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Ecosystem services of church forests and wetlands: supporting rural human well-being in Lake Tana Basin, Ethiopia

Qualifier presentation: 26 February 2019

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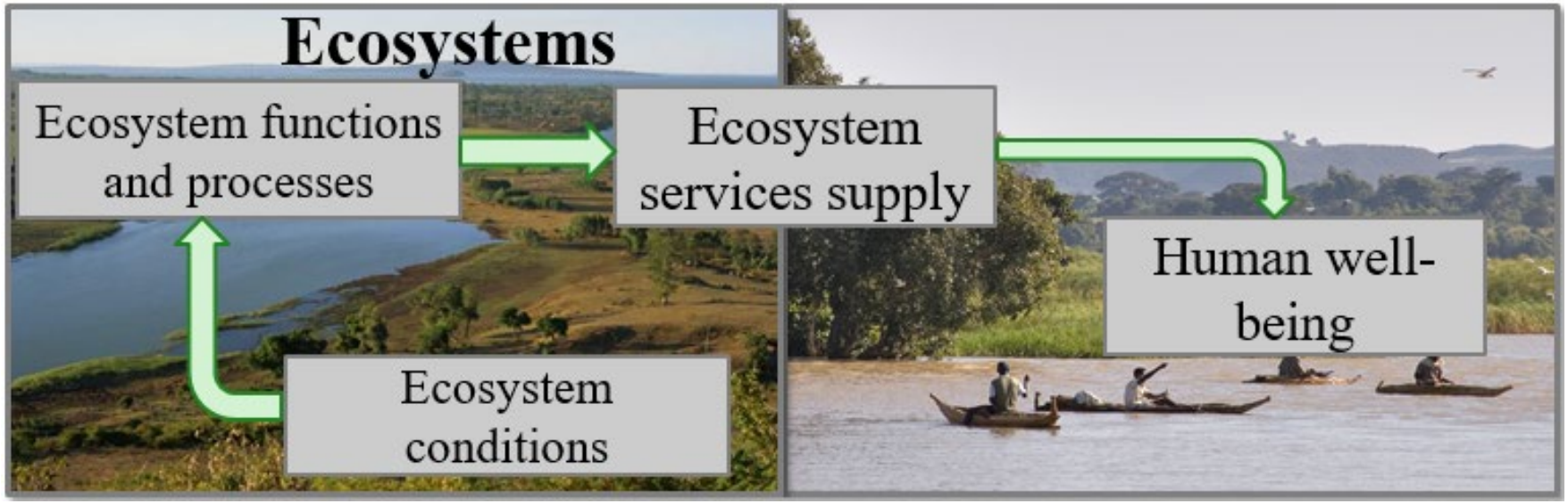
ITC FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

INTRODUCTION

Ecosystems provide vital resources that benefit people ➔ ecosystem services.

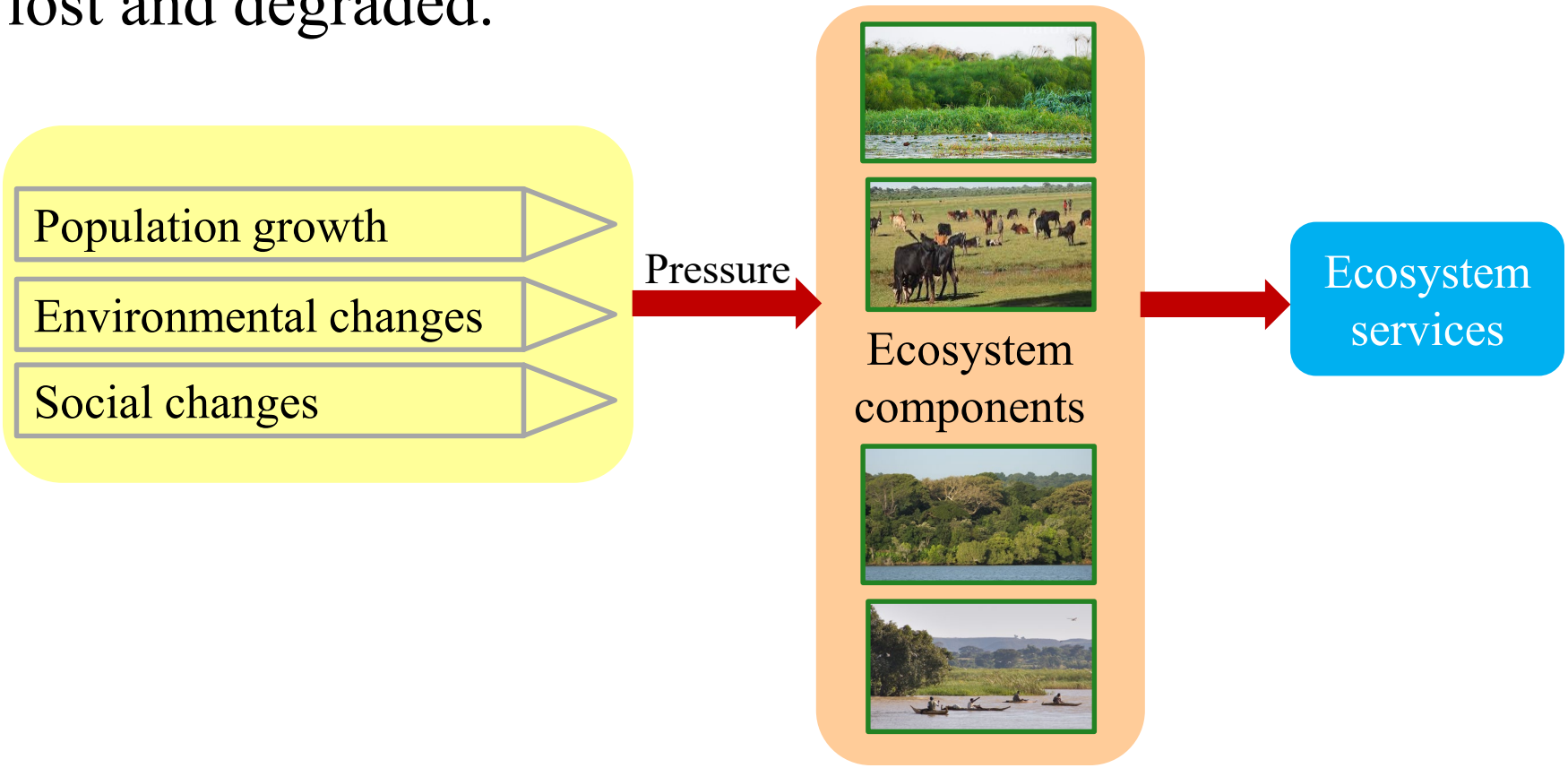
- ✓ **provisioning**, **regulating** and **cultural** services

Ecosystem condition is linked to human well-being through ecosystem service.



Maes *et al.* (2013)

Ecologically important ecosystems are under pressure. Natural forests, wetlands and grasslands continue to be lost and degraded.



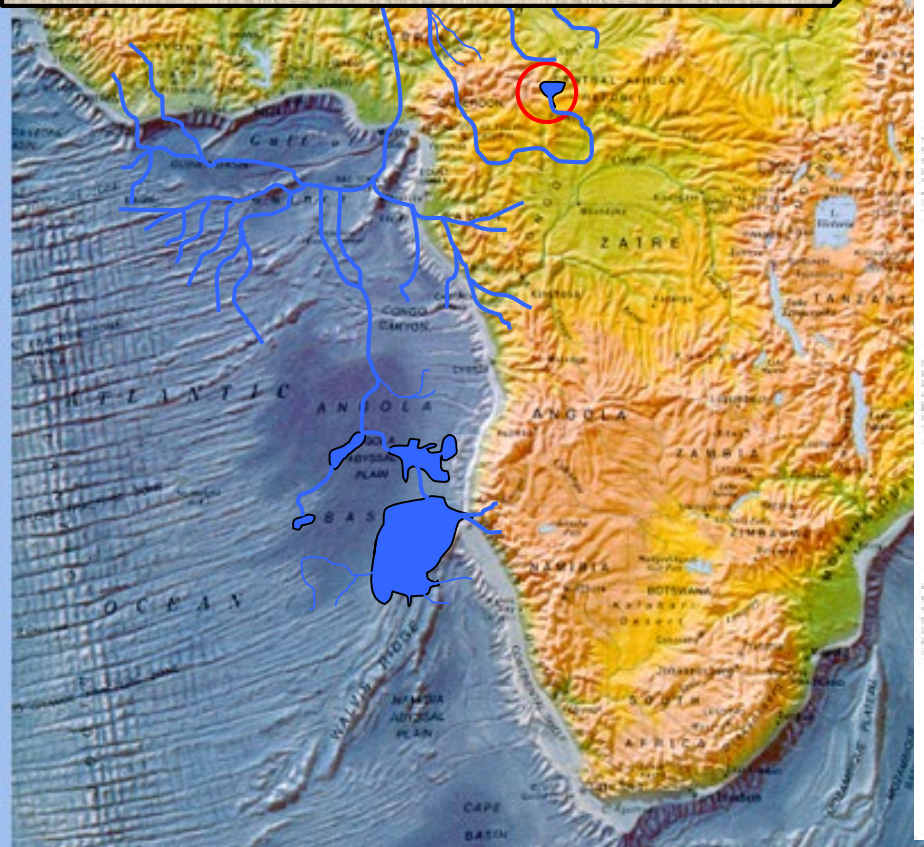
There is lack of information and methods on the links between ecosystem condition and ecosystem service flows in space and time.

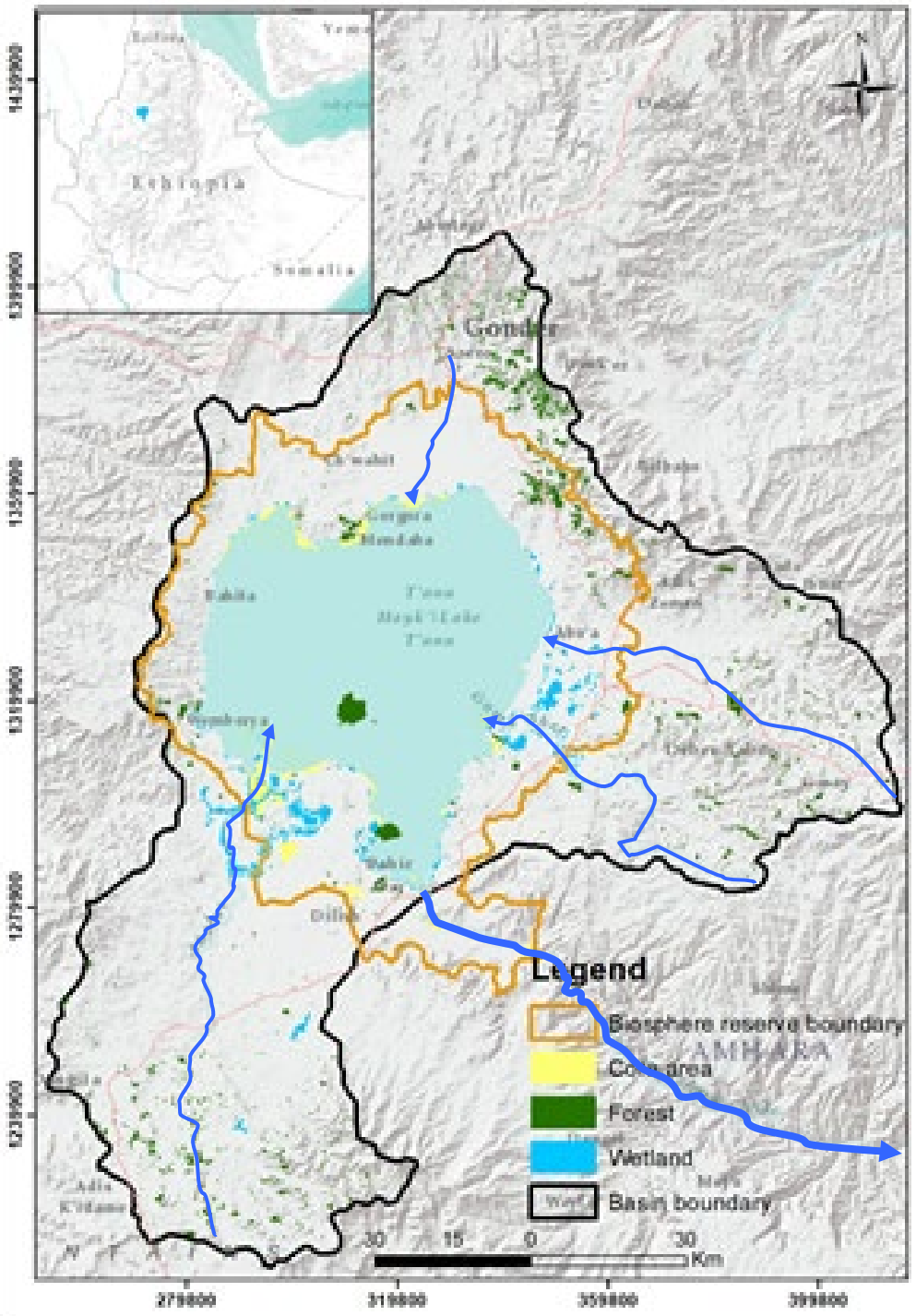
The study area

Lake Tana Basin: important headwater catchment of the Upper Blue Nile River System

Biosphere reserve = 7,000 Km^2

- ✓ Characterised by ecologically important ecosystems
  - ✓church forest and
  - ✓wetland ecosystems





Church forest and wetland ecosystems

Church forests

- Home to old aged Afromontane forests
- Sources of seed, medicinal plants, firewood, tourism
- Conservation of bic
- Protect soil erosion

Wetlands

- Hotspot of biodiversity (birds and fishes)
- Habitat for globally endangered spp
- Agricultural genetic diversity.
- Support natural pasture land

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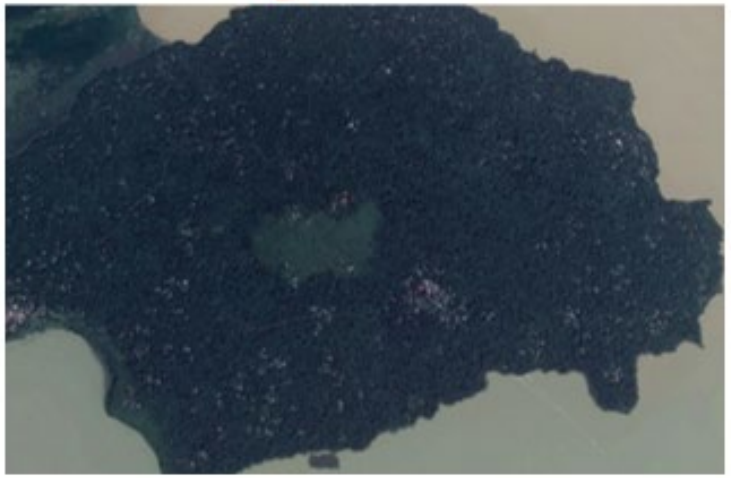
Major causes of ecosystem condition changes

Ecosystem fragmentation

Overexploitation of NRs



Alien species

Overgrazing

Symptoms of land degradation

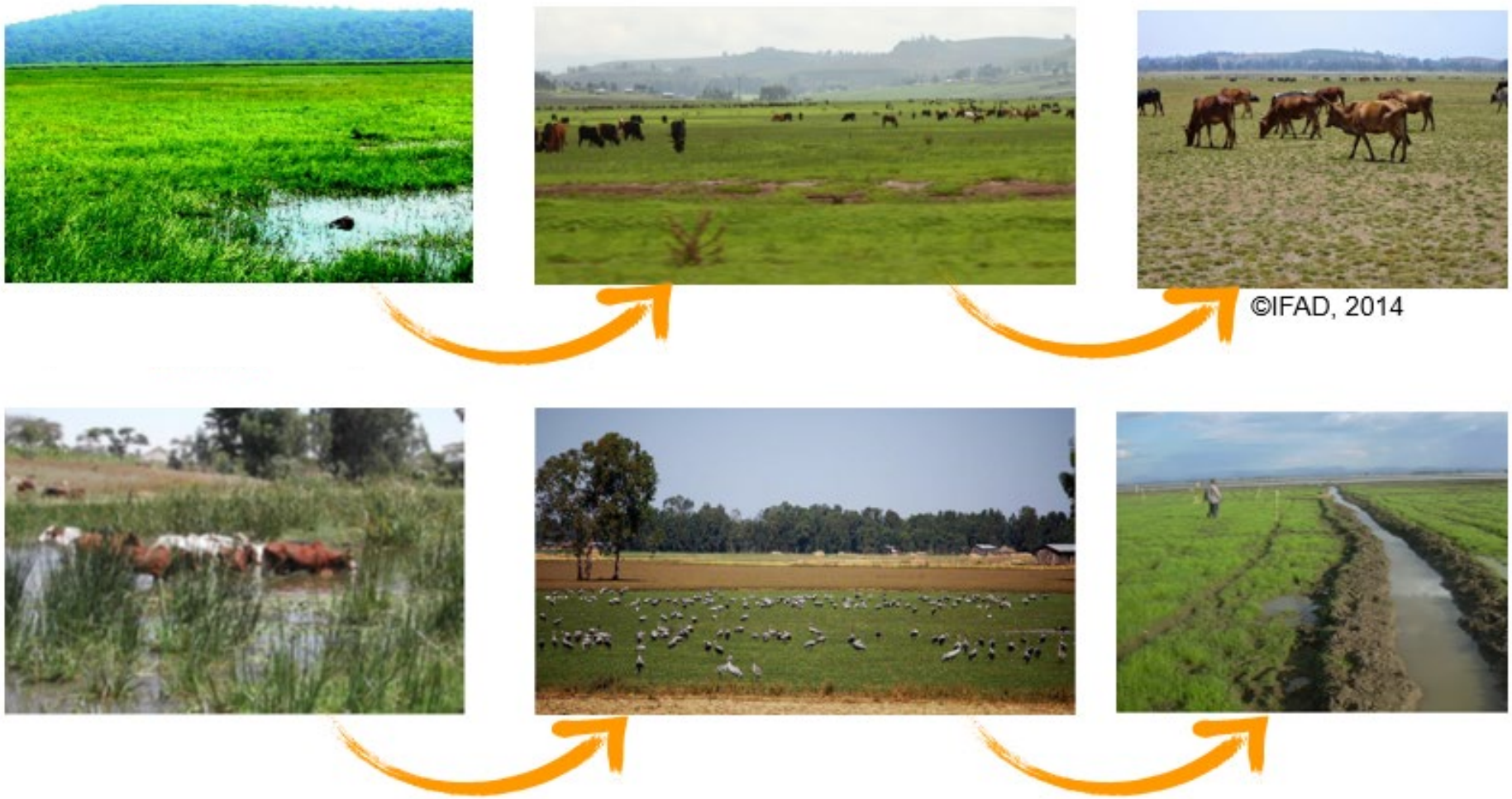


Photo credit: Flickr, wassie, 2010

Research gaps and aim of the PhD thesis

Lack of information about the links between ecosystem condition and ecosystem service flows in space and time

Lack of evidence to define and asses the spill over effects of ecosystem service flows with the existing conceptual frameworks that have been developed.

RS-based information for monitoring ecosystem conditions (vegetation biomass, fragmentation and carbon)

This study will explore the use of RS data and ground-based measurements to assess the ecosystem conditions to supply ecosystem service in space and time.

Specific objectives

1. To assess ecosystem conditions and the link with flows of ecosystem services from church forest and wetland ecosystems
2. To explore the spillover effects of ecosystem service flows from church forest and wetland ecosystems to surrounding areas
3. To assess the spatiotemporal ecosystem condition changes and ecosystem services for the last 40 years to evaluate the protection and management effectiveness
4. To develop scenarios for policy and ecosystem condition changes for the next 30 years to model the impact on ecosystem services

Methodologies per each objectives

Short summary of materials methods for each specific objective is presented in the following slides

The six ecosystem services

Raw materials (reeds)

Pasture for livestock grazing

Carbon sequestration

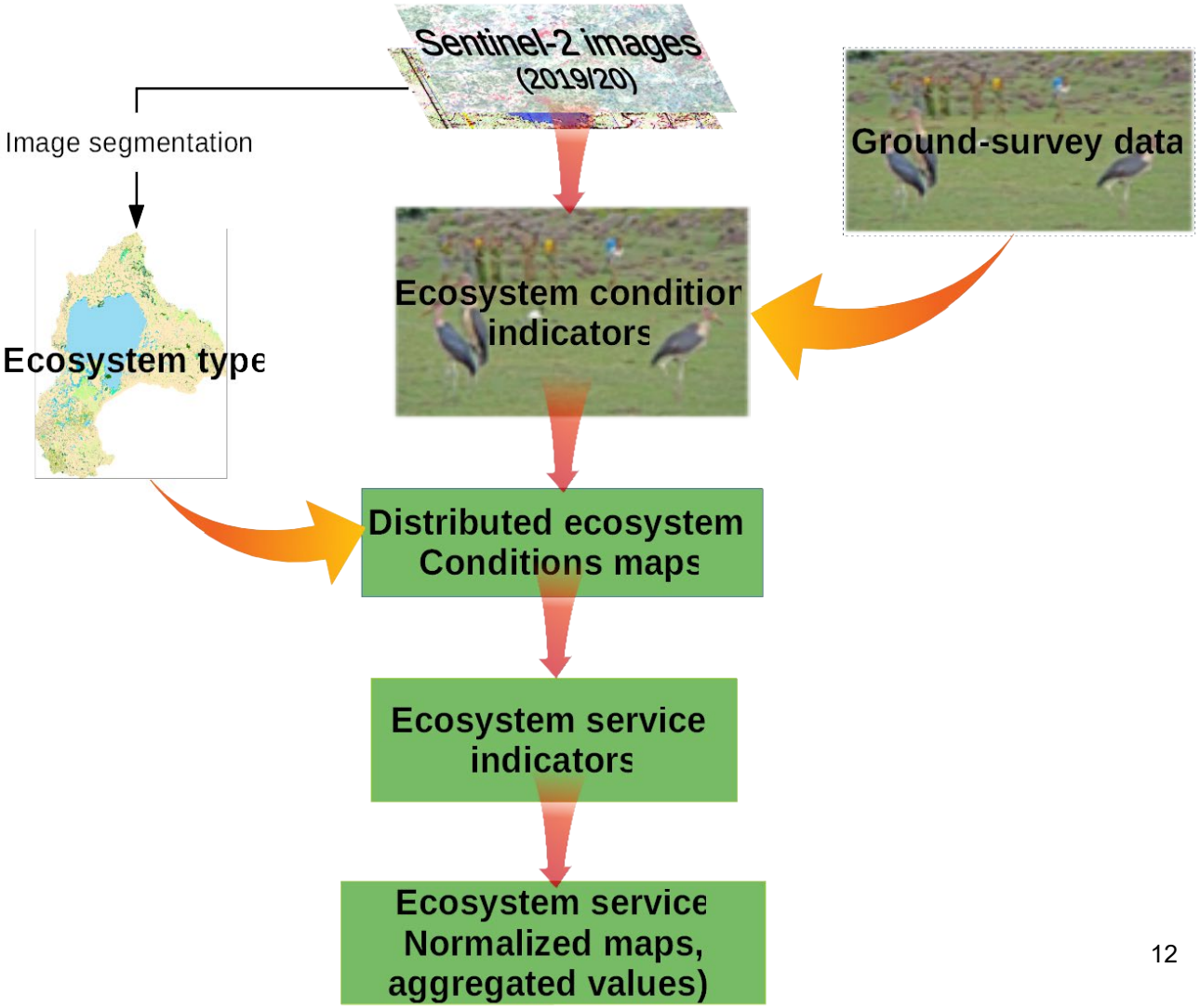
Crop pollination

Erosion control

Tourism

Objective 1: To assess ecosystem conditions and the link with flows of ecosystem services from church forest and wetland ecosystems.

Methodological approach for ecosystem condition characterization



Assessment of ecosystem services

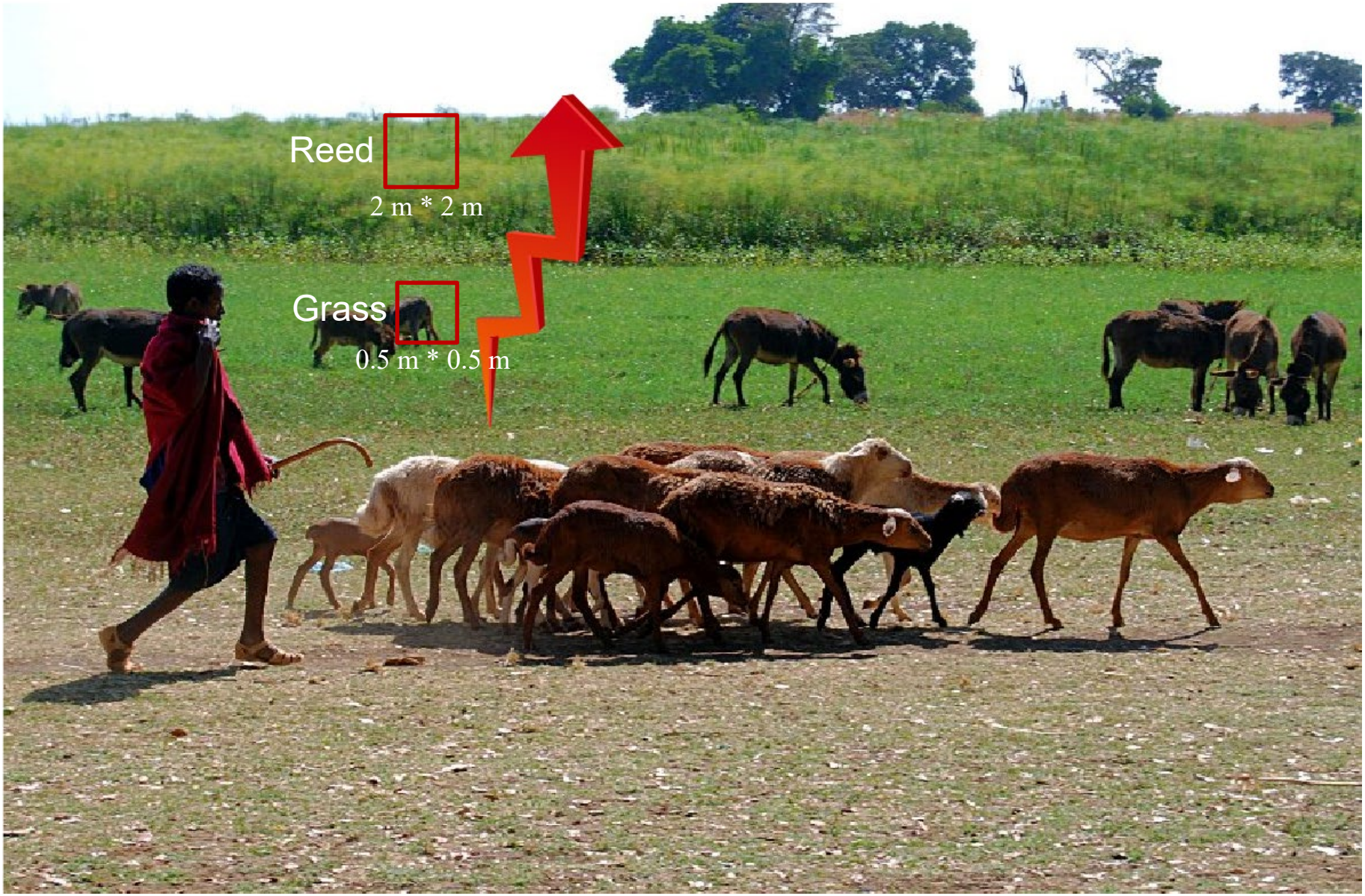
Reed Materials

- ✓ Ground survey aboveground biomass (AGB) data
- ✓ Nine random transects at a right angle to the lake.
  - ✓ 54 reed stems will be clipped and collected for AGB dry weight on 27 sites from 2 m x 2 m quadrants. The height of all reed stems will be measured and recorded.
- ✓ Correlation and regression analysis between AGB and Sentinel-2 VI will be used

Pasture for livestock grazing

- ✓ VI of Sentinel-2 imagery and widely distributed ground-based ANPP
- ✓ Summer (rainy season) and winter (dry) ANPP pasture data
- ✓ 40 sample sites with 0.5 x 0.5 m quadrant for dry weight
- ✓ Livestock carrying capacity of the grassland

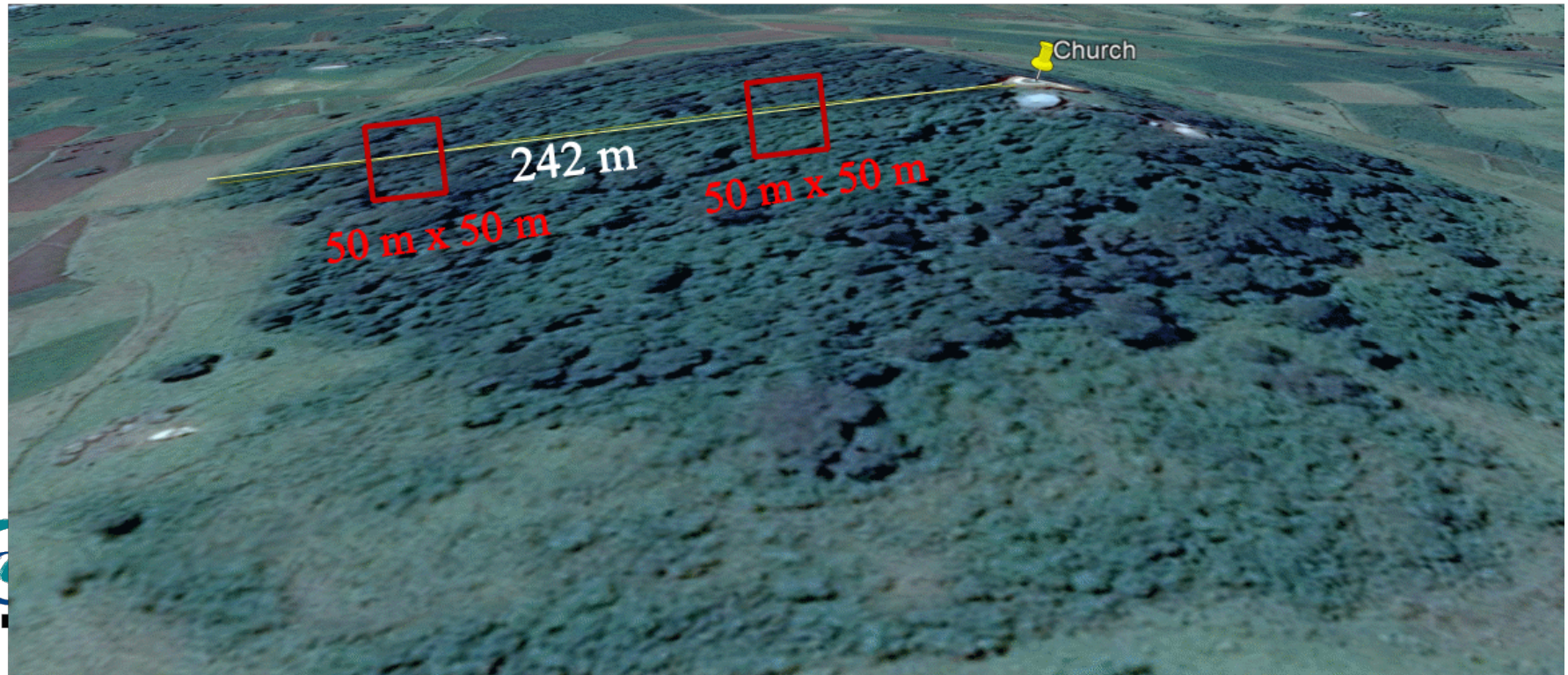
Sampling frame for reed and pasture field data collection



Climate regulation

AGB on 44 plots with 50 m x 50 m quadrants with 100 m distance.
Relationship will be created with the Sentinel-2 VI of Sentinel-2 image
Net ecosystem production (NEP) = carbon sequestration

$$NEP = NPP - R_h$$



Crop pollination

- ✓ Ground survey on 44 plots with 50 m x 50 m quadrants of church forest
- ✓ Floral availability map
- ✓ Foraging range of a specific guild of pollinators
- ✓ Potential pollinator nesting habitats
- ✓ Pollinator activity index

Relative pollination potential

Erosion control

Soil erosion assessment framework: Revised Universal Soil Loss Equation (RUSLE)

Soil erosion control is calculated with and without church forest cover (**C**) and the difference is the erosion control service.

A = R*K*LS*C*P

C-factor – reflect the ecosystem conditions of protected and conservation areas

- ✓ Sentinel-2 VI

Tourism

- Geotagged photos uploaded to social media and web-based photo sharing sites (Google Earth, Flickr, Instagram)
- Geotagged photos as a proxy for number of visitors

Generalized Mixed Effects Model (GME) will be used

Geotagged photos = f (Landscape compositions)

Accessibility,
Naturalness,
Water bodies,
Biodiversity hotsp
Protected areas,
presence of infrast

Source: Google Earth

Objective 2: To explore the spill over effects of ecosystem service flows from church forest and wetland ecosystems to surrounding areas

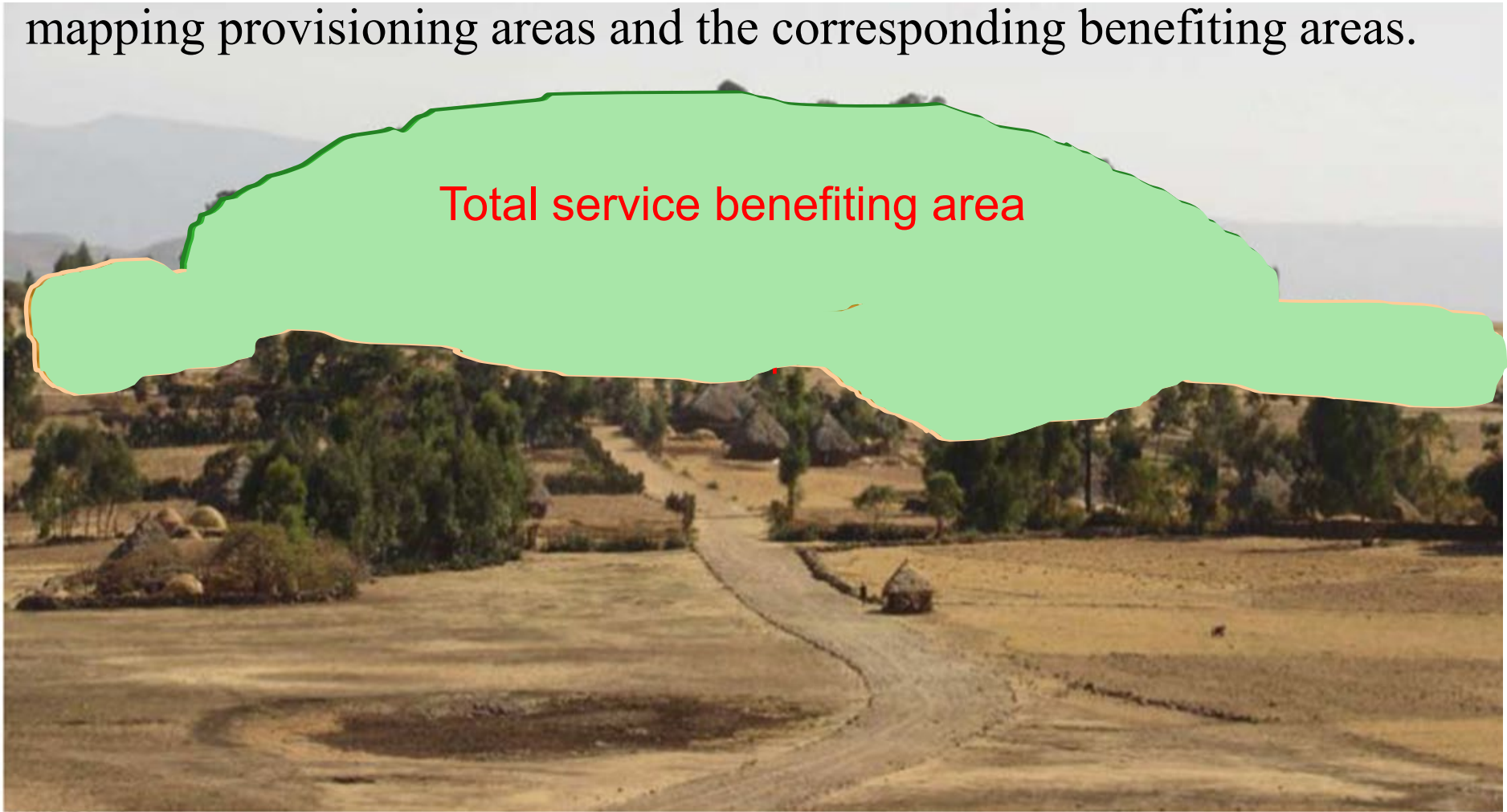
Spill over effect: refers to the path of ecosystems service flow from service providing areas to benefiting areas.

Information on where services are provided and benefits are received is required

Ecosystem service	Directional spill over	What?
Raw materials	Omni-directional	Areas benefiting from conservation areas of reed plants
Pasture for livestock grazing	Omni-directional	Settlement areas benefiting from communal wetland grazing land
Carbon sequestration	Omni-directional	Changes in local surface temperature
Pollination	Local proximal (depends on proximity)	Pollinator dependent agricultural areas crop areas outside the service providing areas
Soil erosion control	Directional (slope)	In-situ erosion control by vegetation cover
Tourism	User movement related	Flow of people to unique natural features

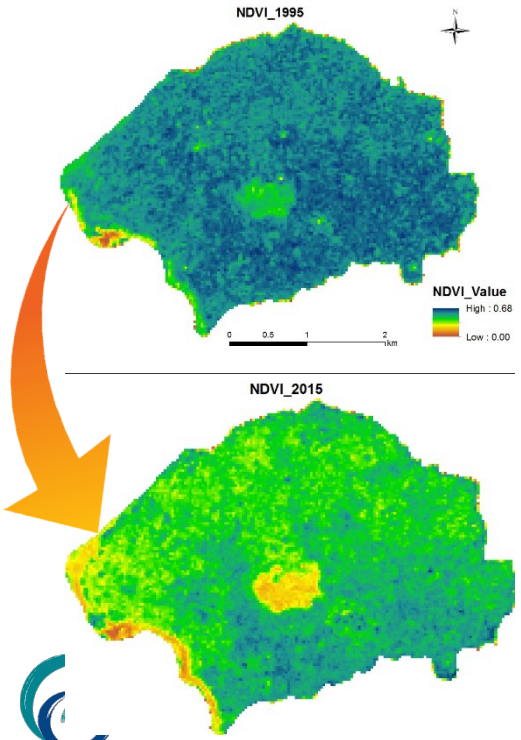
Spill over effects

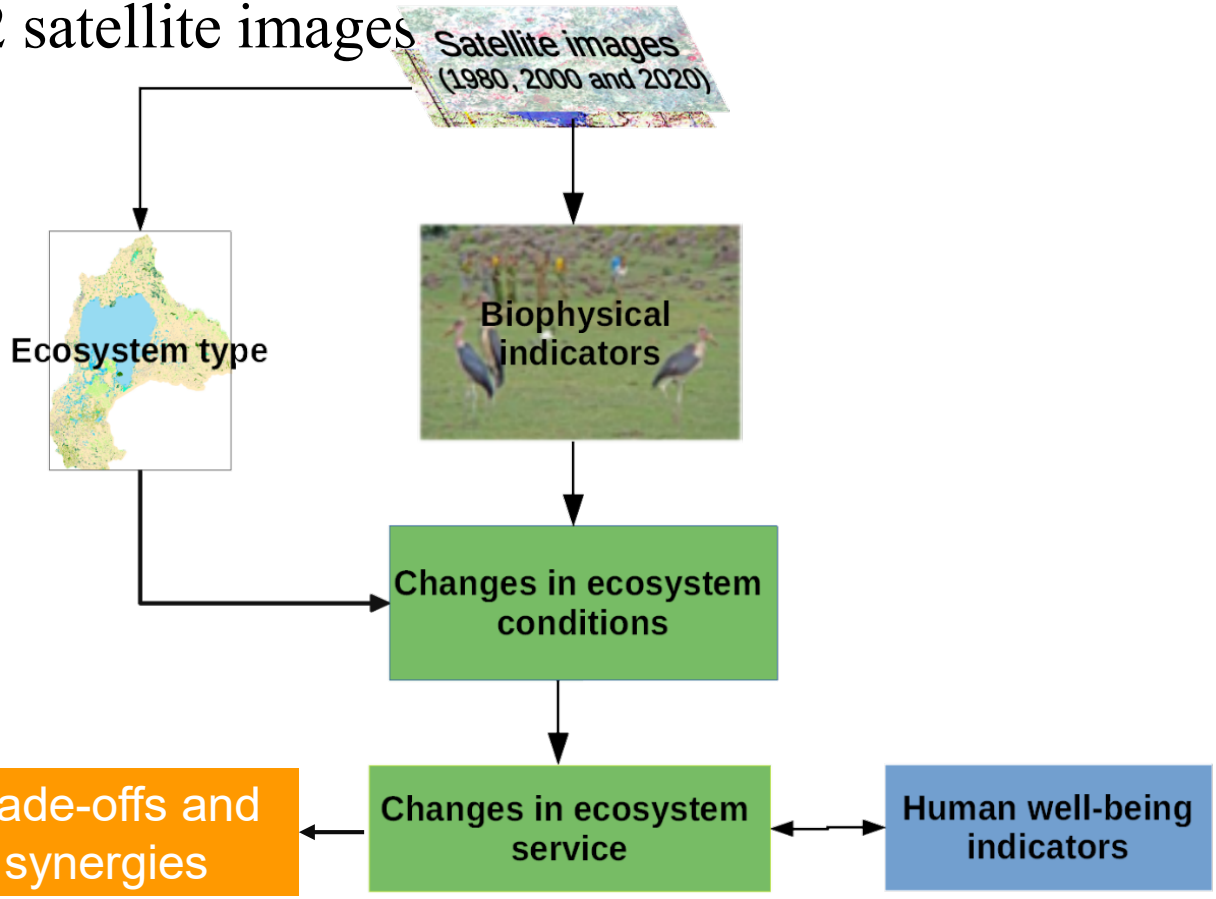
Outcomes of the six ecosystem services in objective 1 will be input to assess the spill over effects to surrounding human dominated areas
In this objective, spatially-explicit regression model will be used assess the spatial spill overs of individual ecosystem services by mapping provisioning areas and the corresponding benefiting areas.



Objective 3: To assess the spatiotemporal ecosystem condition changes and ecosystem services

- ✓ Conversion of native forests, wetlands and grasslands into human-dominated landscapes reduce in many ecosystem services.
- ✓ Designed to assess the conservation effectiveness for the last 40 years
- ✓ Spatiotemporal ecosystem condition changes and services
- ✓ Landsat and Sentinel-2 satellite images





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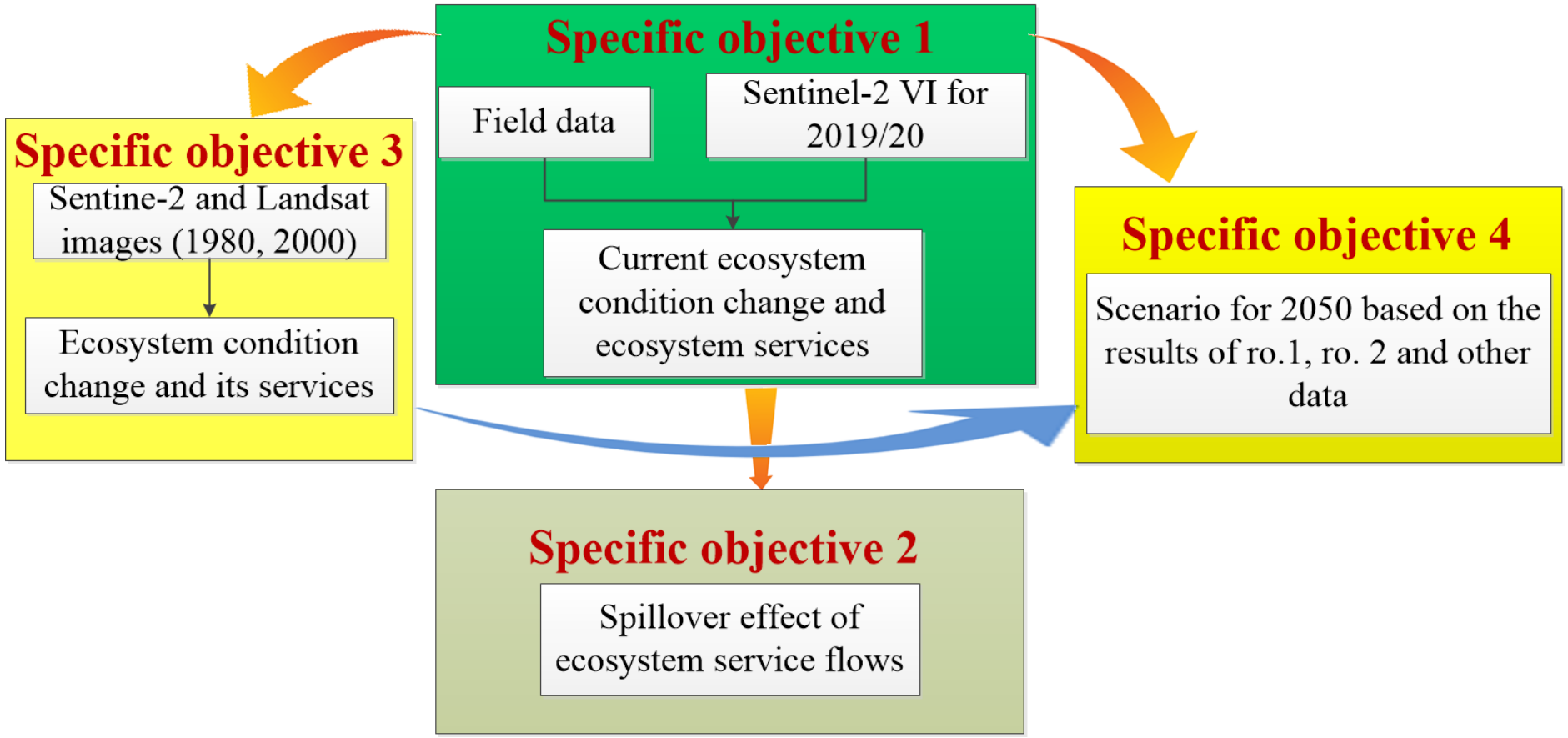
Objective 4: To develop scenarios for policy and ecosystem condition changes for the next 30 years to model the impact on ecosystem services

- Scenarios for policy and ecosystem condition changes for the next 30 years
- scenarios based on biomass degradation, population growth, fragmentation, alien species expansion, infrastructure development and climate change.
- valuable for policy and decision-making processes regarding the conservation and use of natural resources

The data and methodological link between the 4 specific objectives



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Dank u wel

Merci

Danke

Gracias

Shukriyaa

Thanks a lot for your attention

Questions?

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Activity plan

No	Activities	2018		2019				2020				2021				2022	
		3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
1	PhD proposal preparation and qualifier																
2	Preparation of data collection tools																
3	Field data collection																
4	Data analysis and first two objectives paper write-up																
5	Coursework and training																
6	Second round data collection satellite imageries, reference data, policy documents, secondary data																
7	Present findings of the first two papers, sending papers for comments and editing's, and for journals																
8	Data analysis and third objective paper write-up																
9	Data Analysis and final objective papers write-up																
10	Present findings of the 3rd and 4th objective paper, sending papers for comments and editing's, and as well for journals																
11	Incorporate comments and suggestions																
12	Thesis Finalization																