



Water for Food

Water for Life Support

**Balancing Water  
for**

**People and Nature**

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**Balance Water  
for**

**People and Nature**

Competition for limiting resource

growth?

- Population
- Economic

**Water**

- Population

**for**

**People**

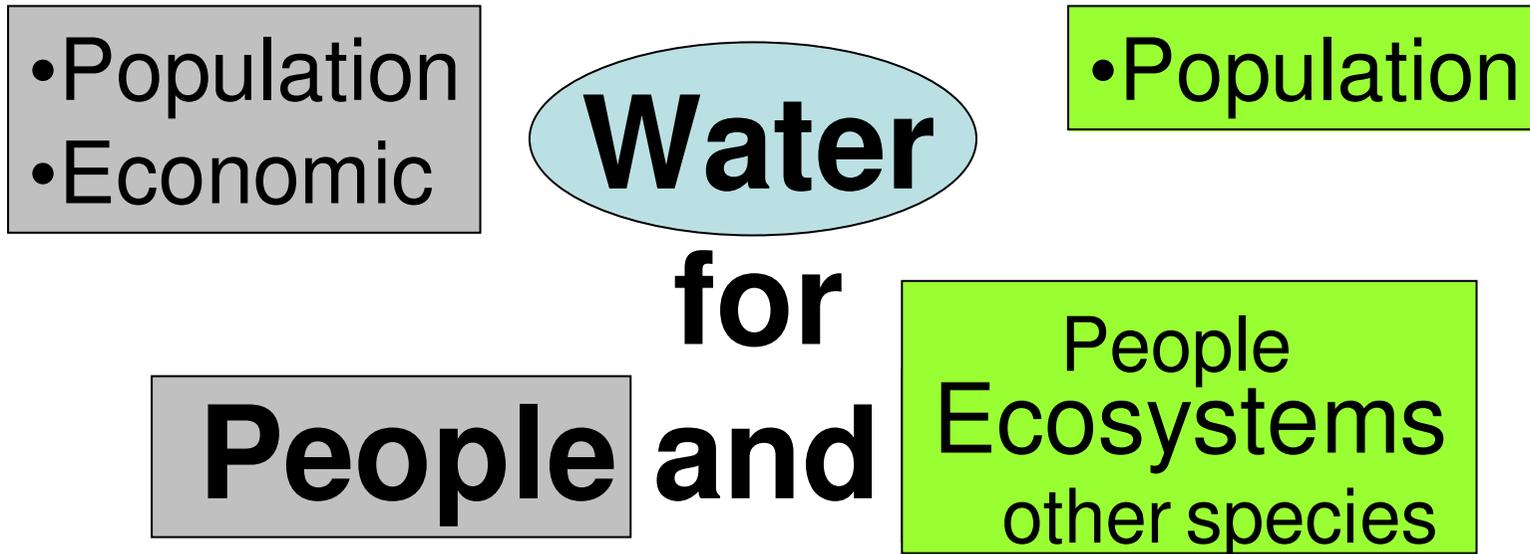
**and**

**Organisms**

Competition for **limiting** resource ?

**Essential**

limiting growth?



Competition for limiting resource ?

Where growth of people and organisms limited by water?

Islands

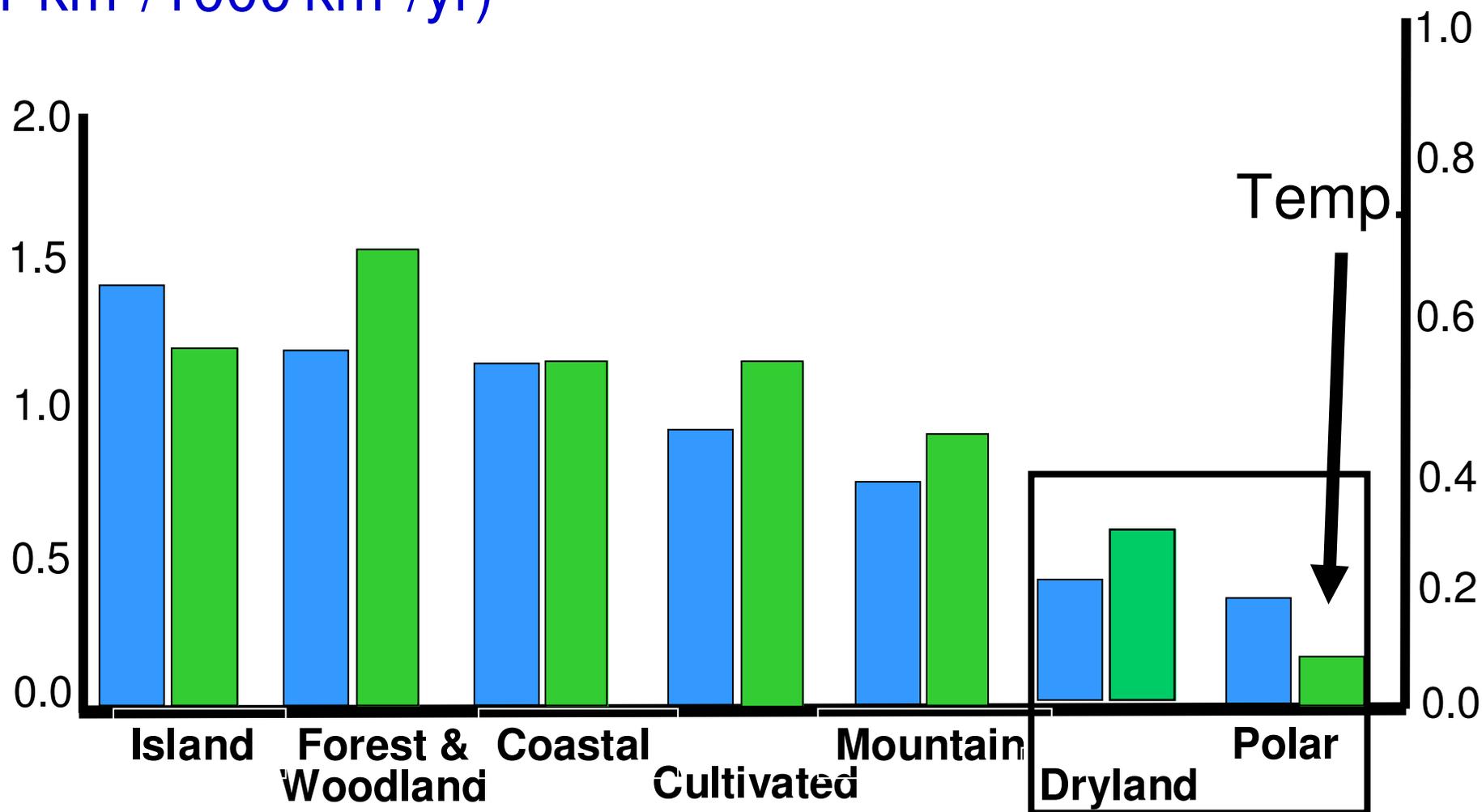
Polar

Forests & Woodlands



Total precipitation  
(1 km<sup>3</sup>/1000 km<sup>2</sup>/yr)

Net primary  
productivity  
(kg/m<sup>2</sup>/yr)

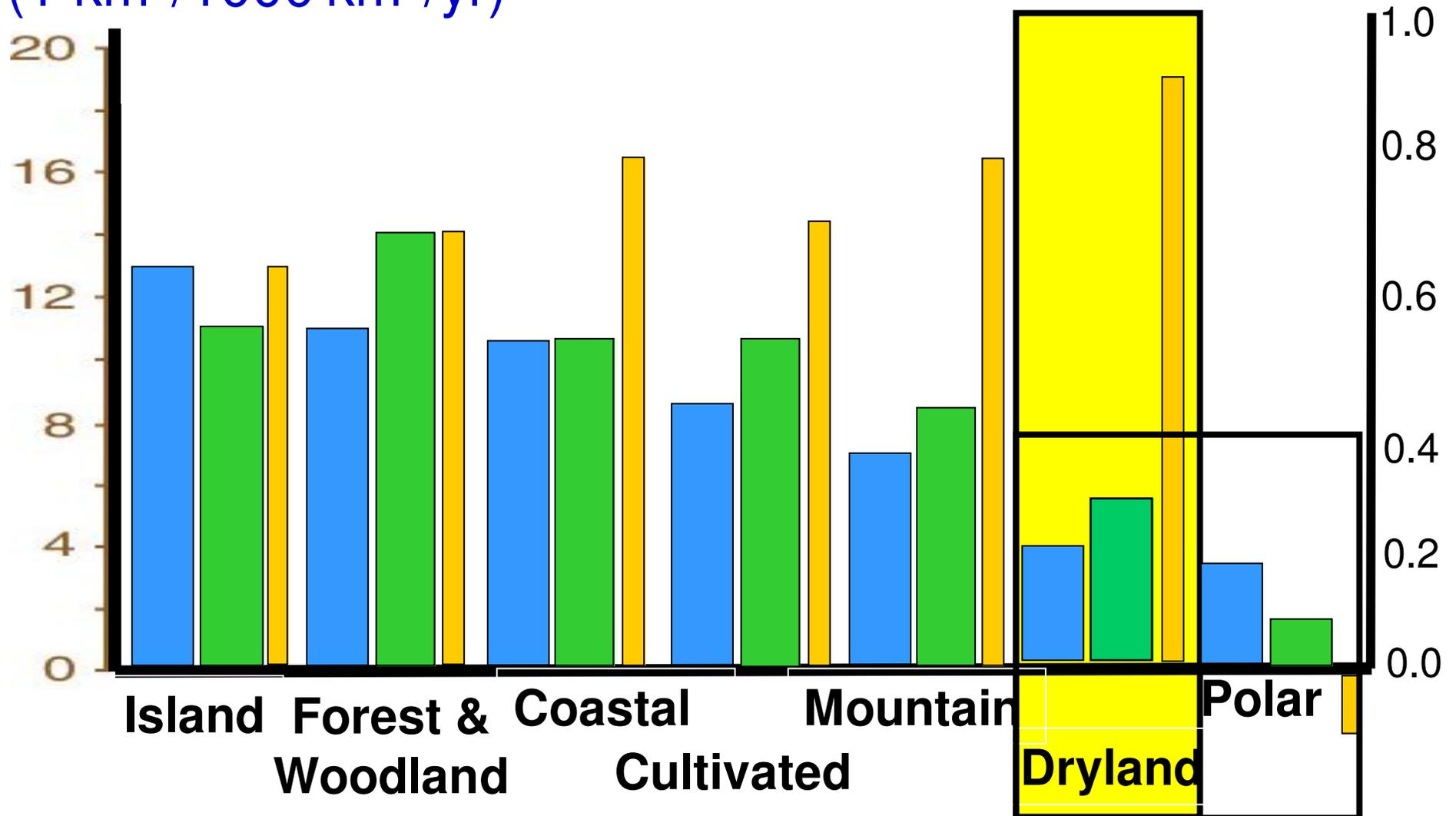




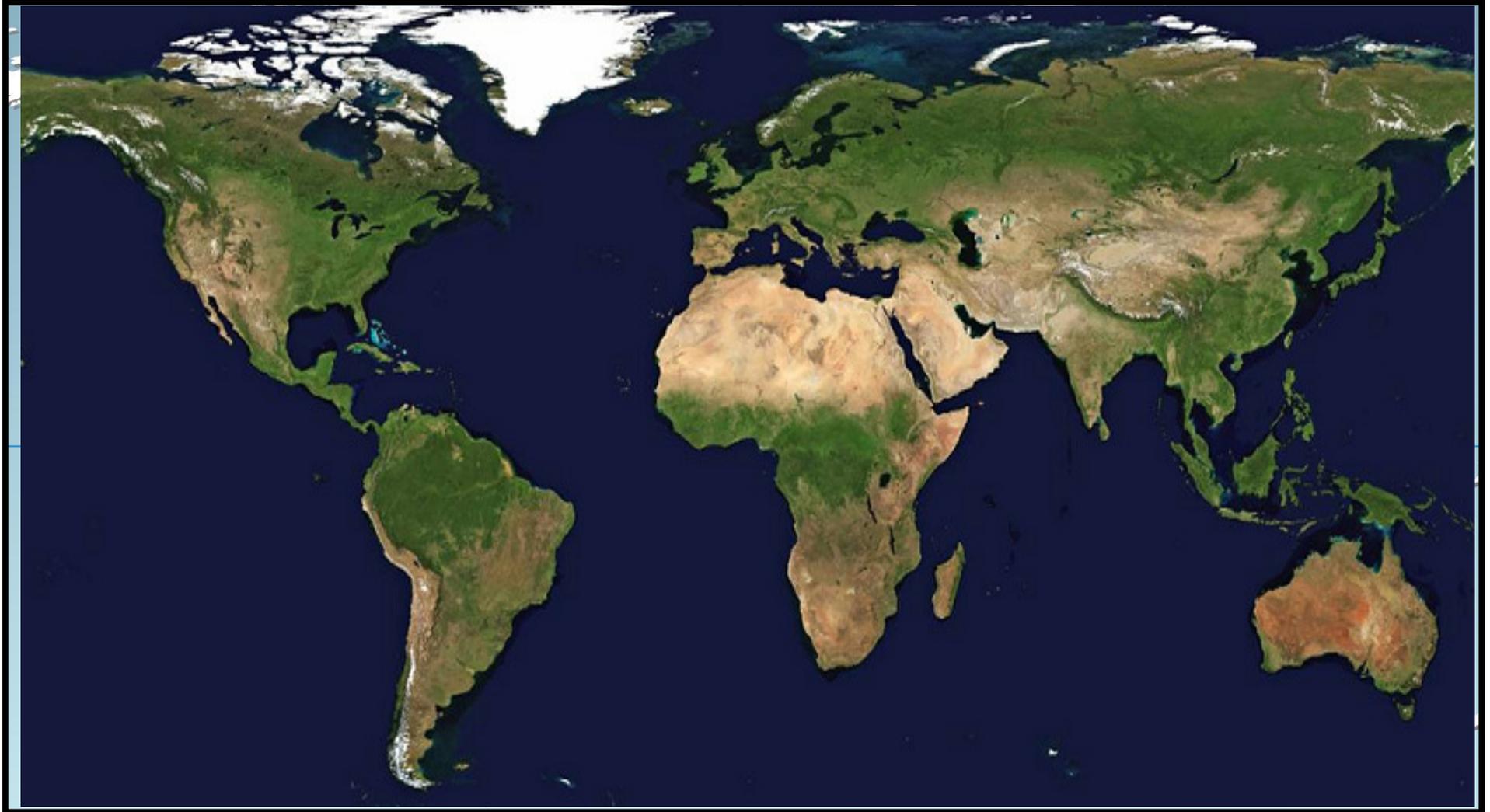
# Population growth between 1990 and 2000 (percentage)

Total precipitation  
(1 km<sup>3</sup>/1000 km<sup>2</sup>/yr)

Net primary  
productivity  
(kg/m<sup>2</sup>/yr)

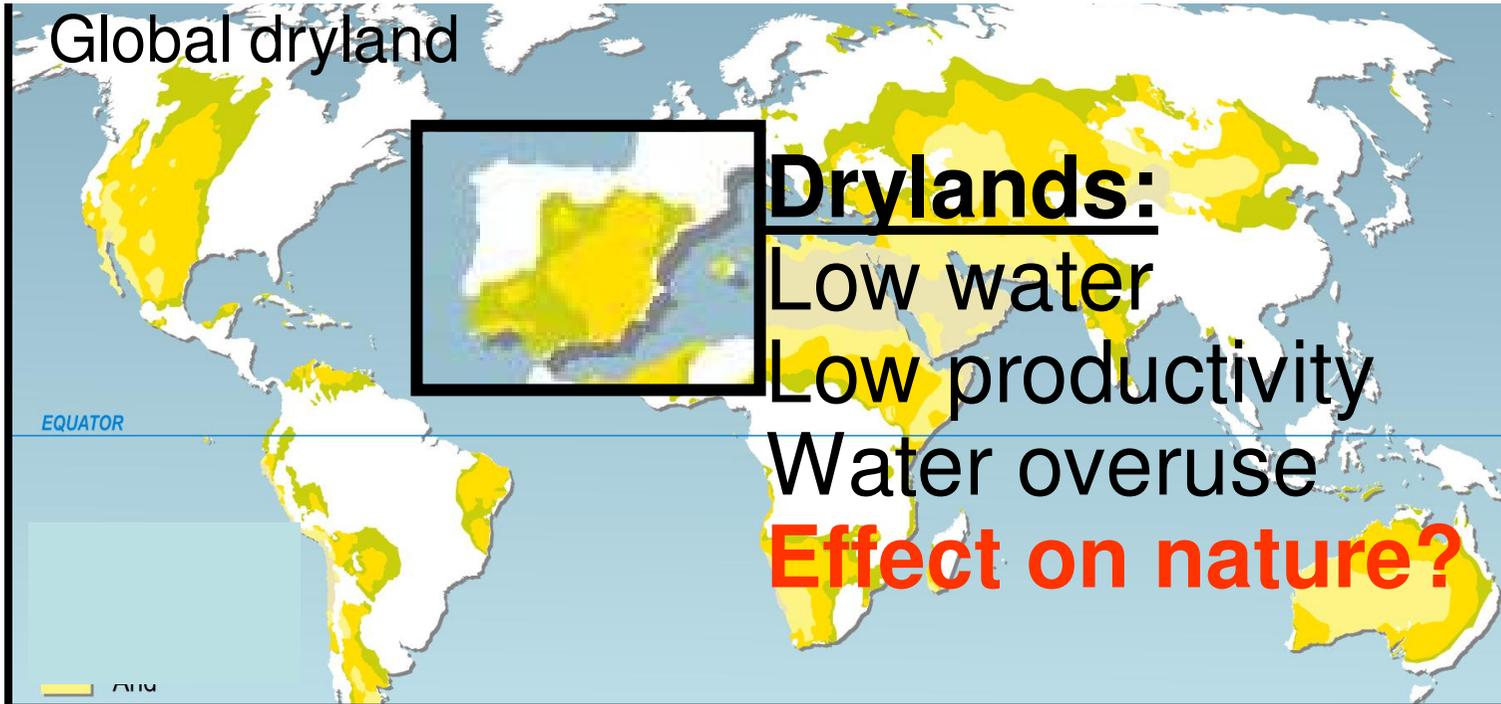


- **Precipitation at least  $\sim 1.5 < \text{evapotranspiration}$**
- **NPP limited by soil moisture**



<b>% of global land</b>	<b>41.3%</b>
<b>% of global population</b>	<b>35.5%</b>

## Global dryland



### Drylands:

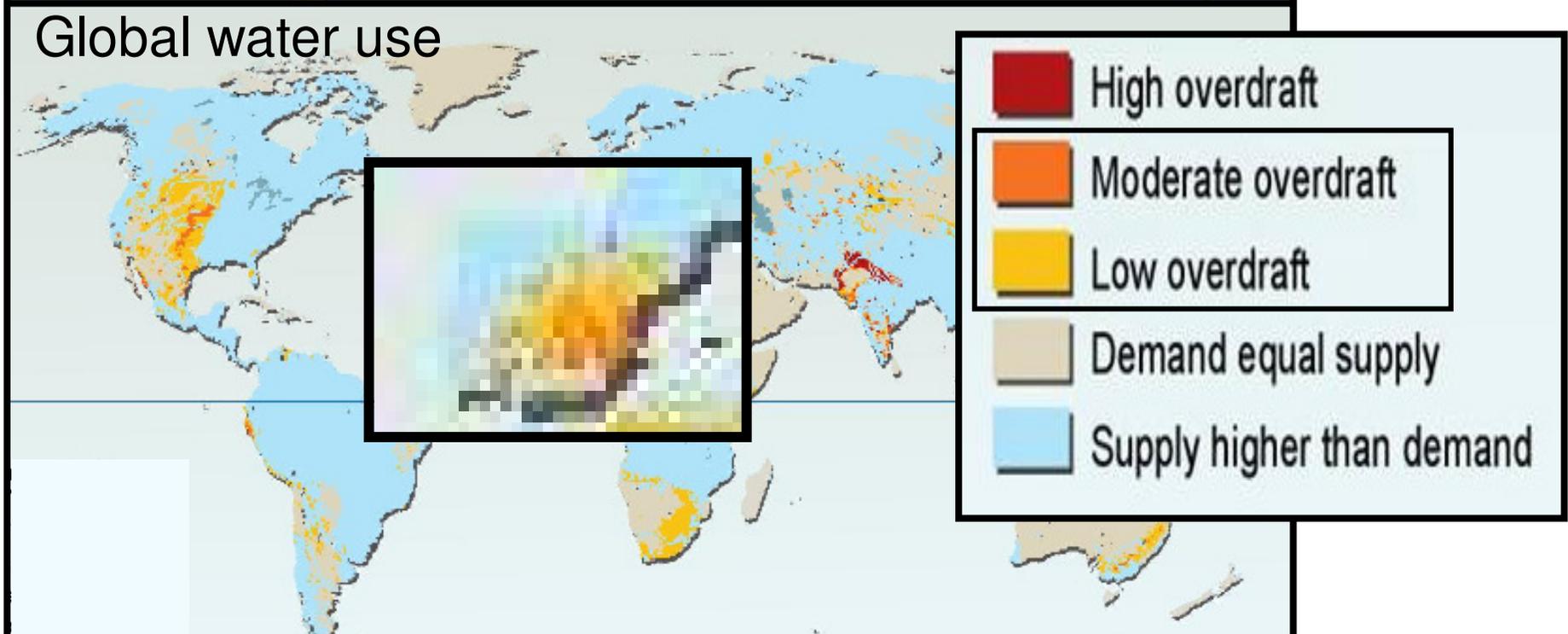
Low water

Low productivity

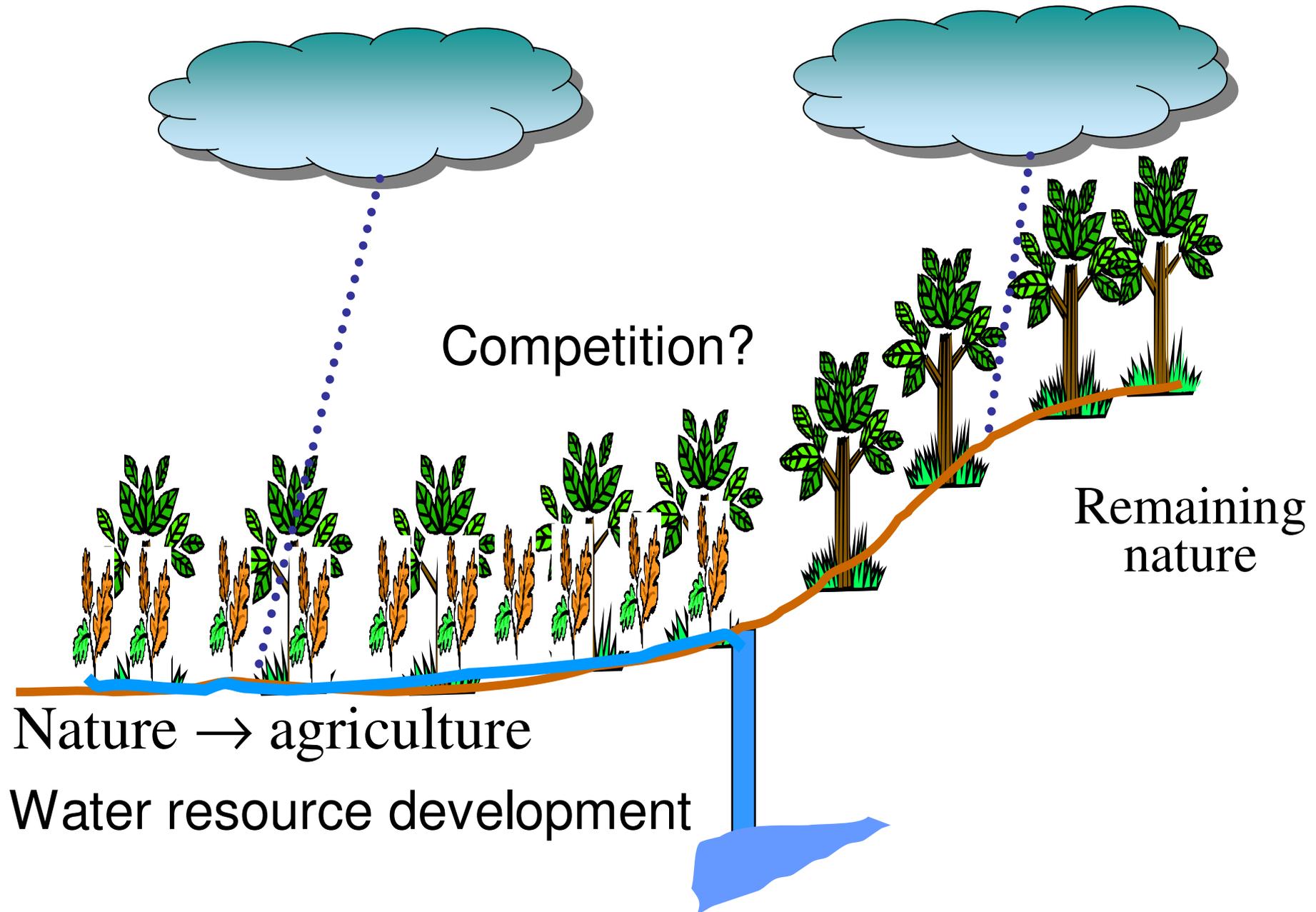
Water overuse

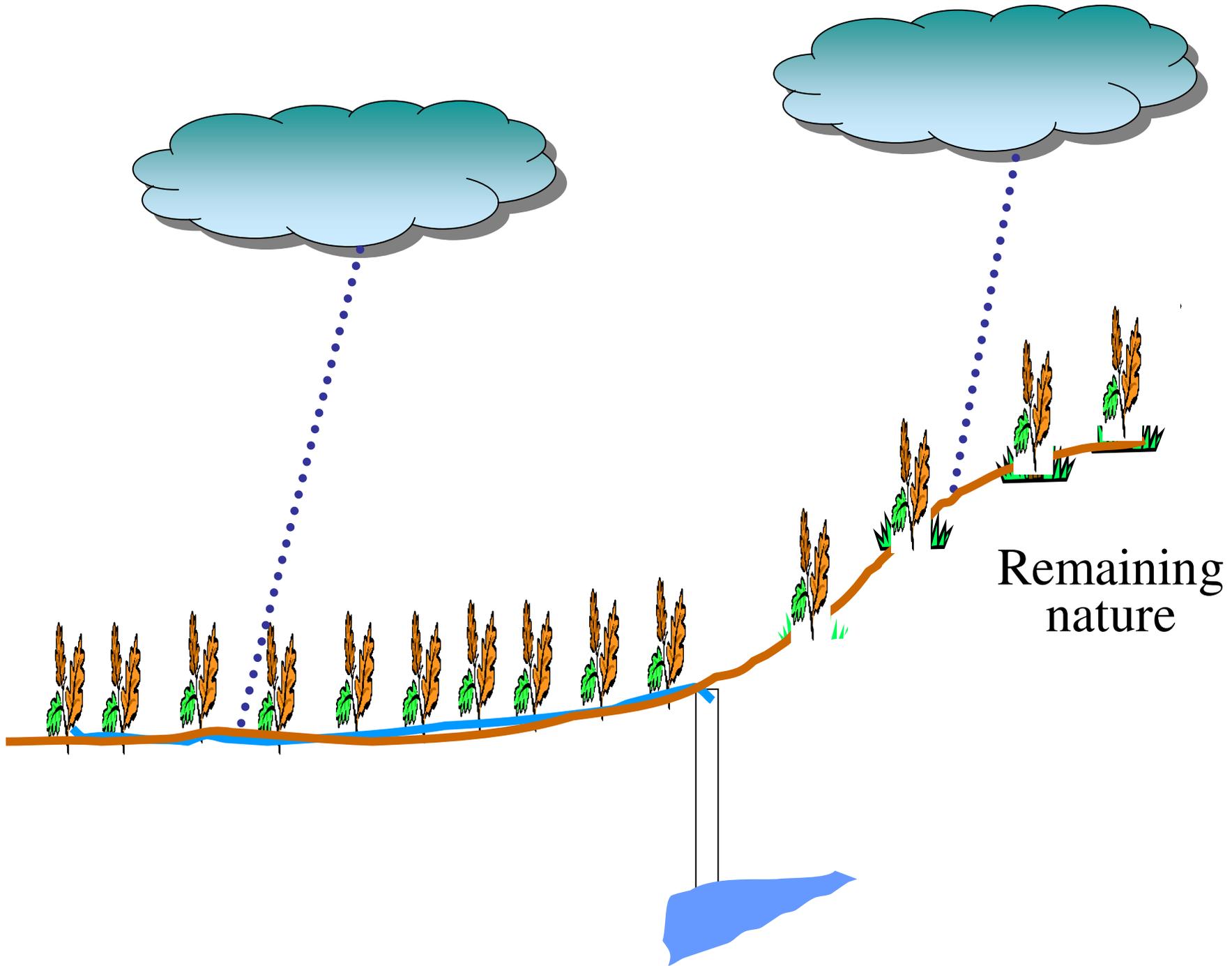
**Effect on nature?**

## Global water use



# Forest ecosystem in drylands

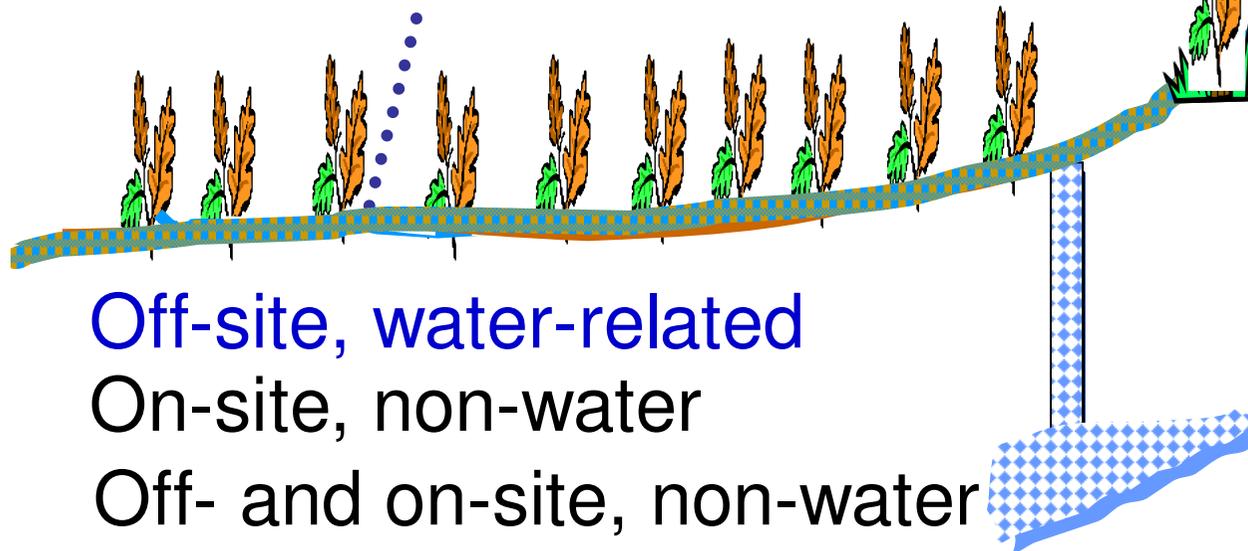




- Remaining nature had enough water

- People did not outcompete nature and denying it water
- Development denied people of nature's **benefit**

## Ecosystem services



Off-site, water-related

On-site, non-water

Off- and on-site, non-water

Remaining nature

- Water regulation
- Water provision
- Flood regulation
- Soil conservation
- Climate regulation

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## Provisioning

*Goods produced or provided by ecosystems*

- food
- water provision
- woodfuel
- timber
- fiber
- biochemicals

## Regulating

*Benefits obtained from regulation of ecosystem processes*

- water regulation
- climate regulation
- disease regulation
- flood regulation
- water purification

## Cultural

*Non-material benefits obtained from ecosystems*

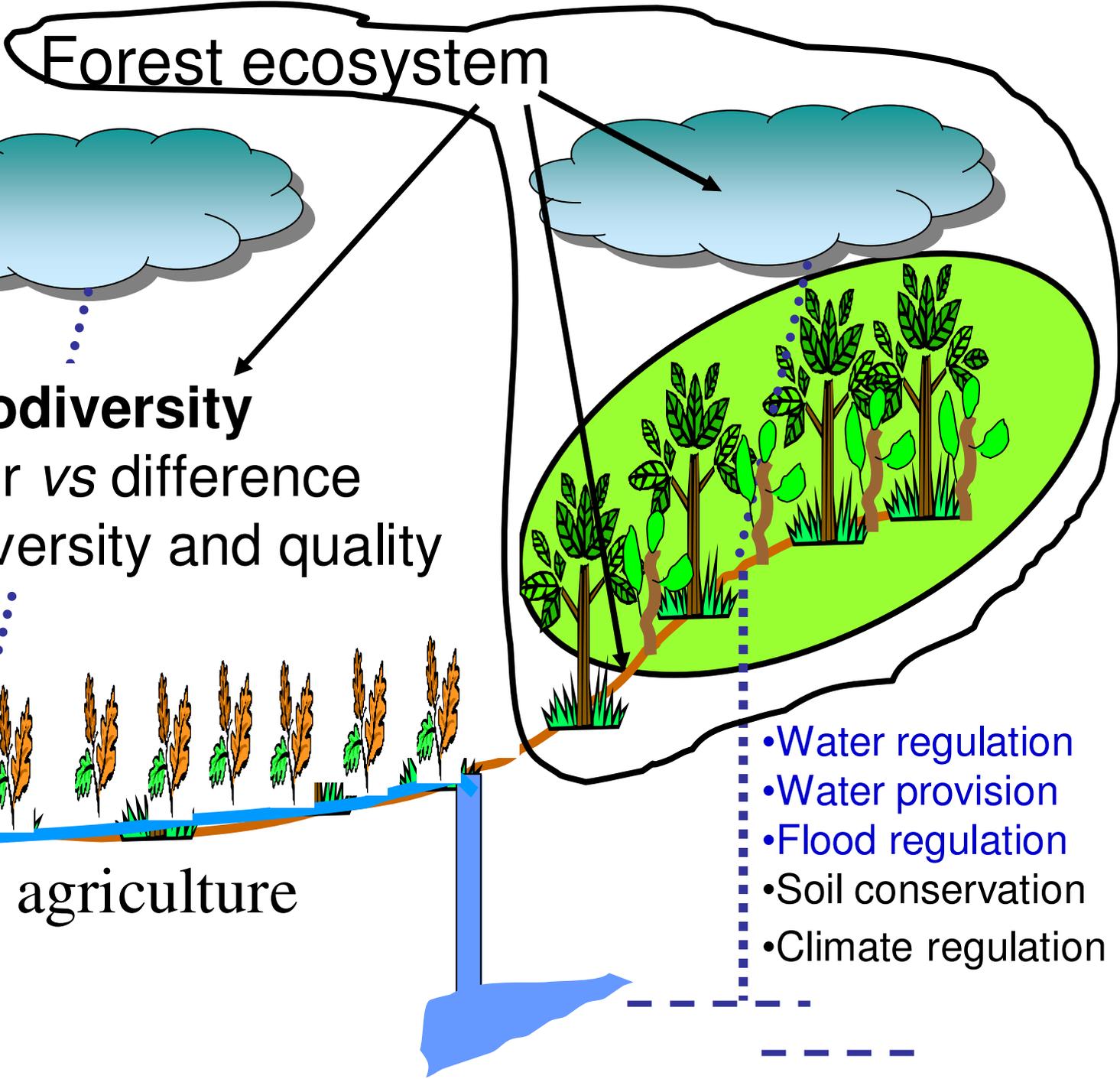
- spiritual
- inspirational
- aesthetic
- educational
- recreational

## Supporting

*Services necessary for production of other services*

*(not directly used by people)*

- soil conservation
- nutrient cycling
- primary production
- supporting biodiversity



# Forest ecosystem

**Biodiversity**  
Number vs difference  
Service diversity and quality

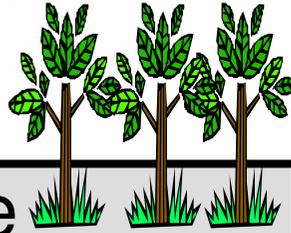
Nature → agriculture

- Water regulation
- Water provision
- Flood regulation
- Soil conservation
- Climate regulation

# Conditions required by a species for optimal service provision



- Large population size
- Presence of other species
  - Food
  - Facilitator
  - Regulator



- Habitat**
- Conditions
  - Abiotic conditions
  - Presence of other species
- **Size**



## Habitat size

- decrease
- fragmentation



Population decrease



Local extinction

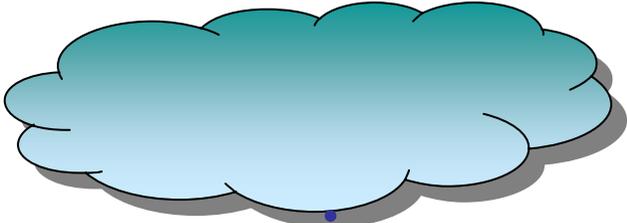


Reduced biodiversity



Service degradation

# Forest ecosystem



**Water resource development**

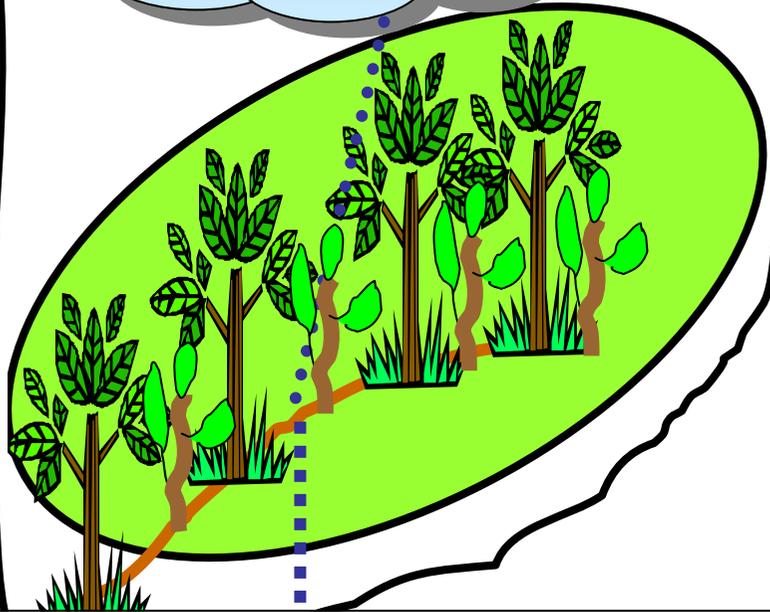
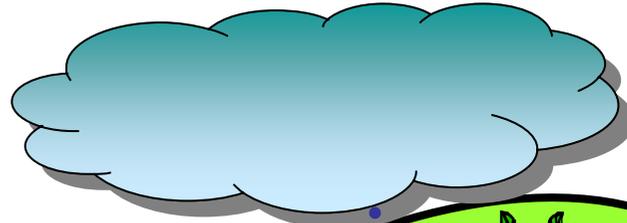
- Ecosystem transformation
- Service tradeoff

**Habitat reduction**

**Still sustainable development**

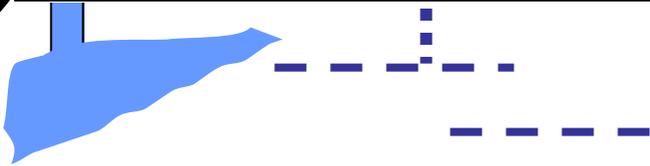


Nature → **Forest** → **cultivated ecosystem**



**Forest services to cultivated**

- Water provision
- Water regulation



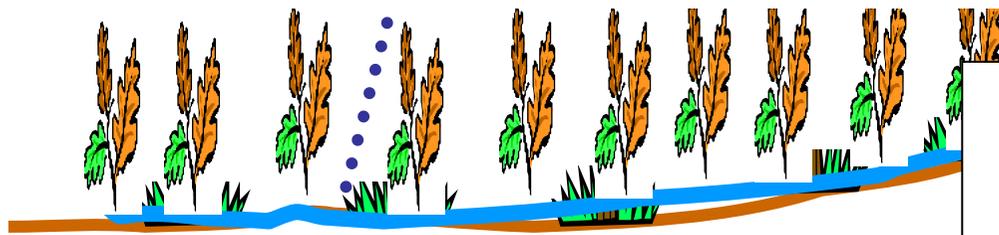
# Forest ecosystem

## Water resource development

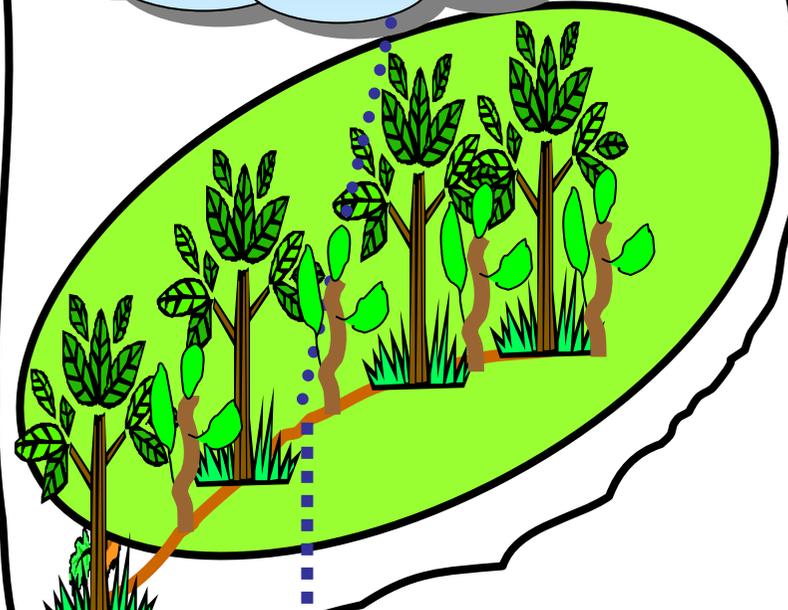
- Ecosystem transformation
- **Service tradeoff**

**Habitat reduction**

Still **sustainable development**



Forest → cultivated



## Forest services to cultivated

- Water provision
- Soil conservation

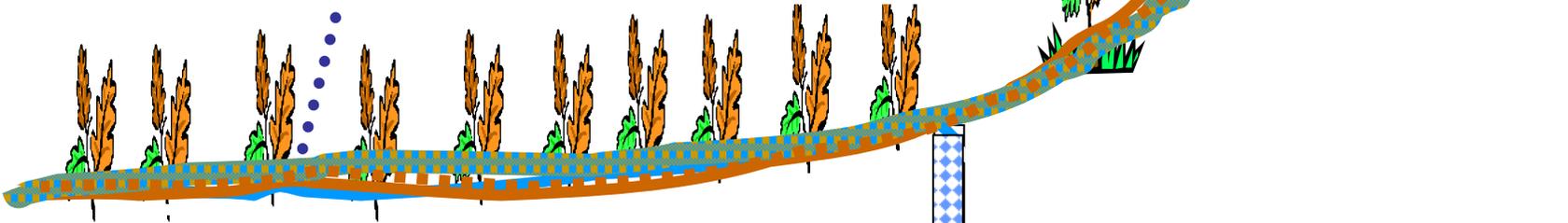
**Natural water provision → Intensified food provision**

Competition is **NOT** on water  
**On space**

**Water resource development**

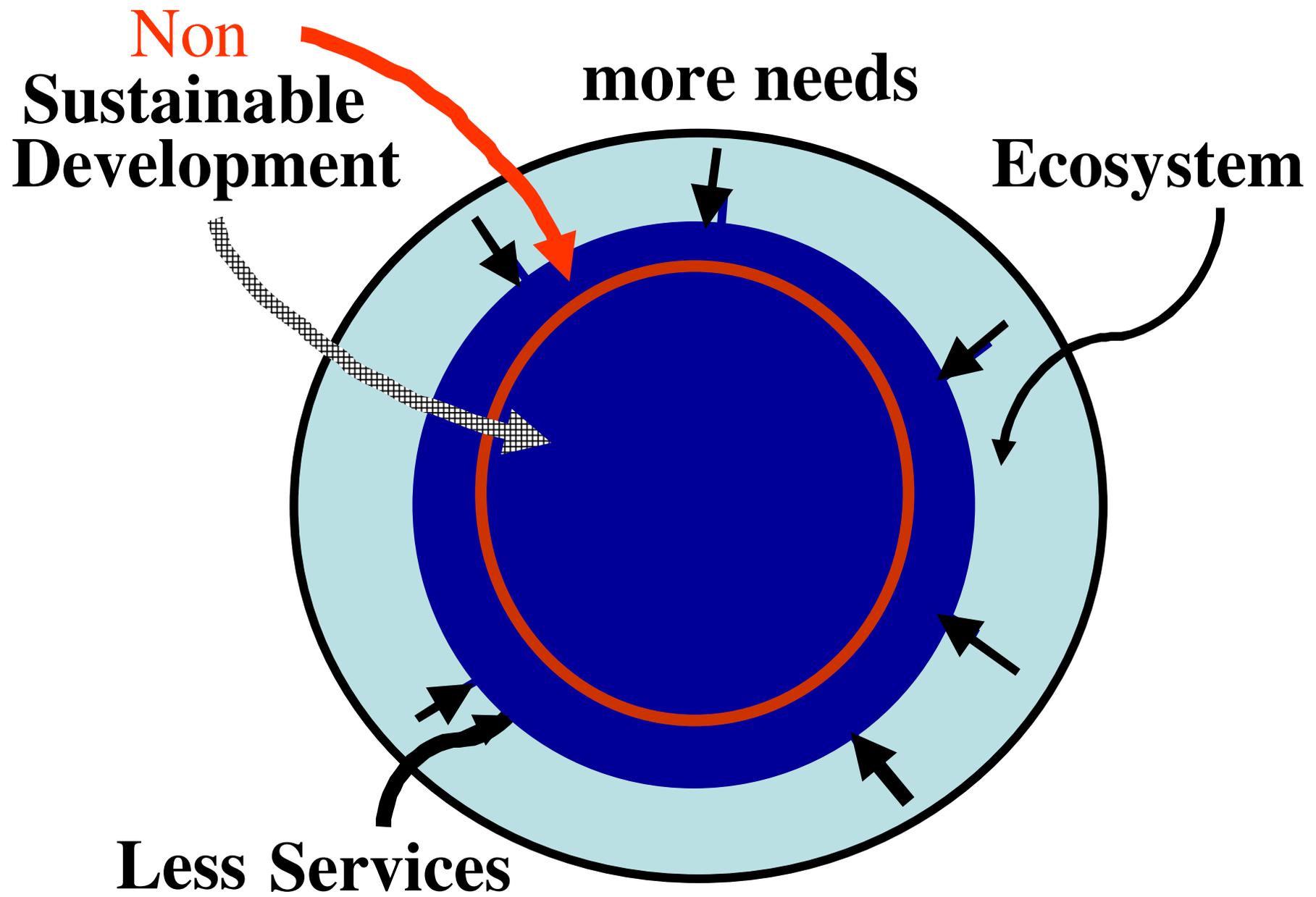
- Ecosystem transformation
- Service tradeoff

**Habitat reduction - increased**  
**Non - sustainable development**



Forest → cultivated

~~Natural water provision~~ > ~~Intensified food provision~~



Local extinction



Regional extinction



Degradation of other services

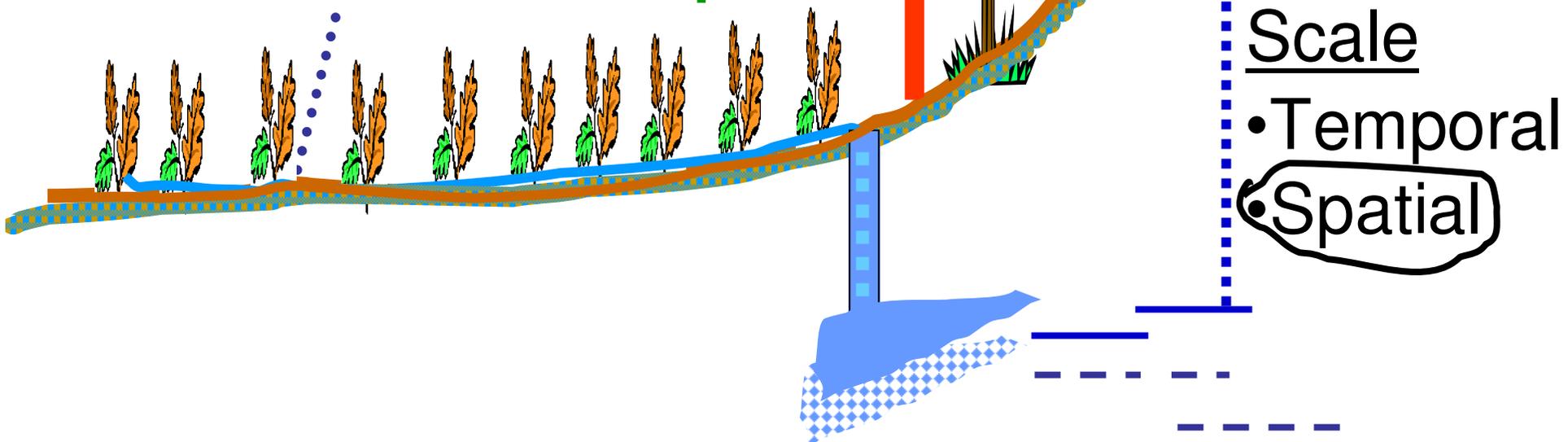
**Water resource development**

- Ecosystem transformation

- Service tradeoff

Habitat reduction - increased

**Non-sustainable development ?**

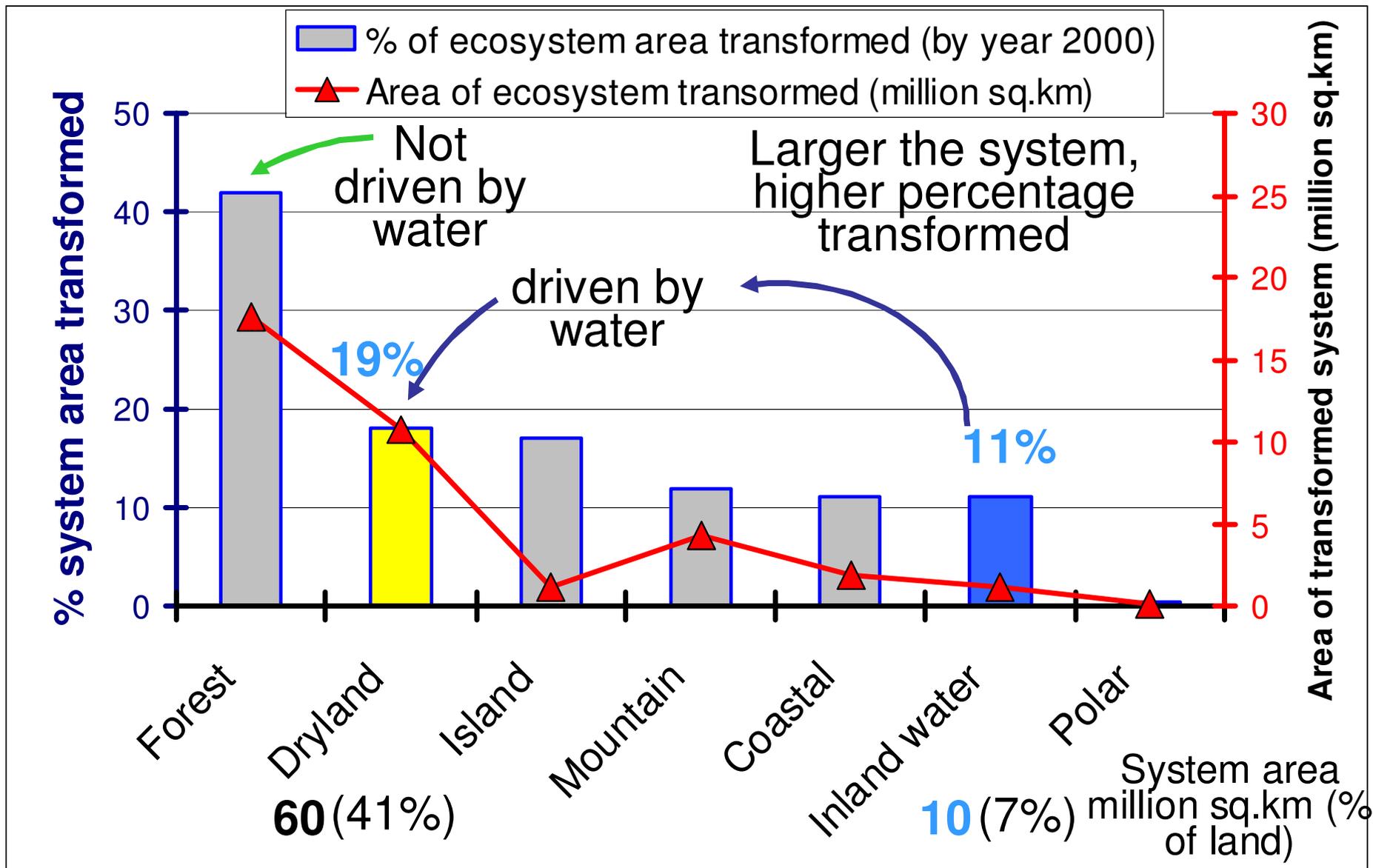


Scale

- Temporal

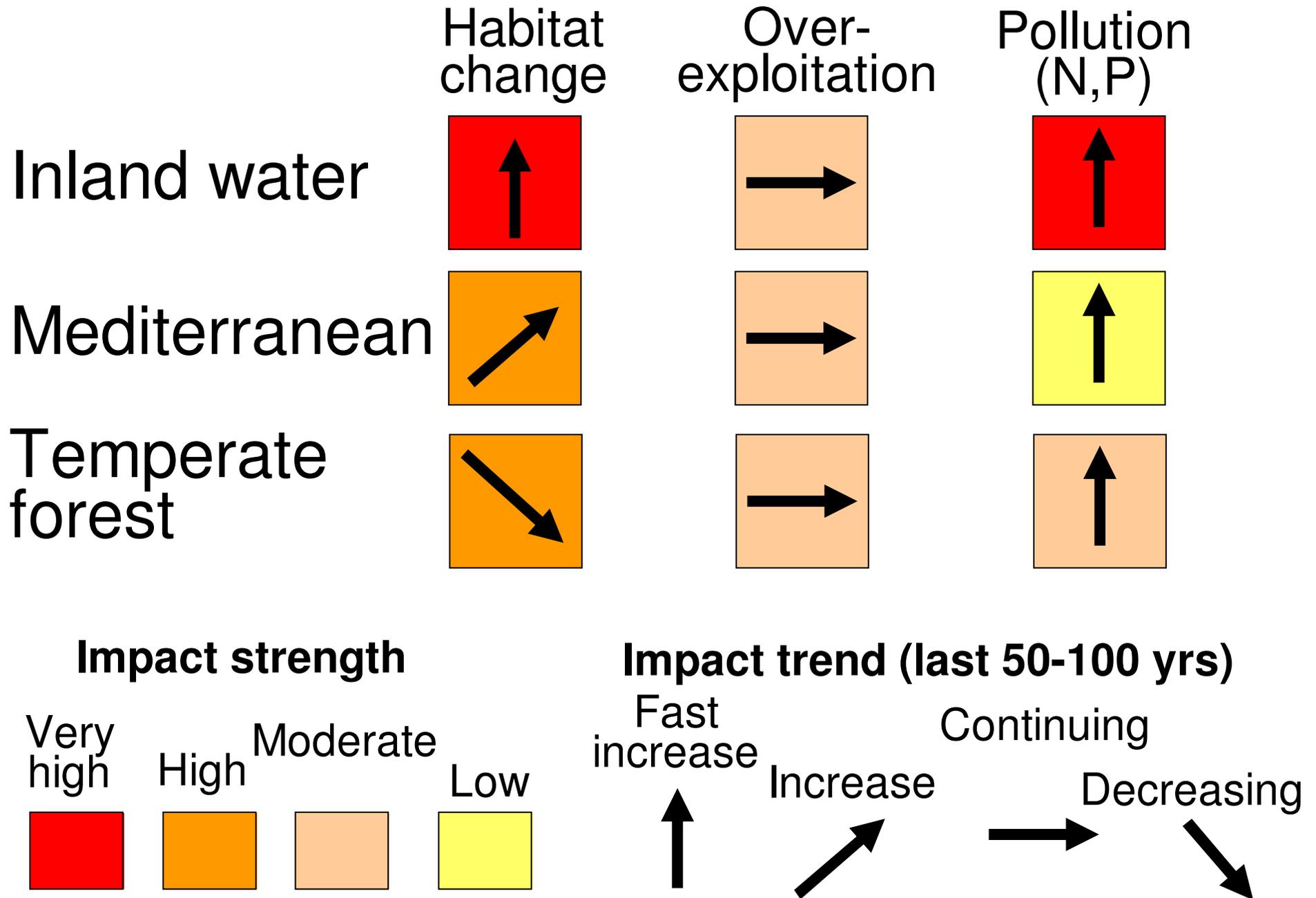
- Spatial

# Ecosystem transformation



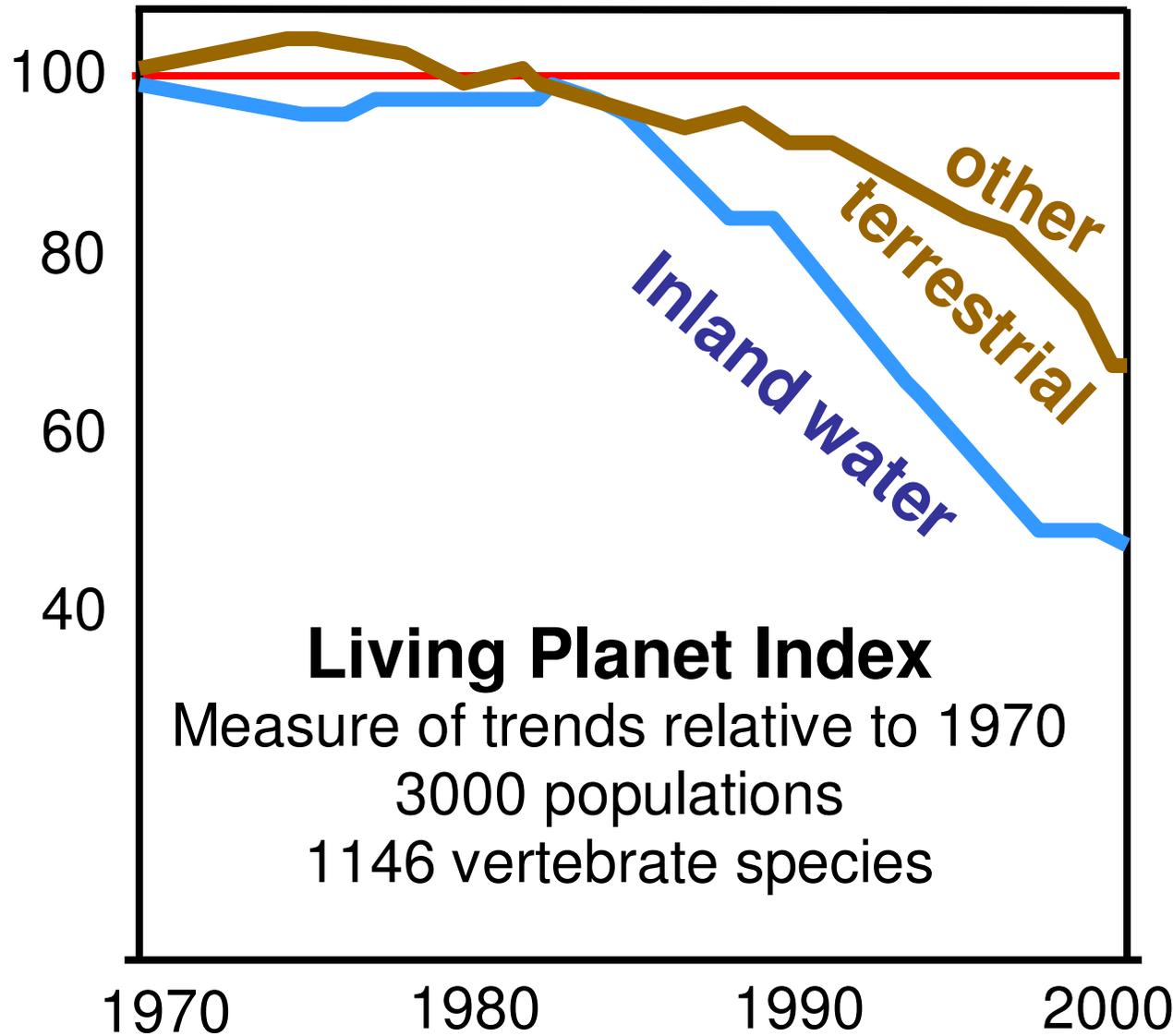
37% of total land area transformed

# Impacts of transformations on biodiversity



# Biodiversity response to impact

## Israel



**45%** of extinct plant species are aquatic

**40** invertebrate species locally extinct

**1** (out of 7) amphibians globally extinct

**1** fish species locally extinct

**10** breeding birds locally extinct as breeders

# Allocation of water to Israeli inland water ecosystems

(as % of annual renewable water, 9.4 km<sup>3</sup>/1000km<sup>2</sup>/yr)

Current allocation		Required flow	Loss to other uses
Best rainy year	Worse rainy year		
<u>0.2%</u>	<u>2%</u>	9%	2%

Efforts to restore freshwater biodiversity do not address damage to terrestrial ecosystems caused by damage to freshwater ones

# Services' tradeoffs

## Provisioning services

- Crops, livestock 
- Capture fisheries 
- Wild food 
- Timber** 
- Woodfuel 
- Biochemicals 

## Regulating services

- Global climate regulation 
- Local climate regulation 
- Water regulation** 
- Water purification 
- Flood regulation 
- Disease regulation** 
- Pollination 

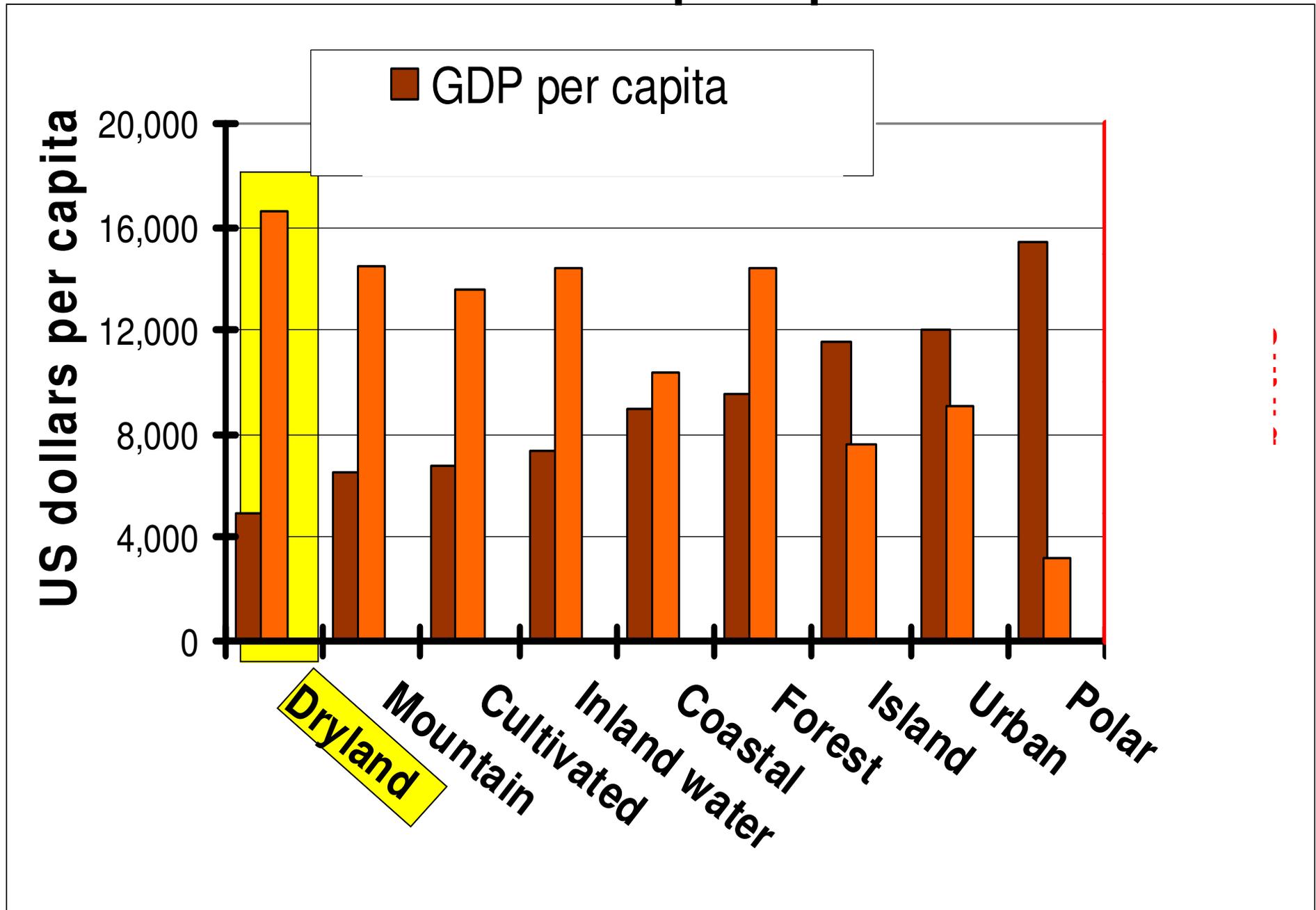
## Cultural services

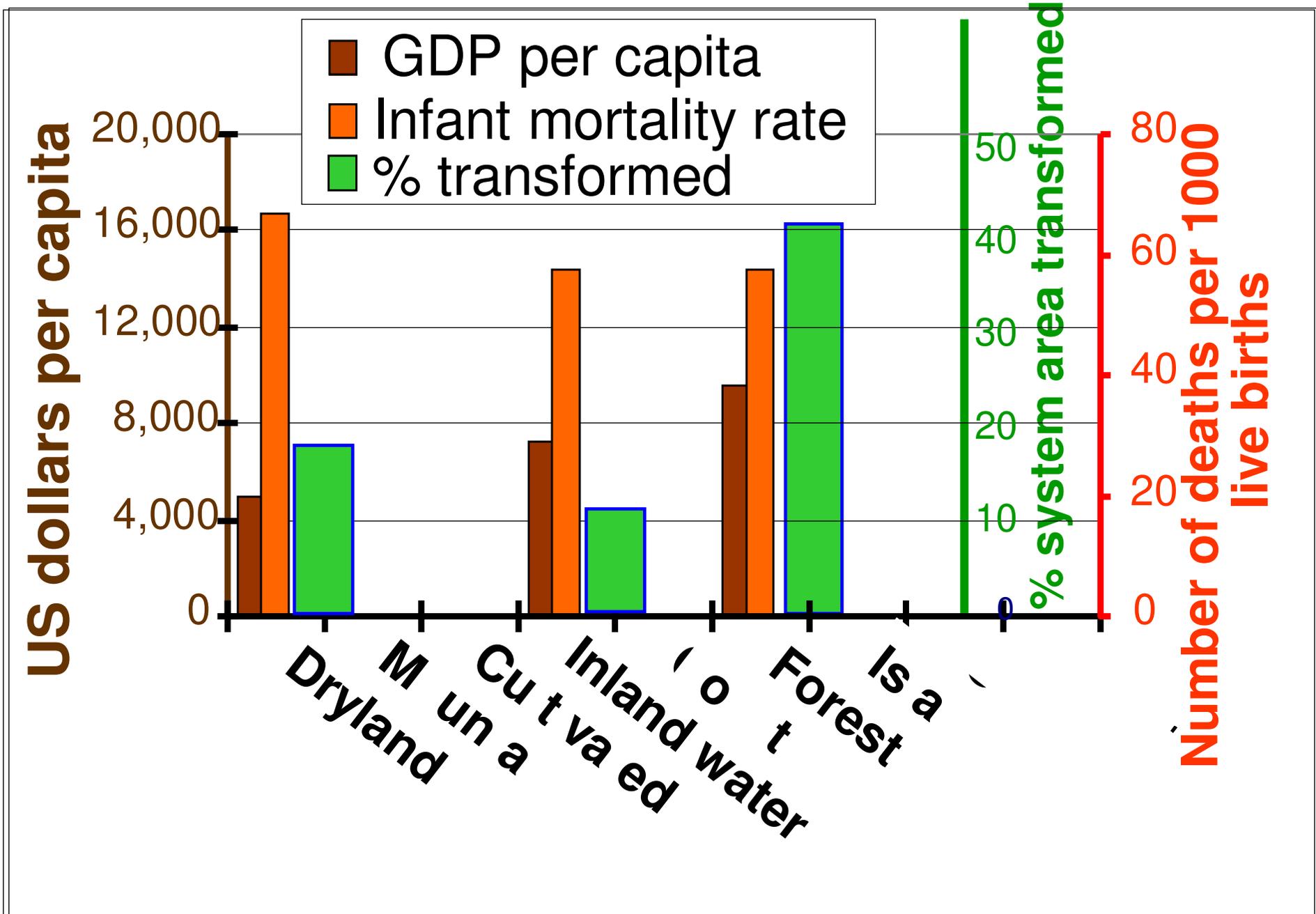
- Spiritual & religious 
- Aesthetic 
- Recreation 

## Supporting services

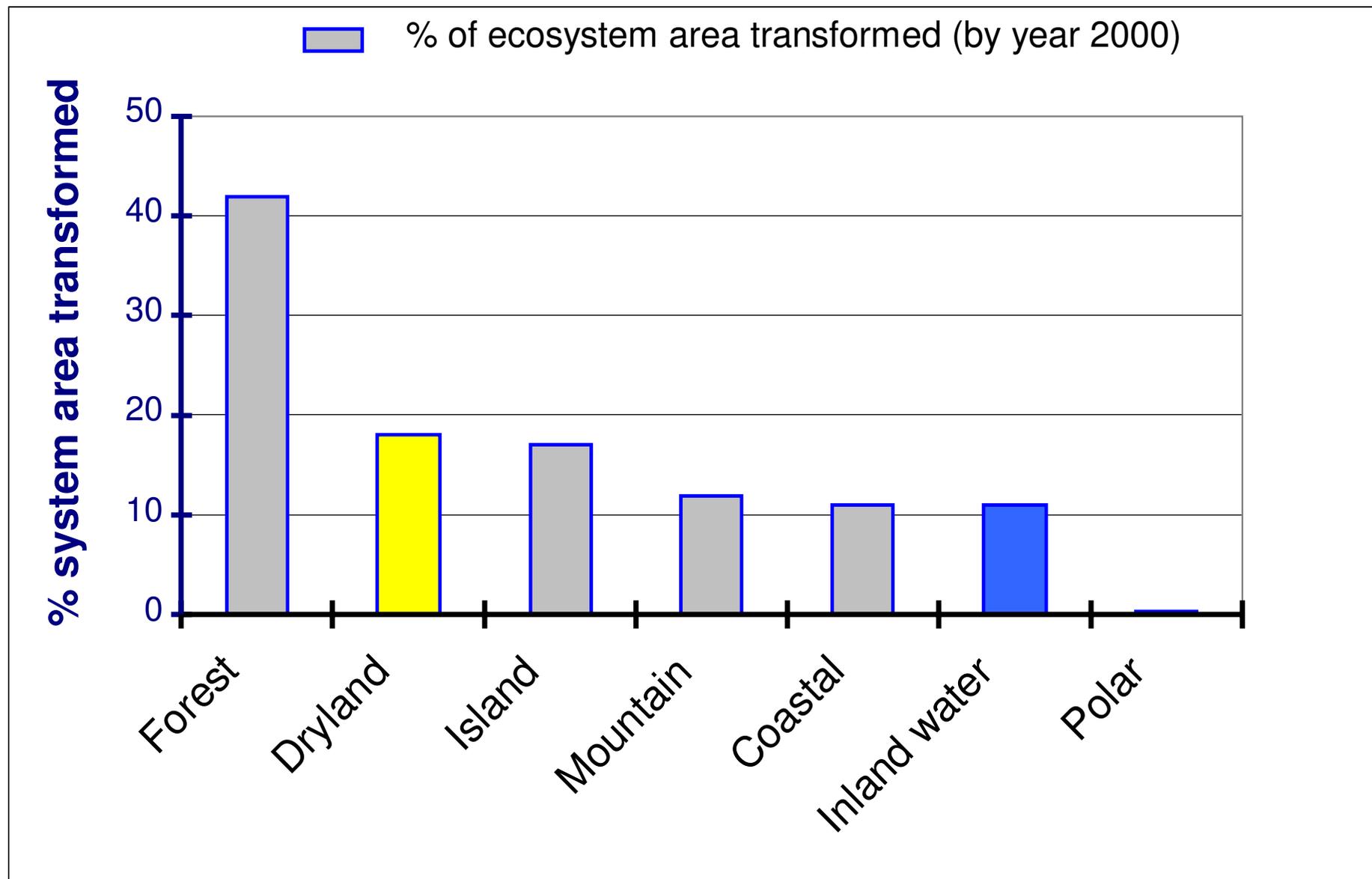
- Soil conservation 
- Supporting biodiversity 

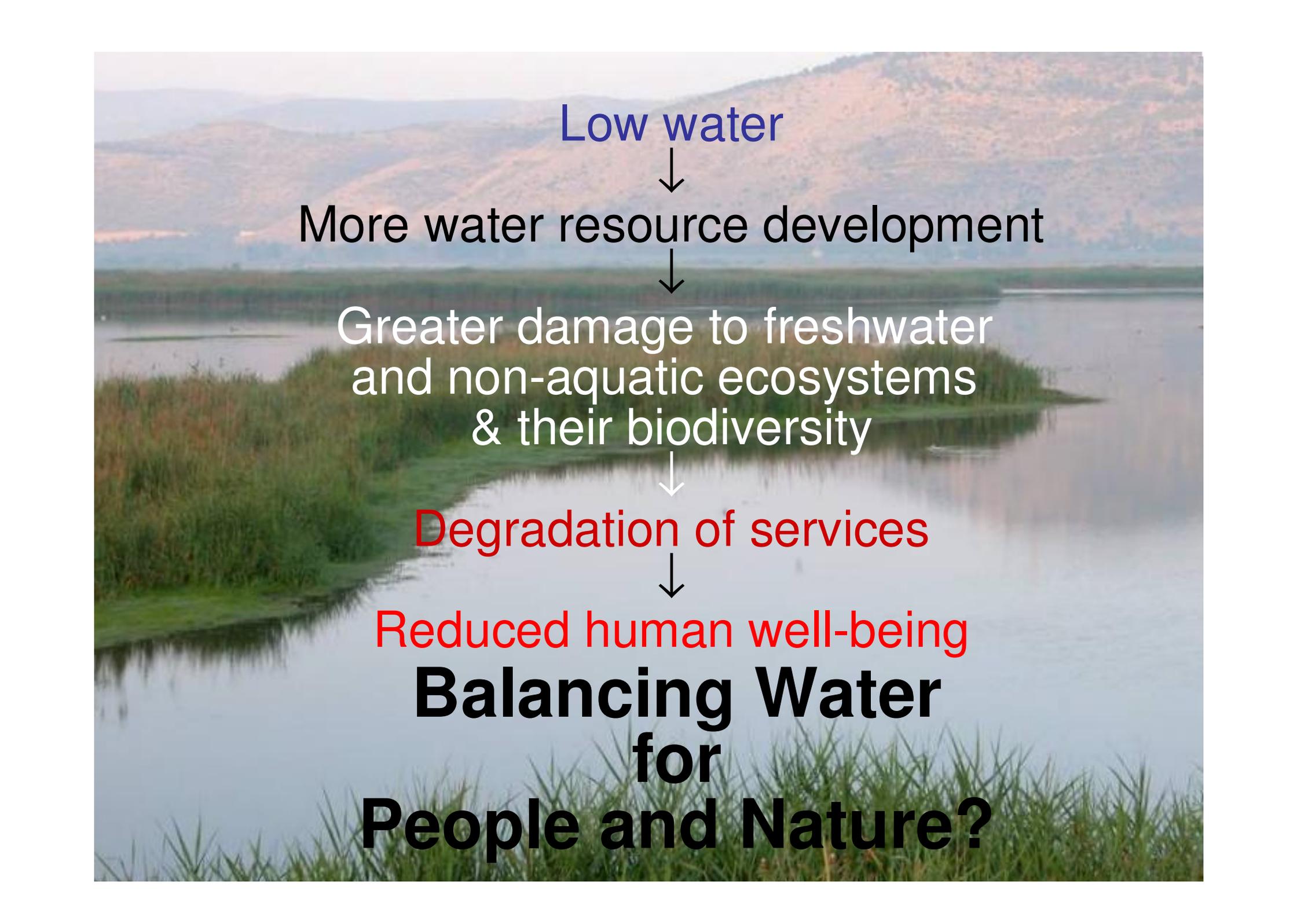
# Effect on people





# Ecosystem transformation





Low water



More water resource development



Greater damage to freshwater  
and non-aquatic ecosystems  
& their biodiversity



Degradation of services



Reduced human well-being

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for  
People and Nature?**

