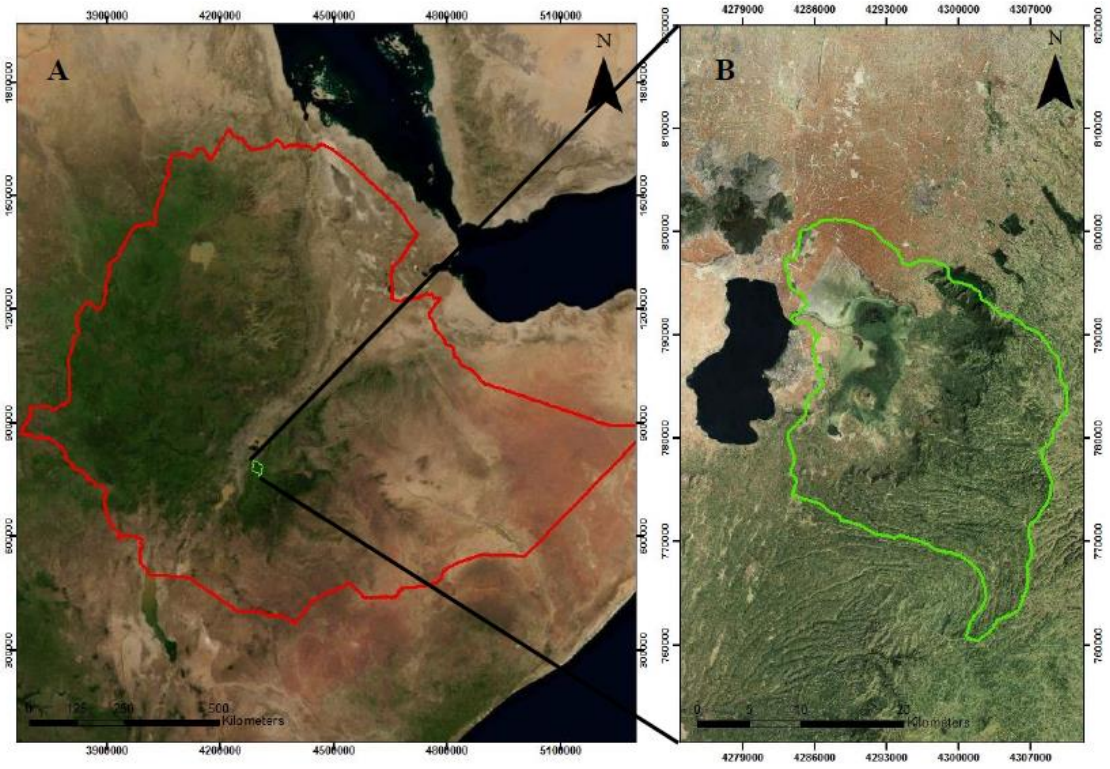
Knowledge gap

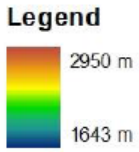
- There is a lack of reliable information on current land use and land degradation status
- Tools to assess land degradation and hydrology on a catchment scale are not available
- Extent and magnitude of hydrology and land degradation in relation with LULC changes during the past decades is not known

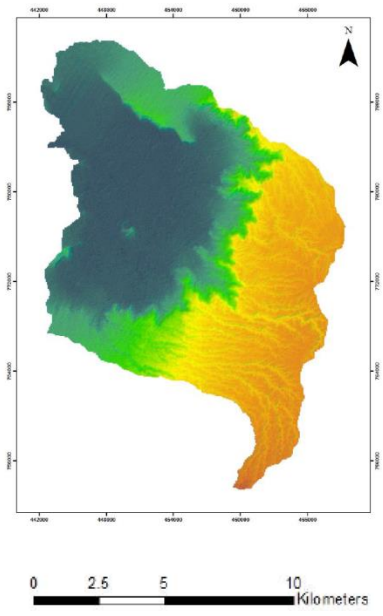
This knowledge is vital to keep the ecosystem services at the desired level

The aim of the project:

To study the influence of past land use changes and future trends in population growth and climate change on hydrology and land degradation in the Tikur Woha catchment in Ethiopia Central Rift







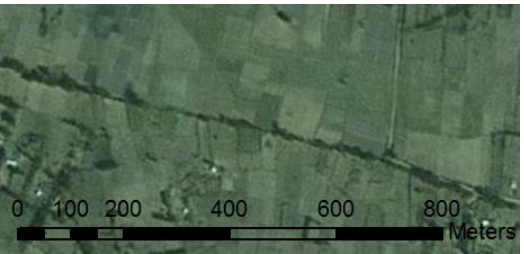
Study area

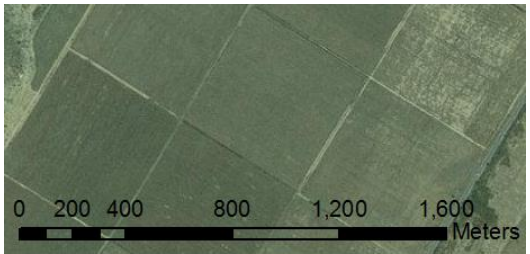
- Bimodal rainfall pattern: annual 1200mm in the wet season (July-September)

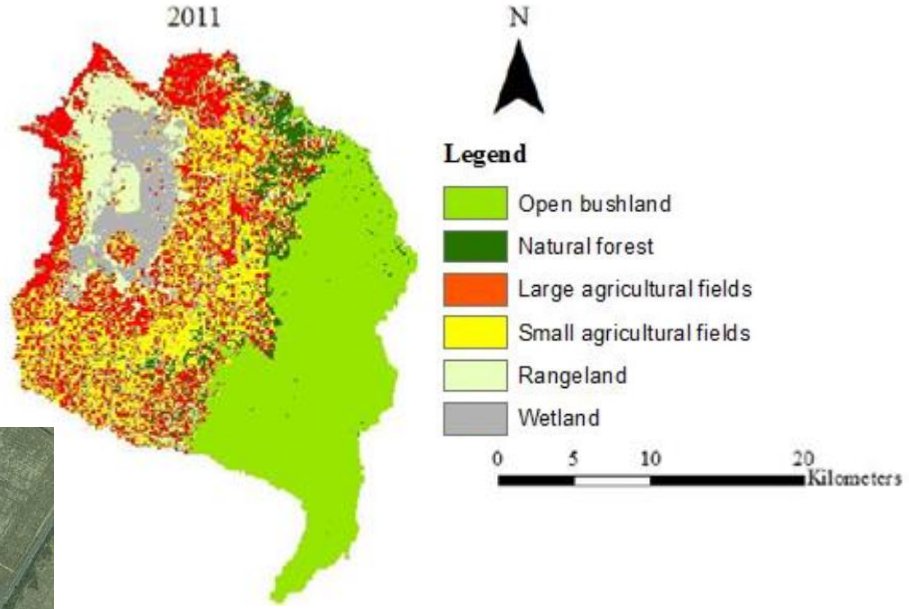
- LULC is dominantly agriculture

Smallholder farms (perennial crops): khat, ensete, coffee and sugarcane

Large agricultural state farms (non-perennial): maize and sweet potatoes

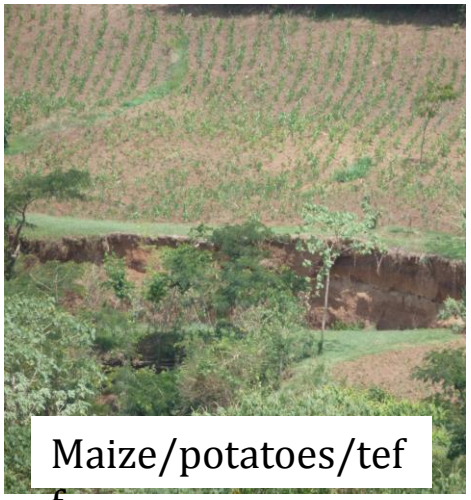






Crop types

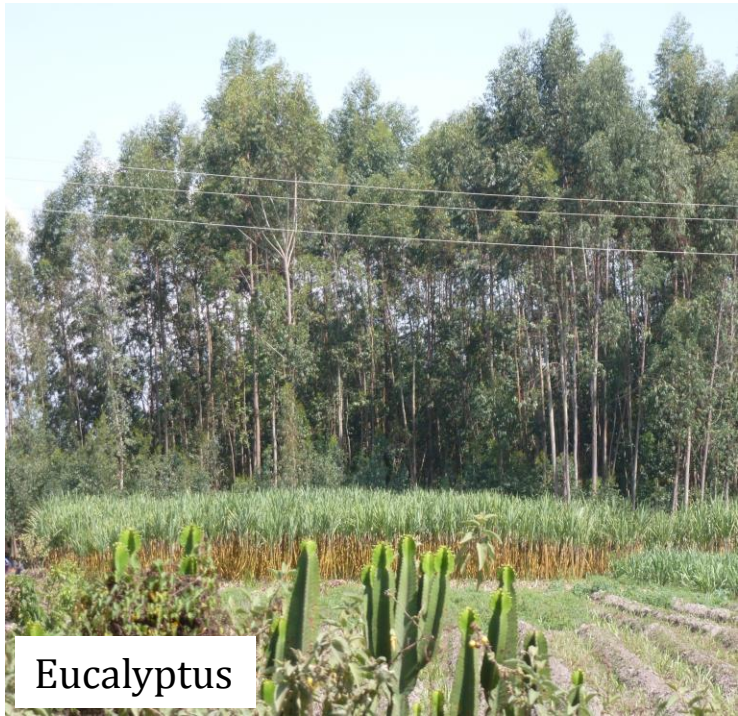

Sugarcane


Maize/potatoes/tef
f


Ensete

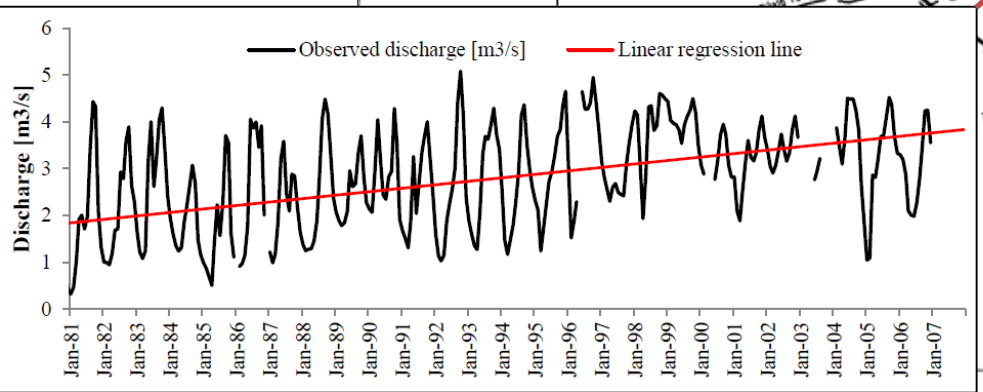

Coffee


Khat


Eucalyptus

Hydrology

- Only in the wet season significant outflow from the Tikur Woha river
- Tikur Woha river has a discharge station (1980-present)



TEXT MAP 15

Hydrology

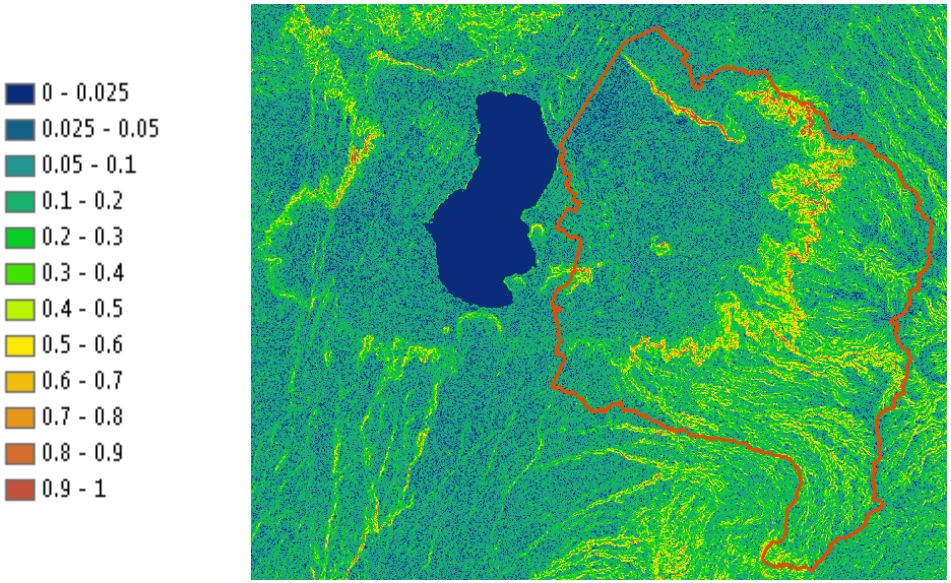
- 8 streams present upstream of swamp area, which all drain into the swamp. 4 are water-carrying year round

- Seasonality of the streams: Rainfall dependent. Very erratic pattern

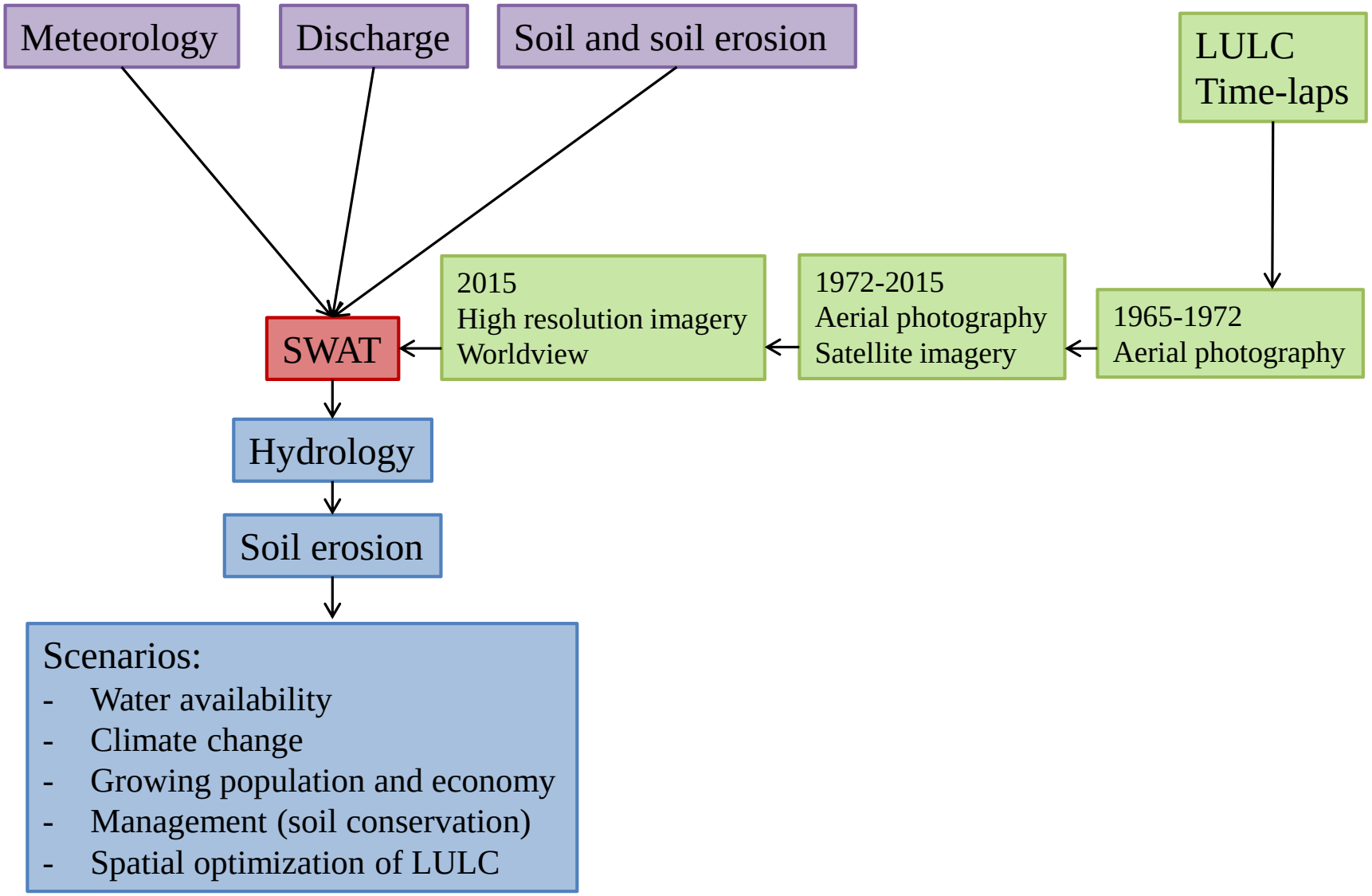
- Irrigation: lot of diversions created from the main streams. Sometimes by a structure, but mostly traditional: digging channels

Erosion

- Large gullies in the west of Lake Hawassa and in the north in the Tikur Woha catchment
- Steeper slopes with seasonal crops most vulnerable
- No soil conservation measures are present

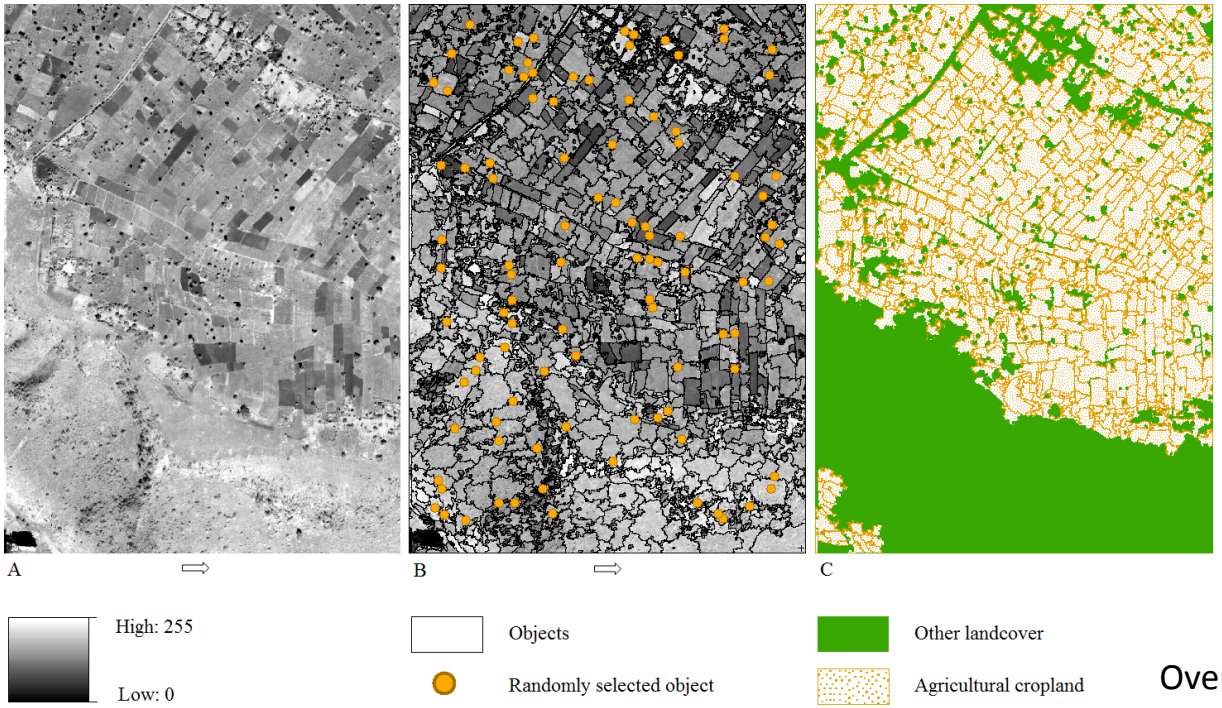


Approach


Meteorology
Discharge
Soil and soil erosion
LULC
Time-laps
2015
High resolution imagery
Worldview
1972-2015
Aerial photography
Satellite imagery
1965-1972
Aerial photography
SWAT
Hydrology
Soil erosion
Scenarios:
- Water availability
- Climate change
- Growing population and economy
- Management (soil conservation)
- Spatial optimization of LULC

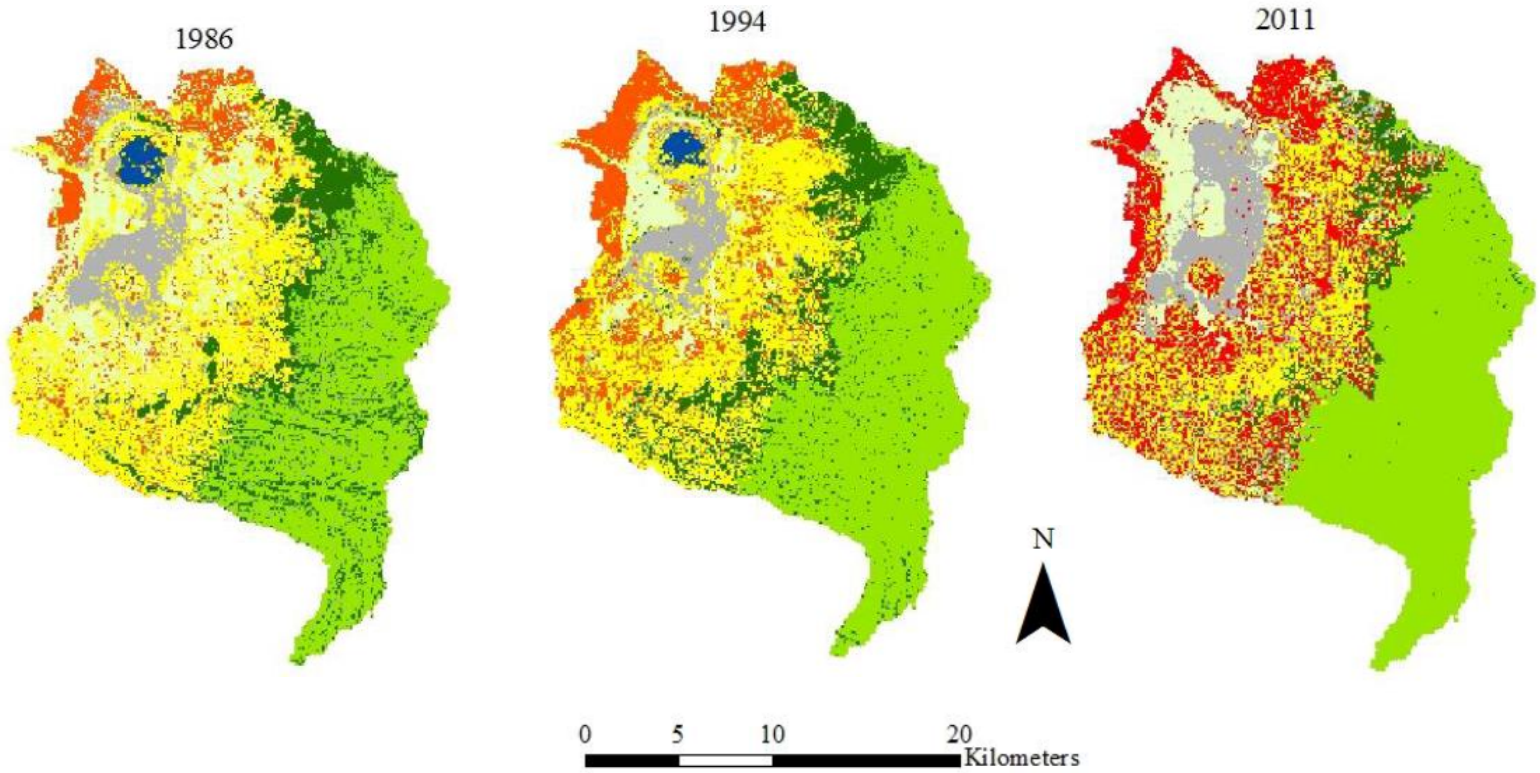
LULC time-lapse: Cropland mapping on black and white aerial imagery

- No satellite imagery available before 1972
- Major LULC changes occurred before 1972: Aerial imagery available for 1960s
- Cropland mapping using Geographic-Object-Based-Image-Analysis and Random Forests (ongoing work)→ SWAT model input



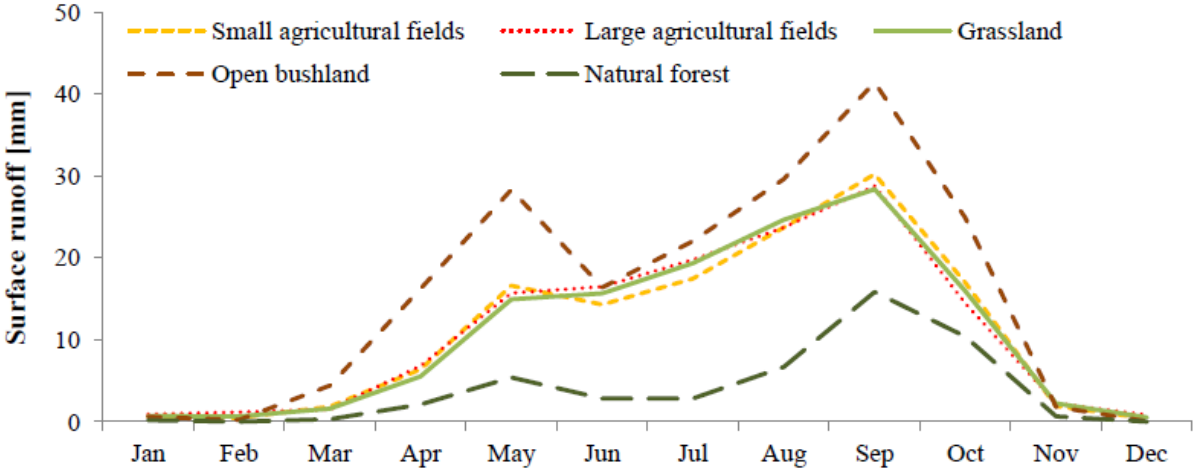
Overall accuracy: 88%

Preliminary results

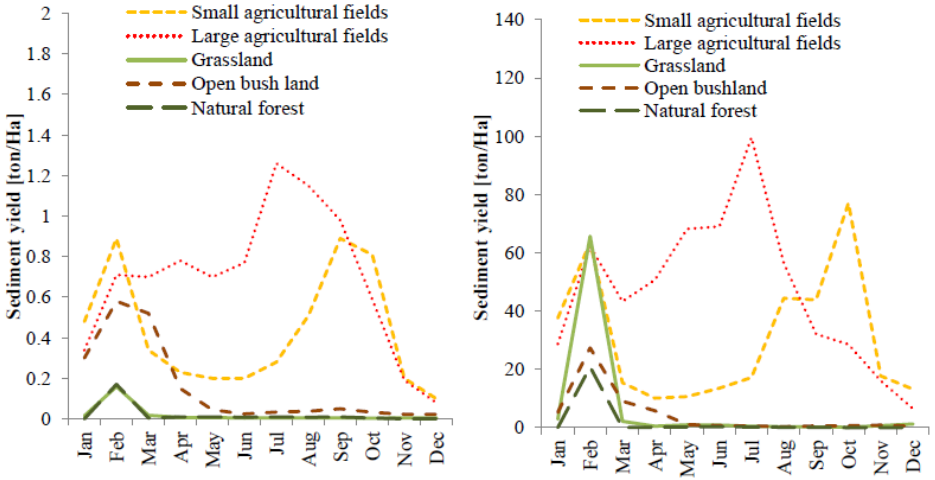


Herder, 2013

Preliminary results



Mean monthly surface runoff (SURQ [mm]) rates (1978-2007) for each land use type, Wondo Genet catchment, Ethiopia.



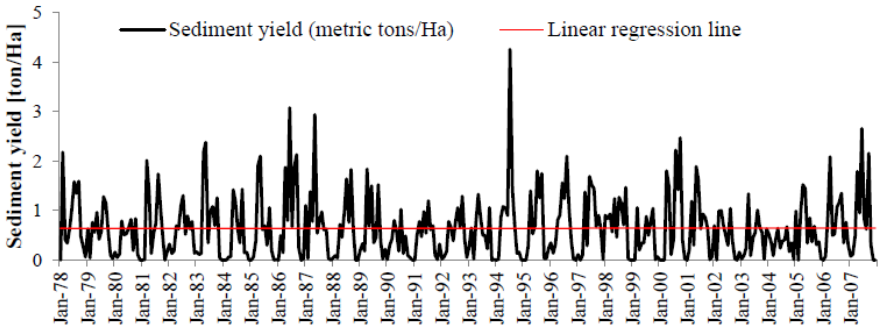
Mean sediment yield [ton/Ha/month] (A) and maximum sediment yield [ton/Ha/month] (B) for the Wondo Genet catchment, Ethiopia.

Herder, 2013

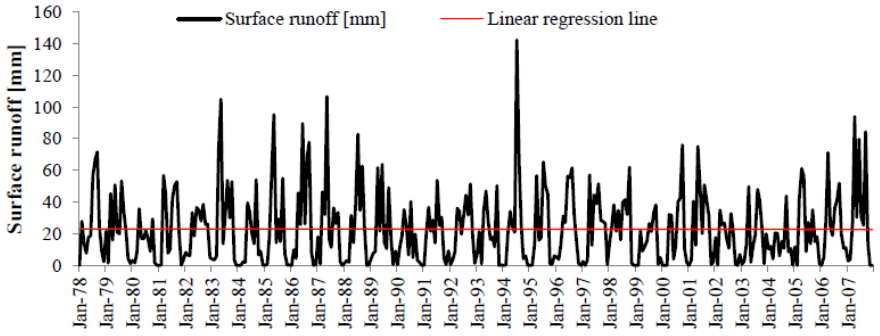
Preliminary results

- The land use maps in combination with the computed characteristic sediment yield and surface runoff per land use class indicate an overall increase in both for the catchment

- This signal is lost at the watershed outlet, probably due to the presence of the wetland



Mean monthly sediment yield [ton/Ha], Wondo Genet catchment, 1978 – 2007.



Mean monthly surface runoff [mm], Wondo Genet catchment, Ethiopia

Herder, 2013

SWAT model

Field campaign September-November 2015

- LULC ground truth for high-resolution imagery (Worldview-2)
- Stream measurements upstream of the swamp area with the SENSA flow velocity meter
- Irrigation quantification, because it re-routes water through the catchment
- Soil loss estimates by Assessment of Current Erosion Damage (Herweg, 1996)

This project will demonstrate a service that will optimize water availability and minimize land degradation while meeting the requirements of a growing population and considering future changes in precipitation patterns

Questions and/or suggestions are highly appreciated



Thank you for your attention!