

# Evaluation of soil functions and microbial biodiversity to indicate ecosystem services in the Okavango catchment

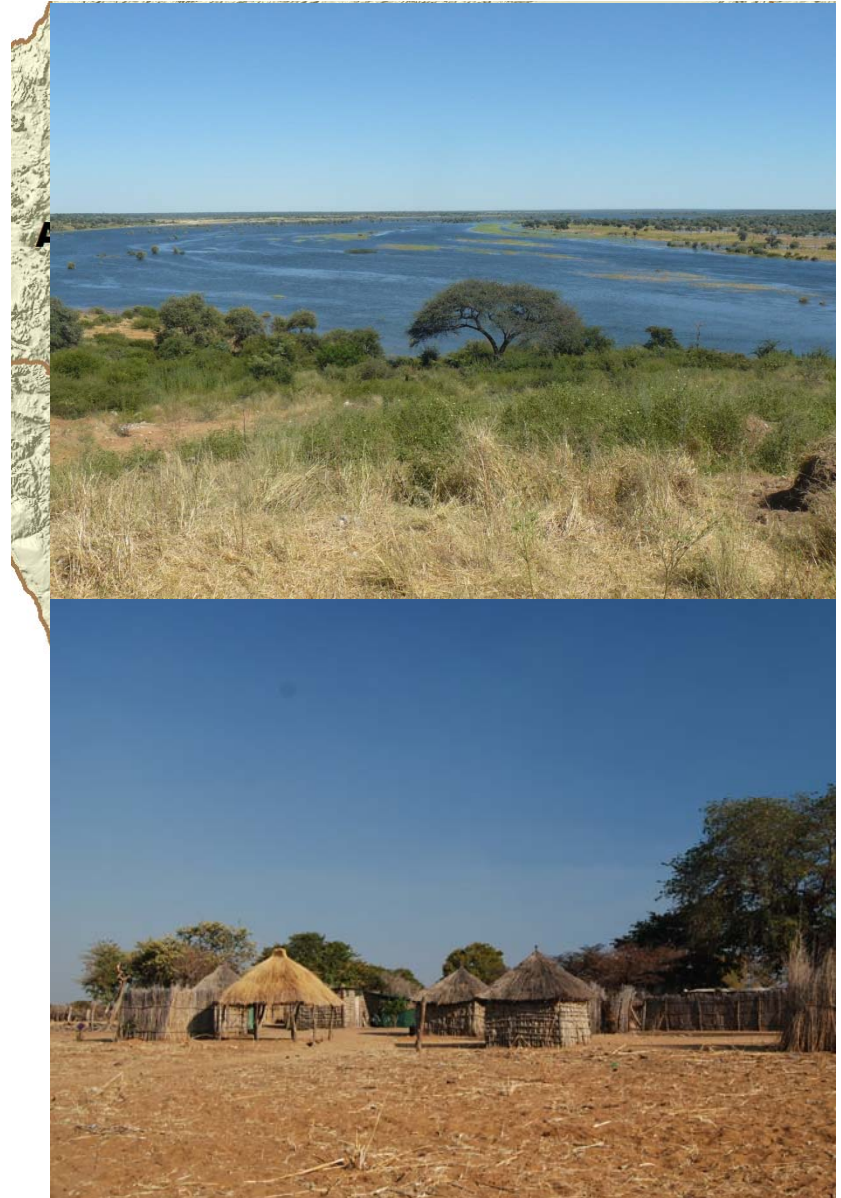
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## The Future Okavango (TFO)

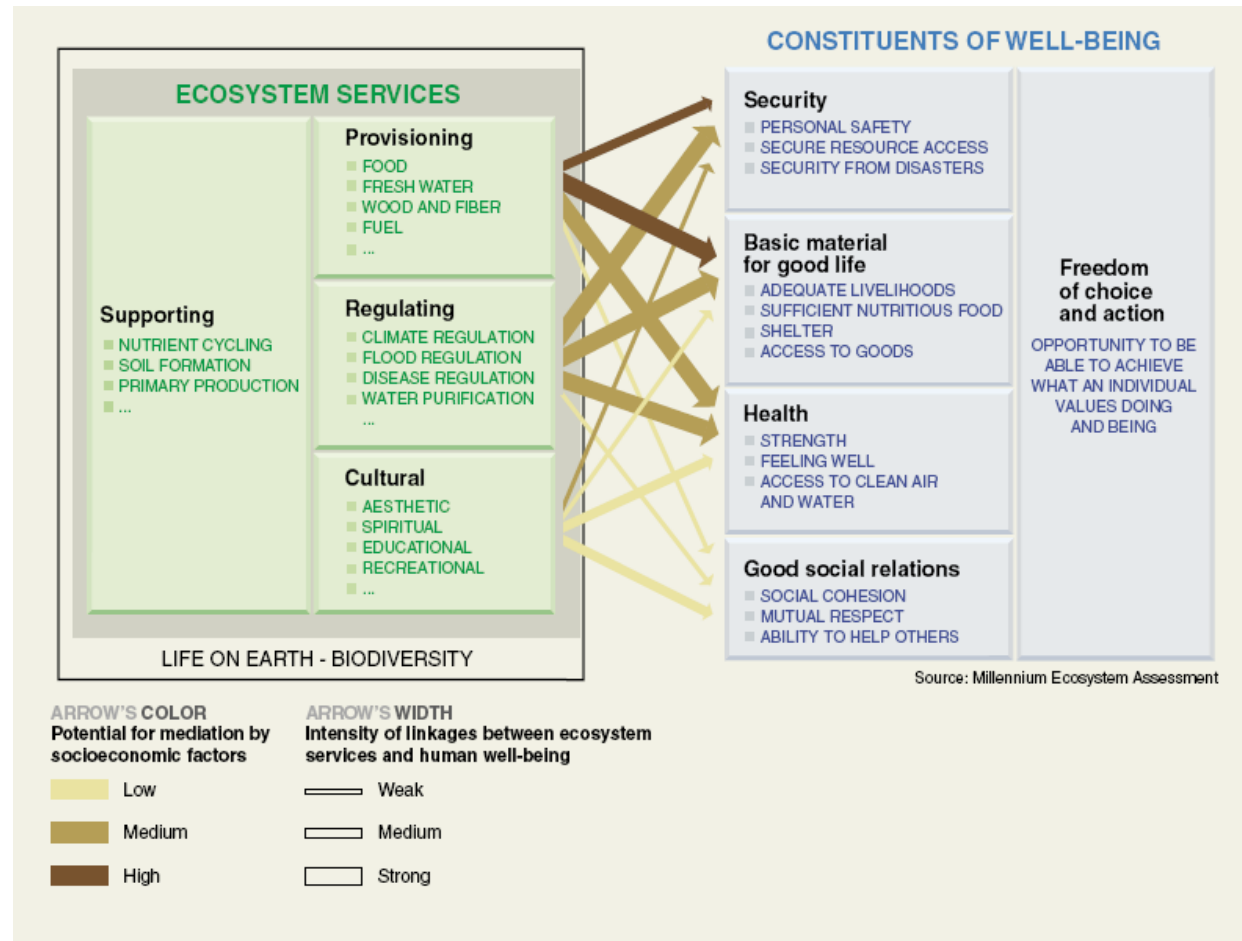
# Background: General aims of TFO

## The Future Okavango

- an improvement of knowledge based land use management within the Okavango catchment – involving the countries Angola, Botswana and Namibia
- the application of a trans-disciplinary approach by involving relevant stakeholders on different scales
- the analysis of ecosystem functions (ESF) and services (ESS) under scenarios of global change.

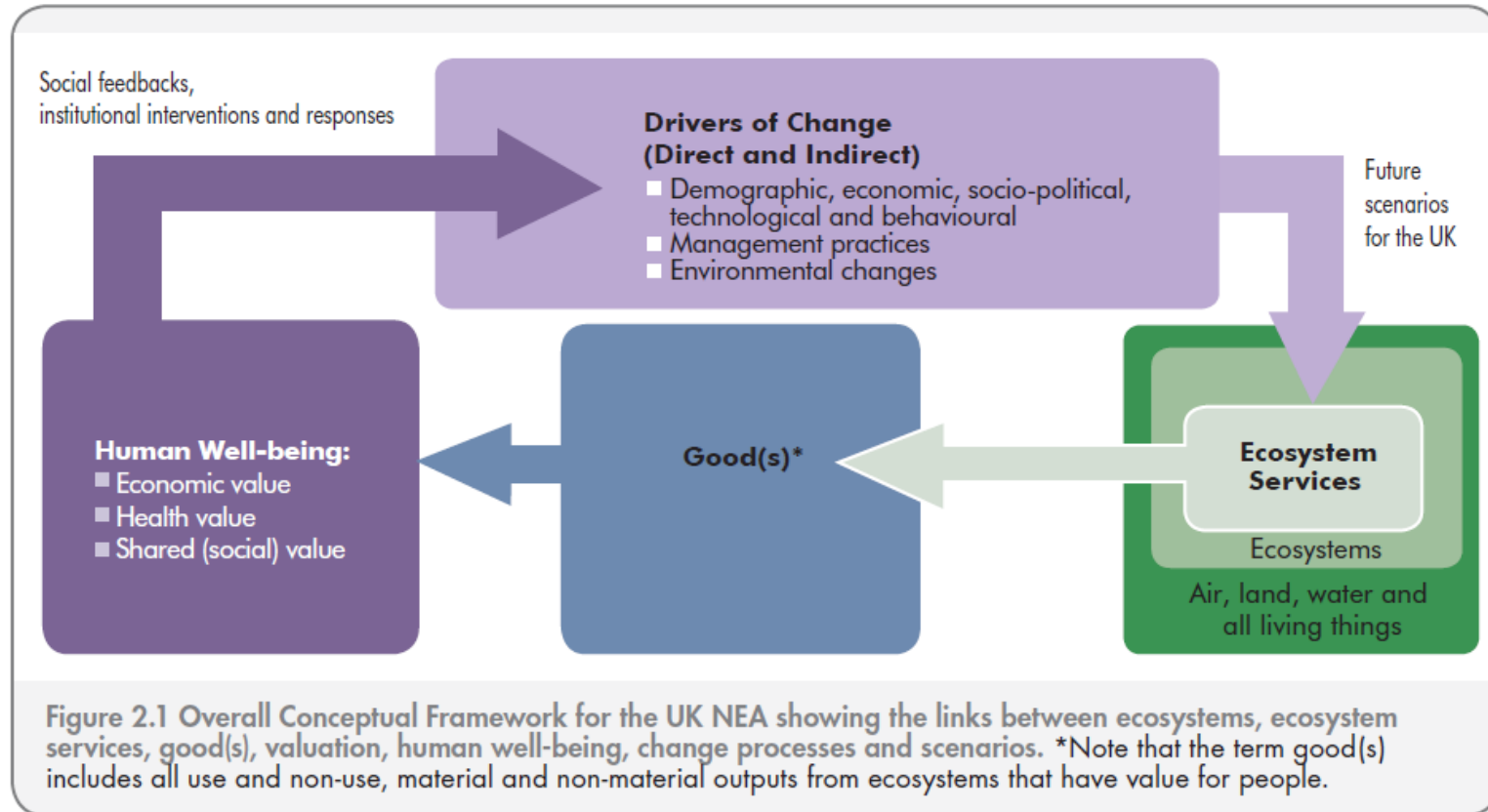


# Ecosystem Services and Human Well-being



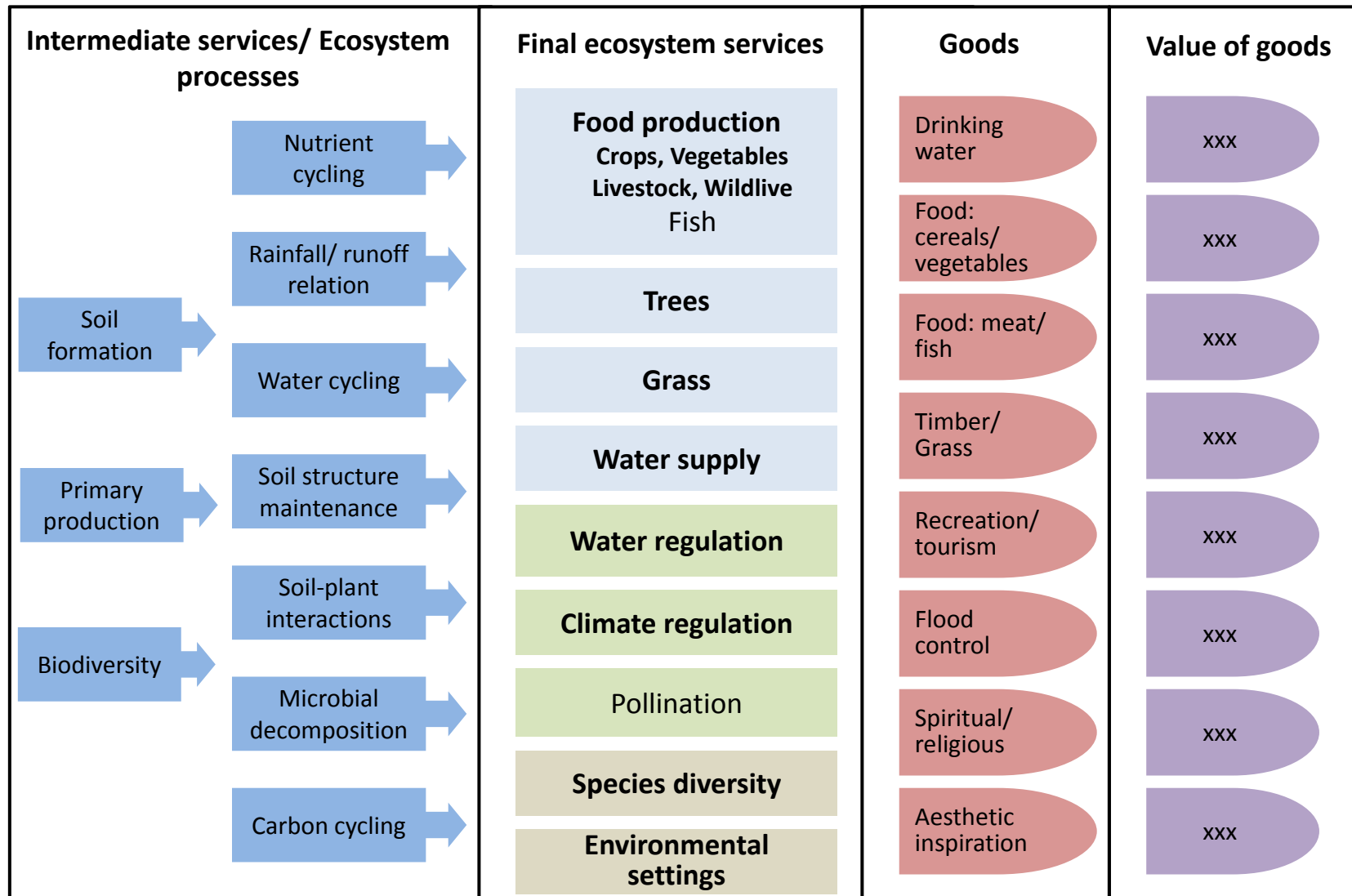
Millennium Ecosystem Assessment 2005

# Framework of UK NEA



Mace et al. 2011

# TFO: Set of EFS/ESS/Goods (extract)



# Definitions

**Soil Quality:** „Capacity of a specific kind of soil to **function**, within natural or managed ecosystem boundaries, to sustain plant and animal **productivity**, maintain or enhance water and air quality, and support human health and habitation.“

SSSA Ad-Hoc-Committee on Soil Quality (Karlen et al. 1997)

**Natural Capital of Soils:** „The stocks of mass and energy and their organization (entropy). The value of the stocks can be quantified and evaluated in terms of their quantity and quality.“

(Robinson et al. 2010)

# Soil natural capital framework

## 1) Mass

Solid	Inorganic material: Mineral stock, nutrient stock; organic material: OM/carbon stock, organisms
Liquid	Soil water content
Gas	Soil air

## 2) Energy

Thermal energy	Soil temperature
Biomass energy	Soil biomass

## 3) Organization/structure

Physio-chemical structure	Soil physico-chemical organization, soil structure
Biotic structure	Biological population organization, food webs and biodiversity
Spatio-temporal structure	Connectivity, patches and gradients

adapted from: Robinson et al. 2010



# What are the controls of crop yield?

Crop yield =  
f (crop property; natural condition; land use management)

Natural condition =  
f (weather conditions; soil quality; biological interactions)

Climate change

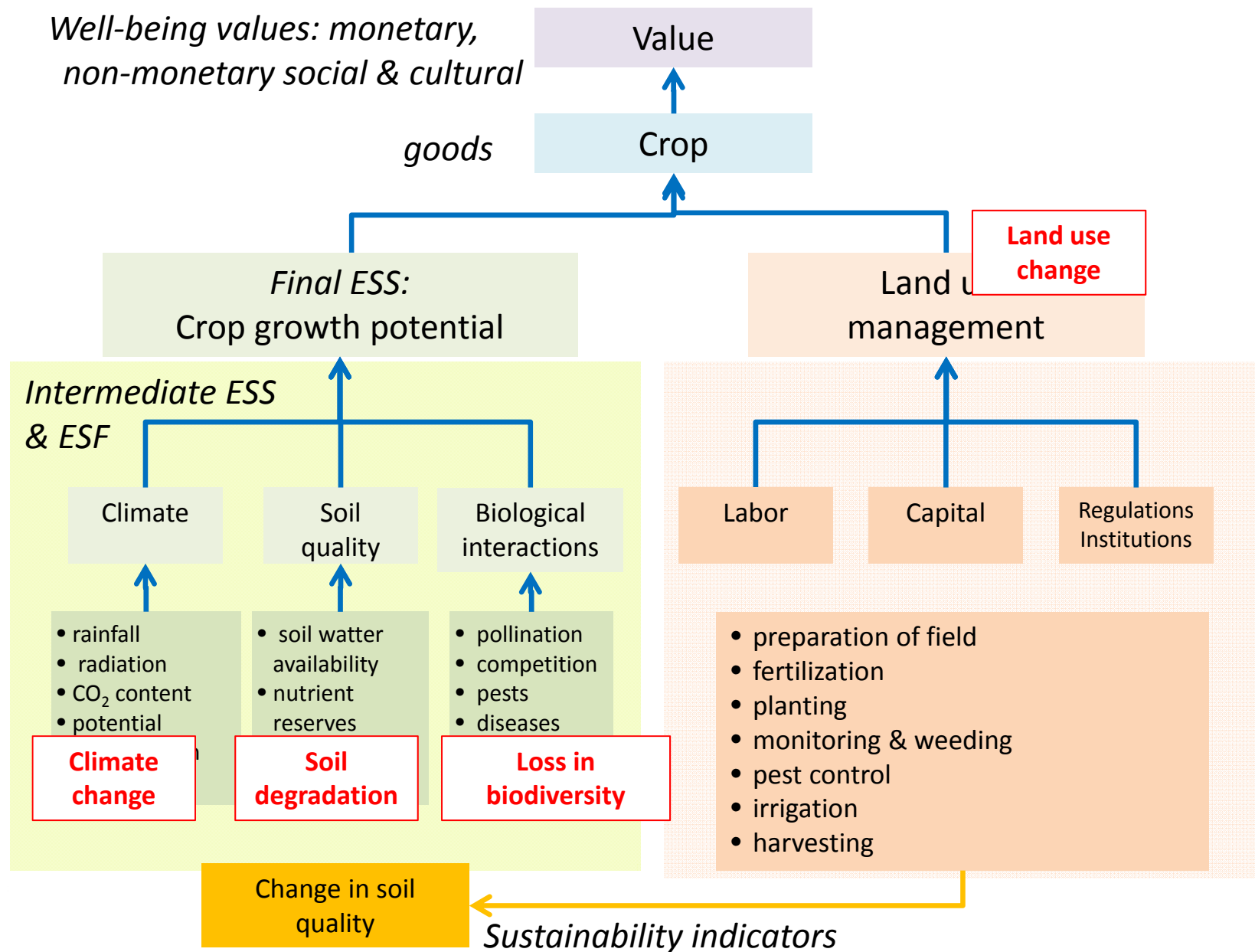
Soil degradation

Loss in Biodiversity

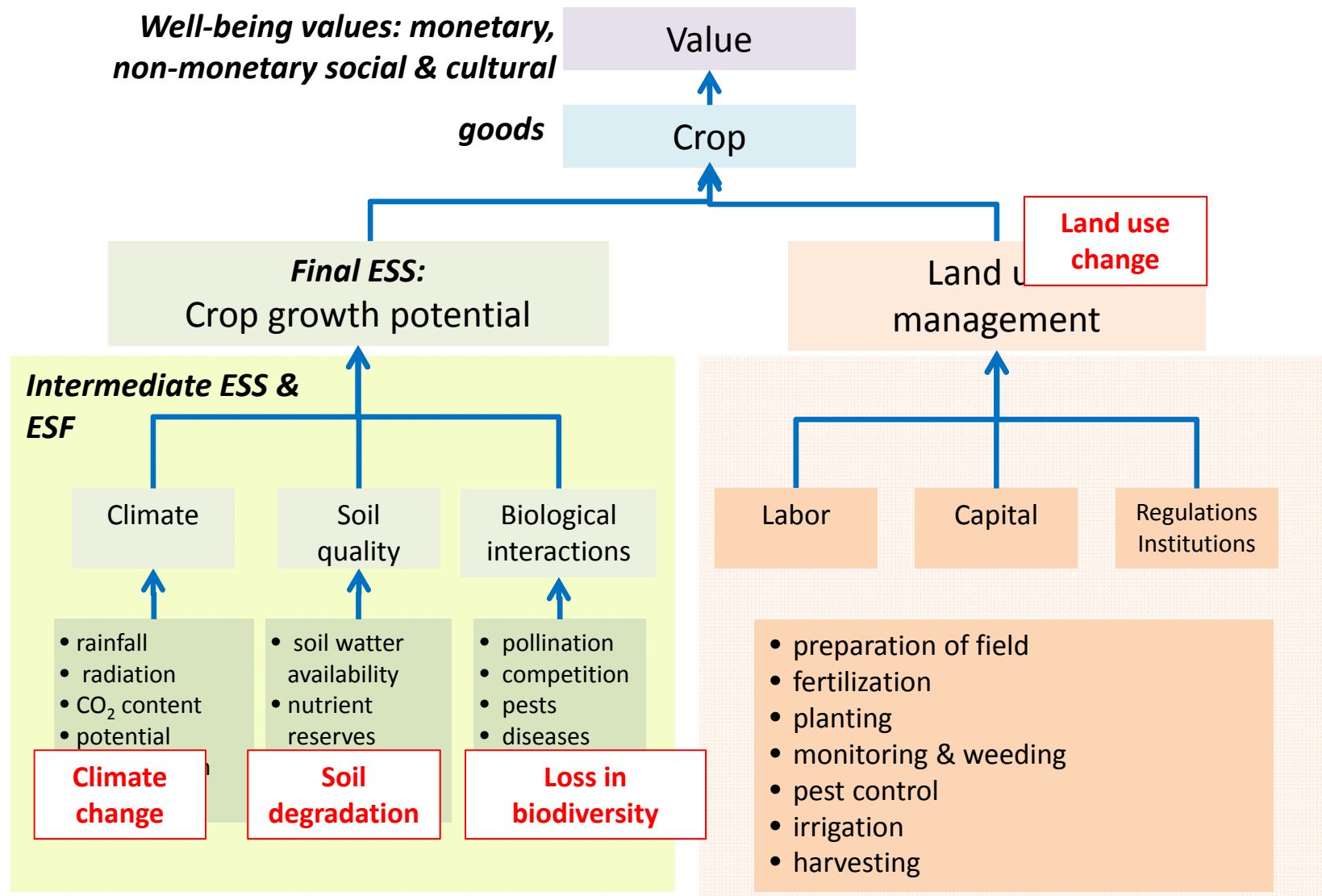


# What are the controls of crop yield?

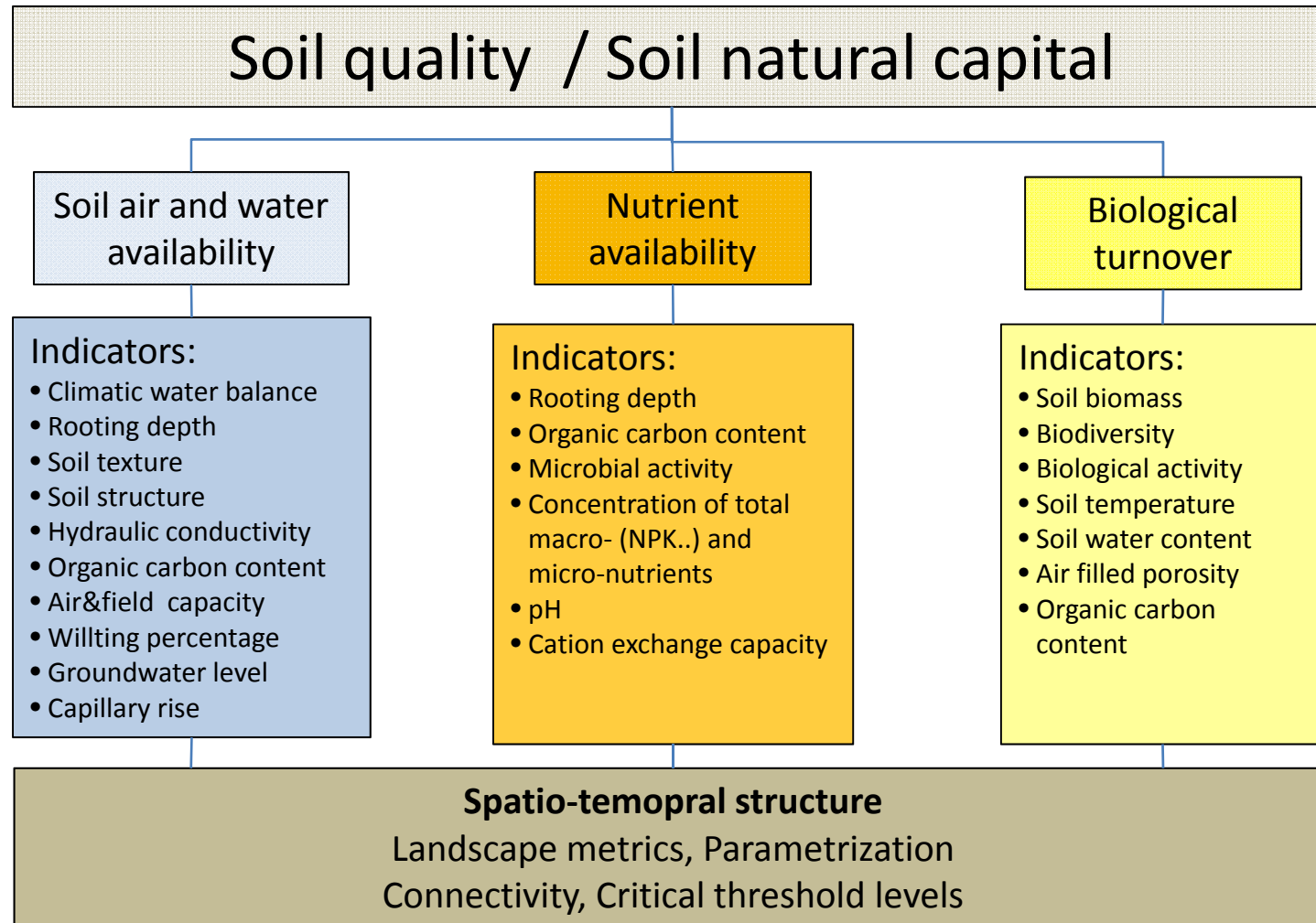
*Well-being values: monetary,  
non-monetary social & cultural*



# What are the controls of crop yield?



# Concept for an assessment of soil ESF



# Methodology

## Quantifying soil water balances and dynamics

Point Scale

### Profile Description & Sampling

- Topography
- Thickness above parent material
- Physical, chemical and biological soil properties
- Root density and distribution
- Vegetation cover (together with SP05)

### Laboratory Analysis

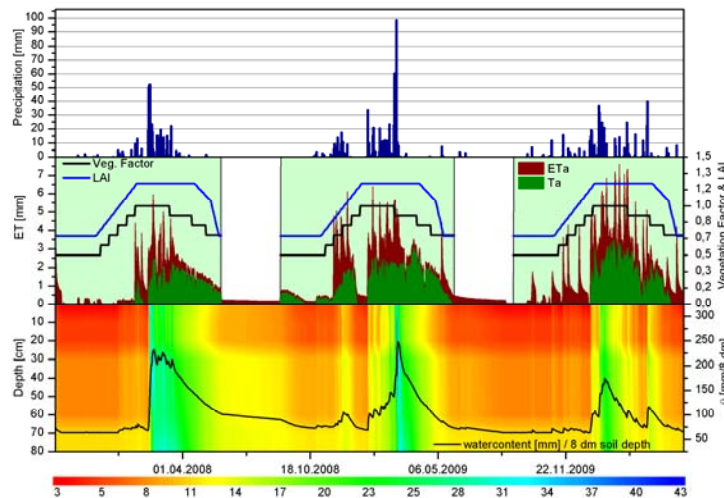
- Saturated & unsaturated hydraulic conductivity
- Grain size distribution
- Porosity
- Bulk density

### Field Measurements

- Spatio-temporal variation of
  - Volumetric water content
  - Matrix pressure head
- Weather data
- Infiltration capacity
- Bare soil evaporation characteristics

## Parameterization

### 1D Model SWAP



Landschreiber (2010)

### Model output

- Relation between soil evaporation and transpiration
- Deep drainage resp. groundwater recharge
- Spatio-temporal dynamics of soil water content



Predicting future changes through incorporation of climate and land use scenarios

# Methodology

## Quantifying soil carbon balances and dynamics

Point Scale

### Profile Description & Sampling

- Topography
- Spatial distribution of reference soil types
- Root density and distribution
- Bulk density
- Integration of land use data

### Laboratory Analysis

- Total carbon pool
- Microbial biomass
- Heterotrophic soil respiration
- Carbon fractions regarding decomposability
  - Light fraction
  - Intermediate fraction
  - Recalcitrant fraction
- Isotopic composition of carbon ( $^{13}\text{C}/^{12}\text{C}$ )

### Field Measurements

- Gas diffusivity
- $\text{CO}_2$  fluxes
- Soil temperature
- Soil moisture
- NPP

## Parameterization

### Model



### Model output

- Influence of land use and climate on carbon pools
- Spatio-temporal dynamics of soil carbon content
- Climatic relevance of carbon pools



Predicting future changes through incorporation of climate and land use scenarios

