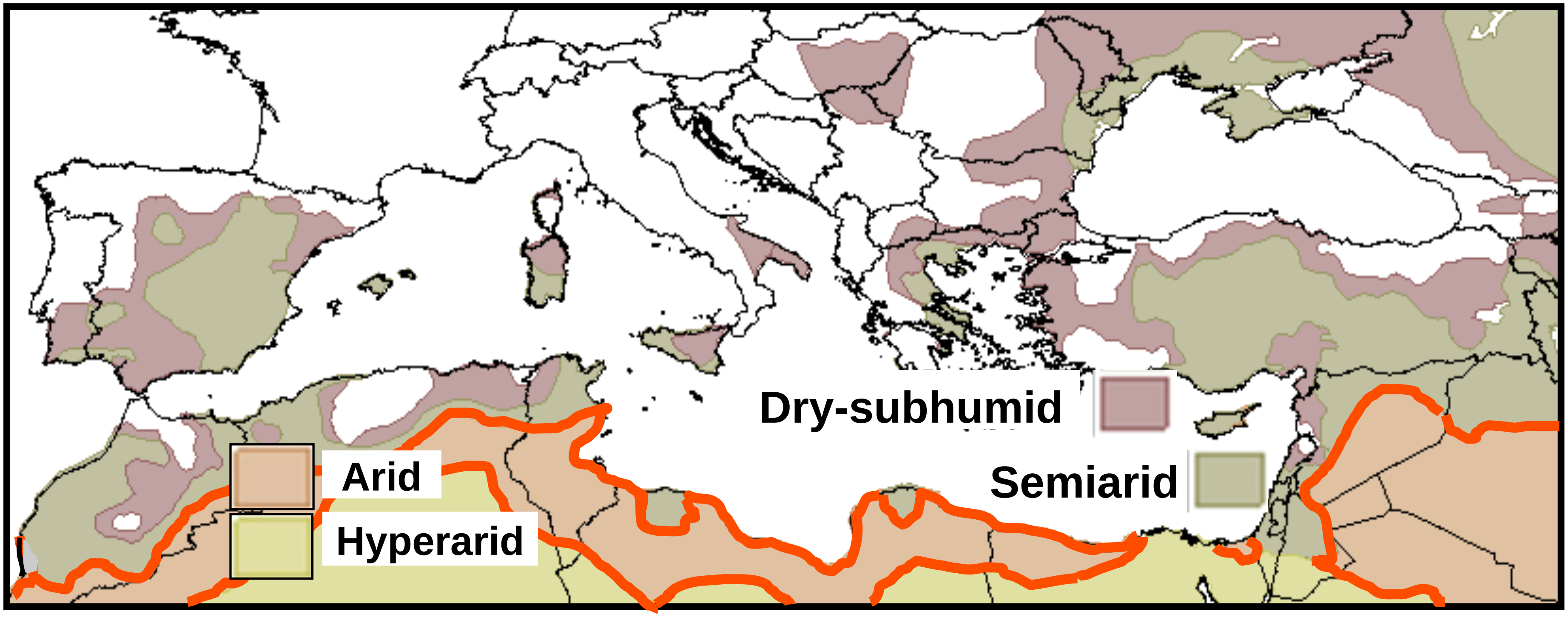
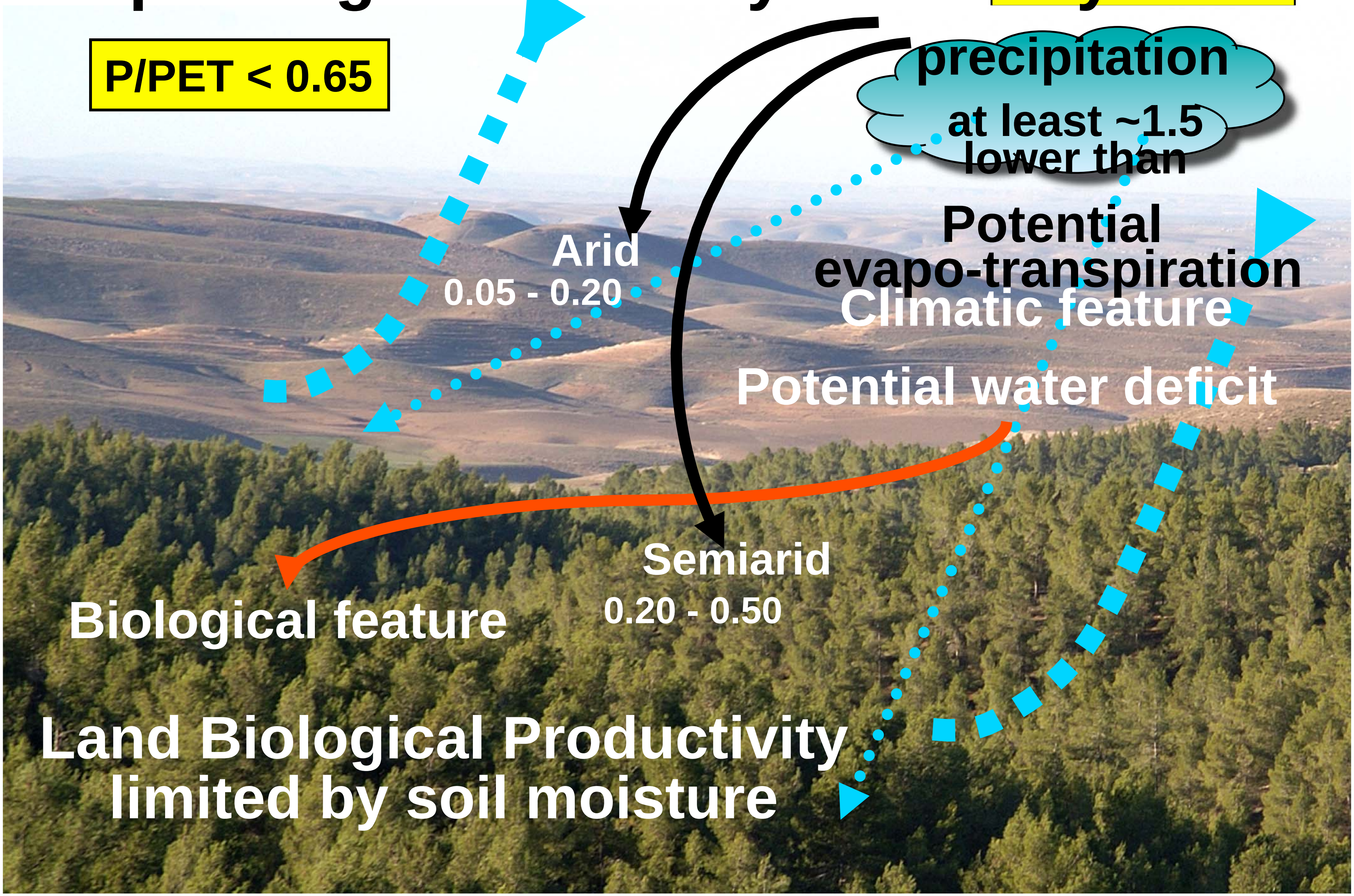
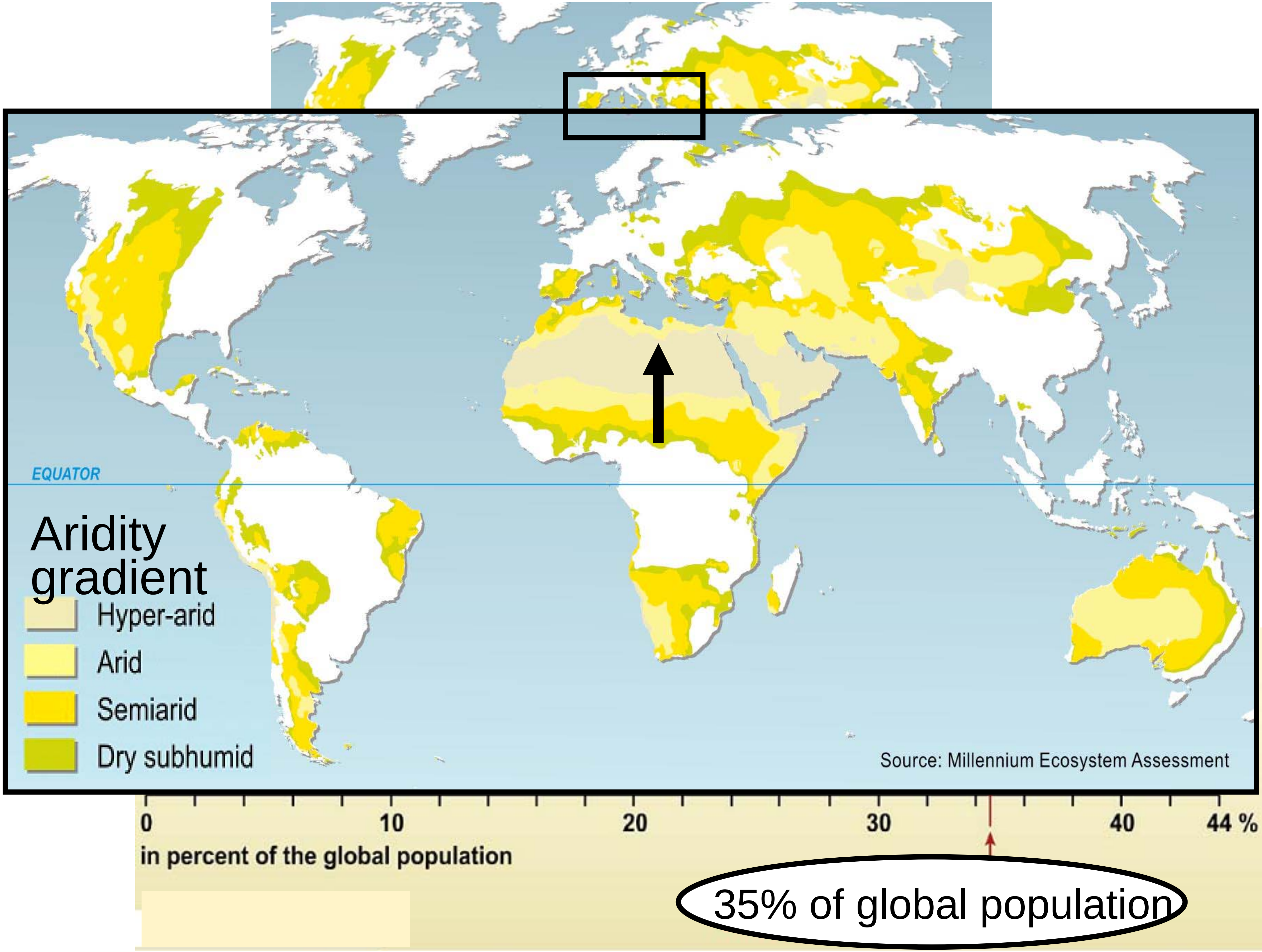
Food Security, Agriculture in Arid zones

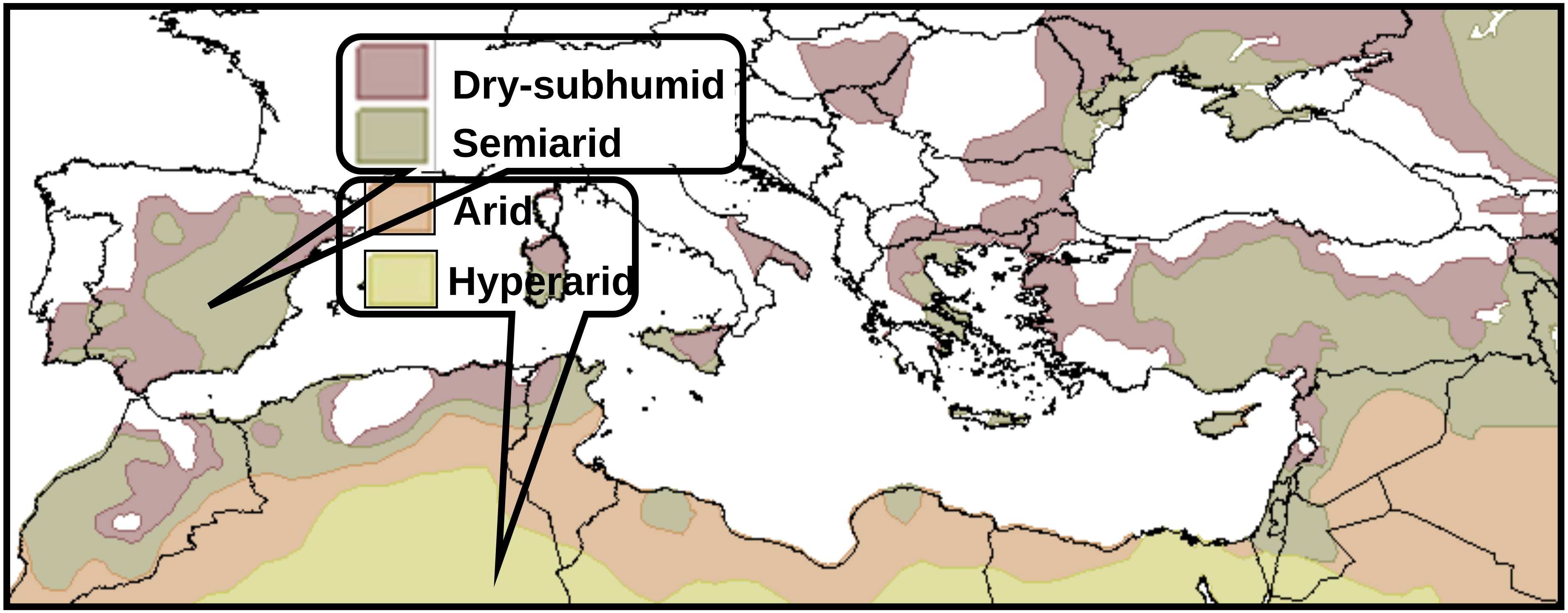
Improving Productivity in the Arid Zones



Improving Productivity in the Drylands




EQUATOR
Aridity gradient
Hyper-arid
Arid
Semiarid
Dry subhumid
Source: Millennium Ecosystem Assessment
0
10
20
30
40
44 %
in percent of the global population
35% of global population



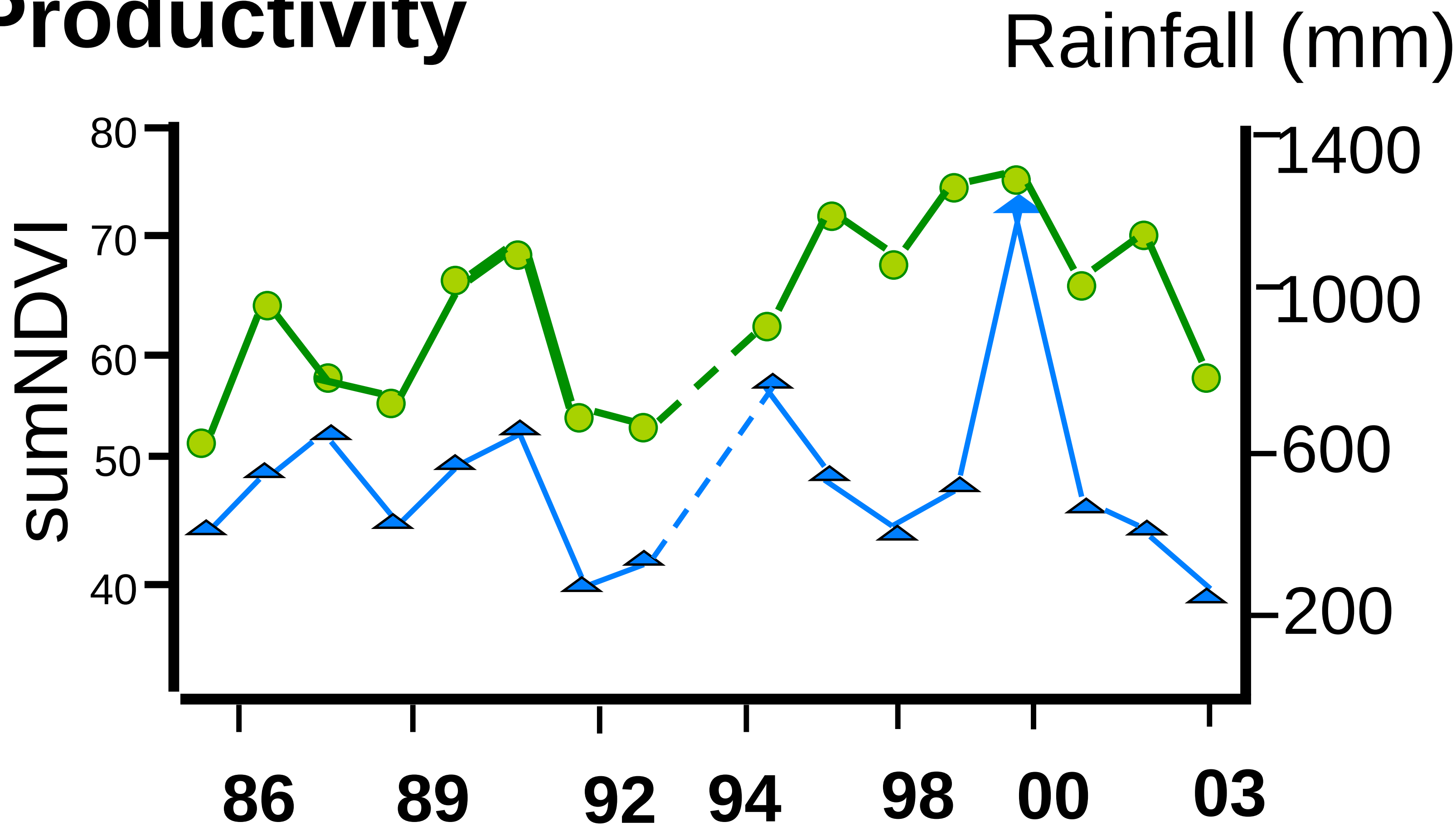
UNEP

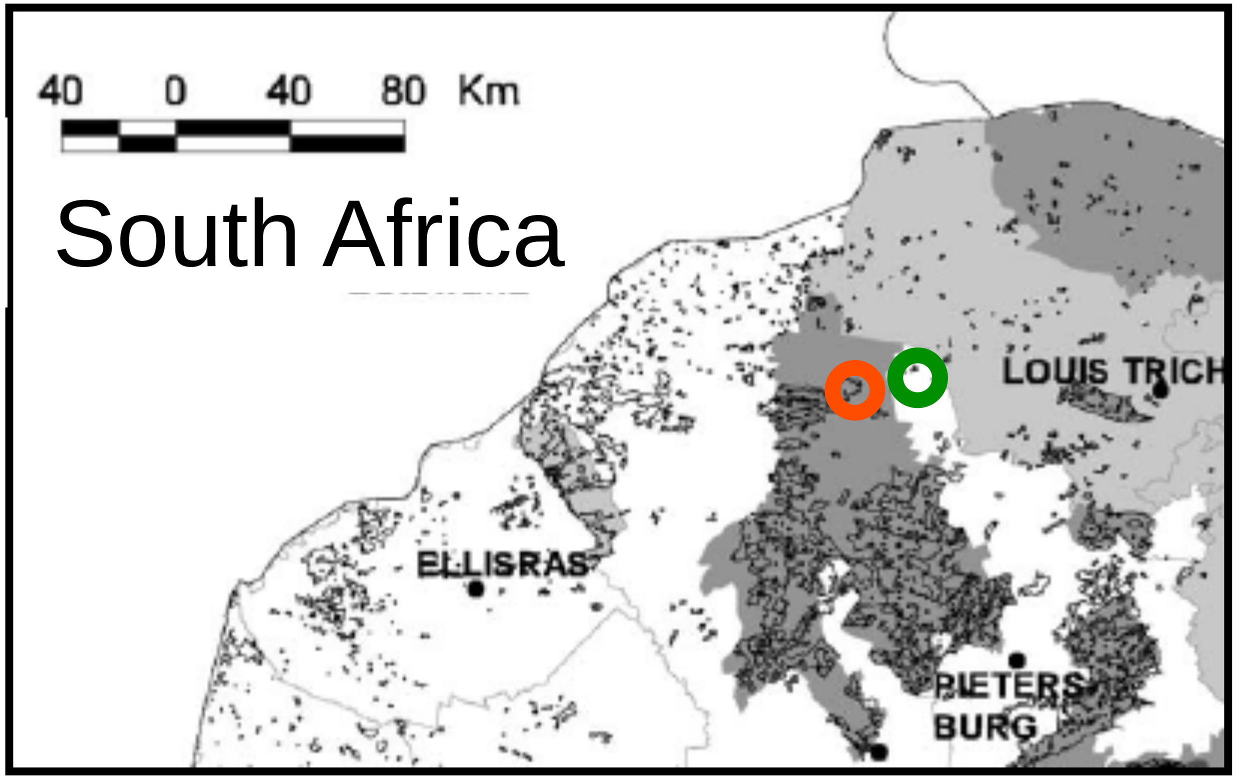
↓

UN Convention to Combat Desertification (UNCCD)

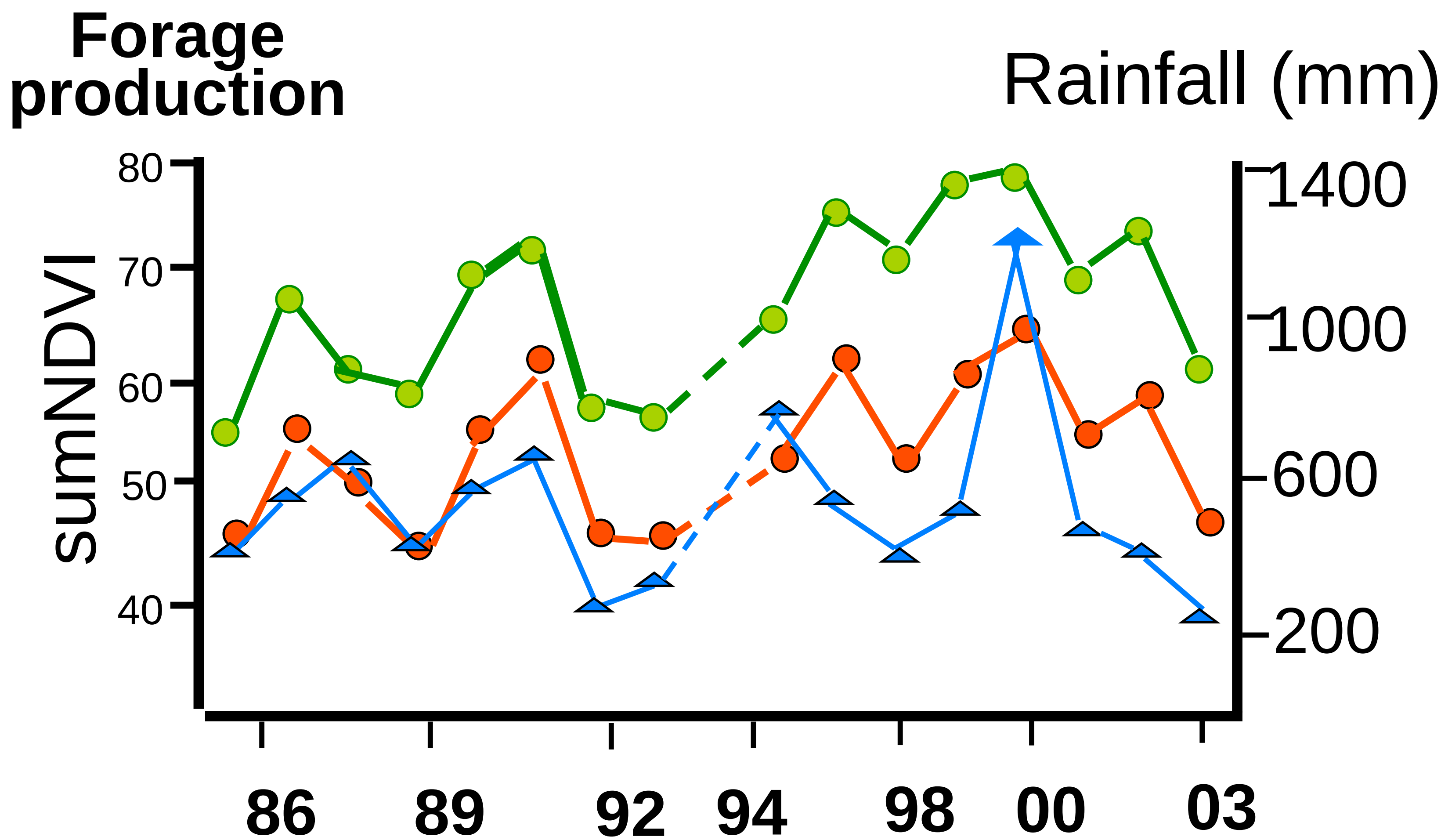
Reducing Productivity in the Drylands

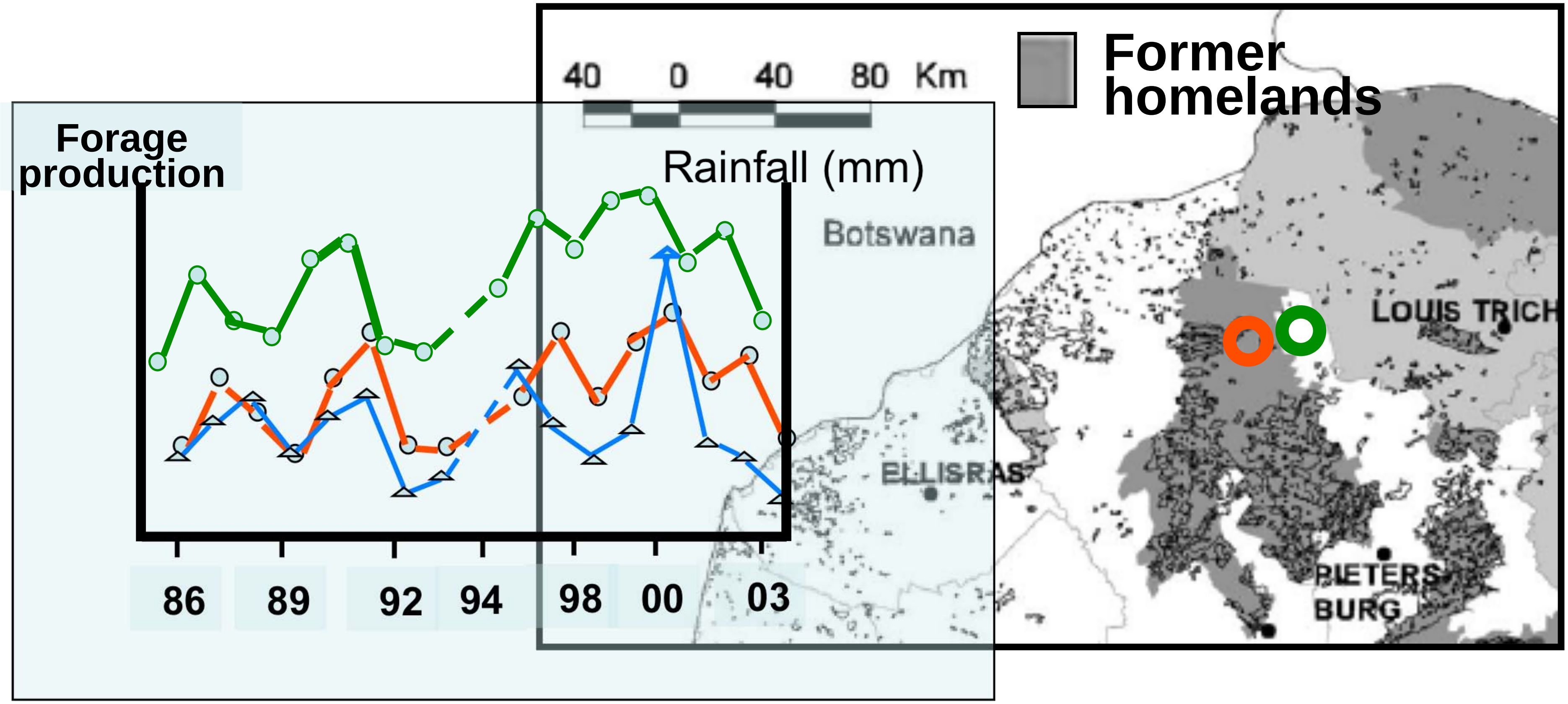
Productivity





40 0 40 80 Km
South Africa
LOUIS TRICH
ELLISRAS
PIETERS-
BURG


Forage production
Rainfall (mm)
sumNDVI
80
70
60
50
40
1400
1000
600
200
86
89
92
94
98
00
03



Desertification

Persistent

√ **Reduction in Biological Productivity** In the Drylands

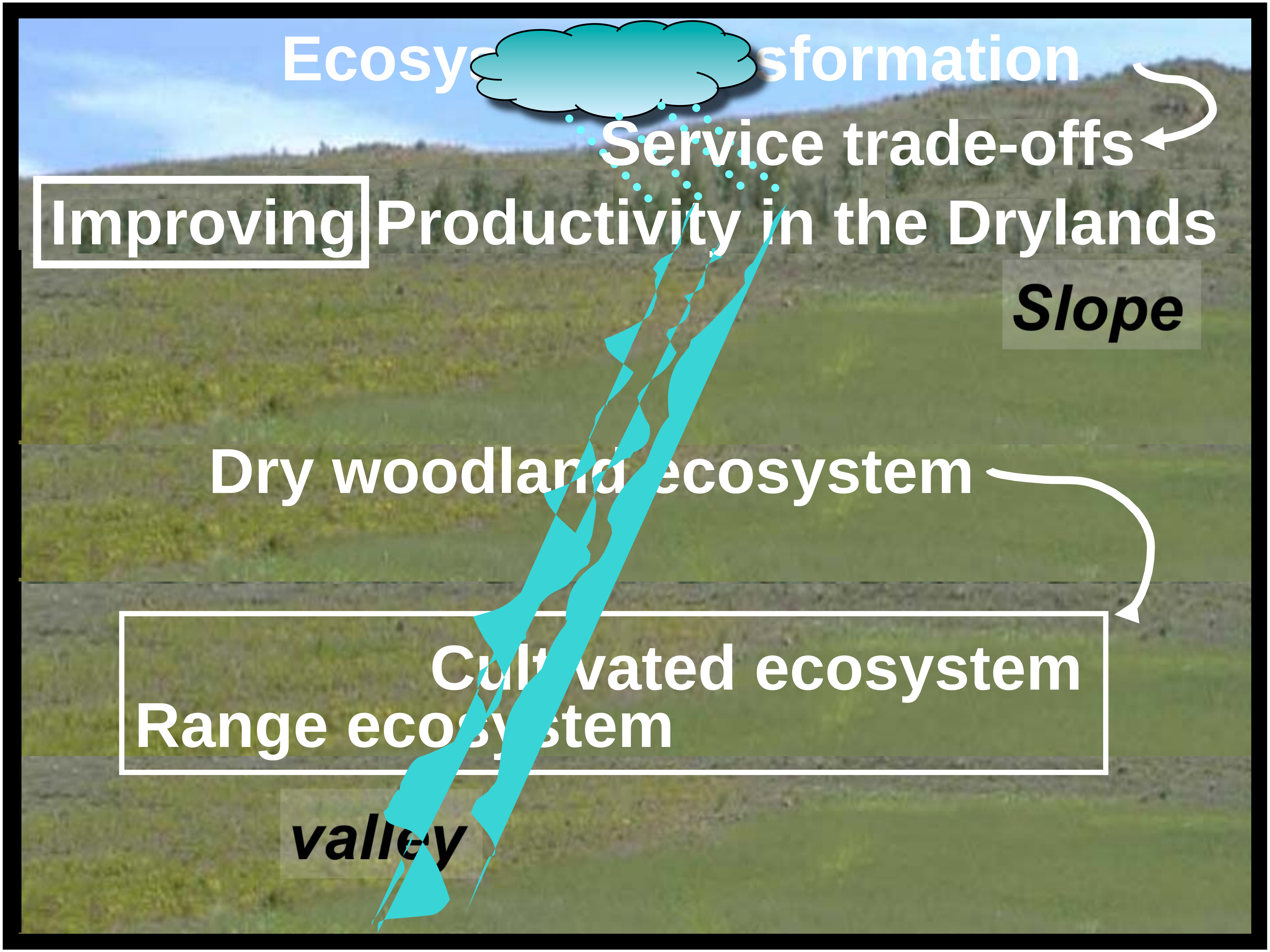
UN Convention to Combat Desertification

Millennium Ecosystem Assessment

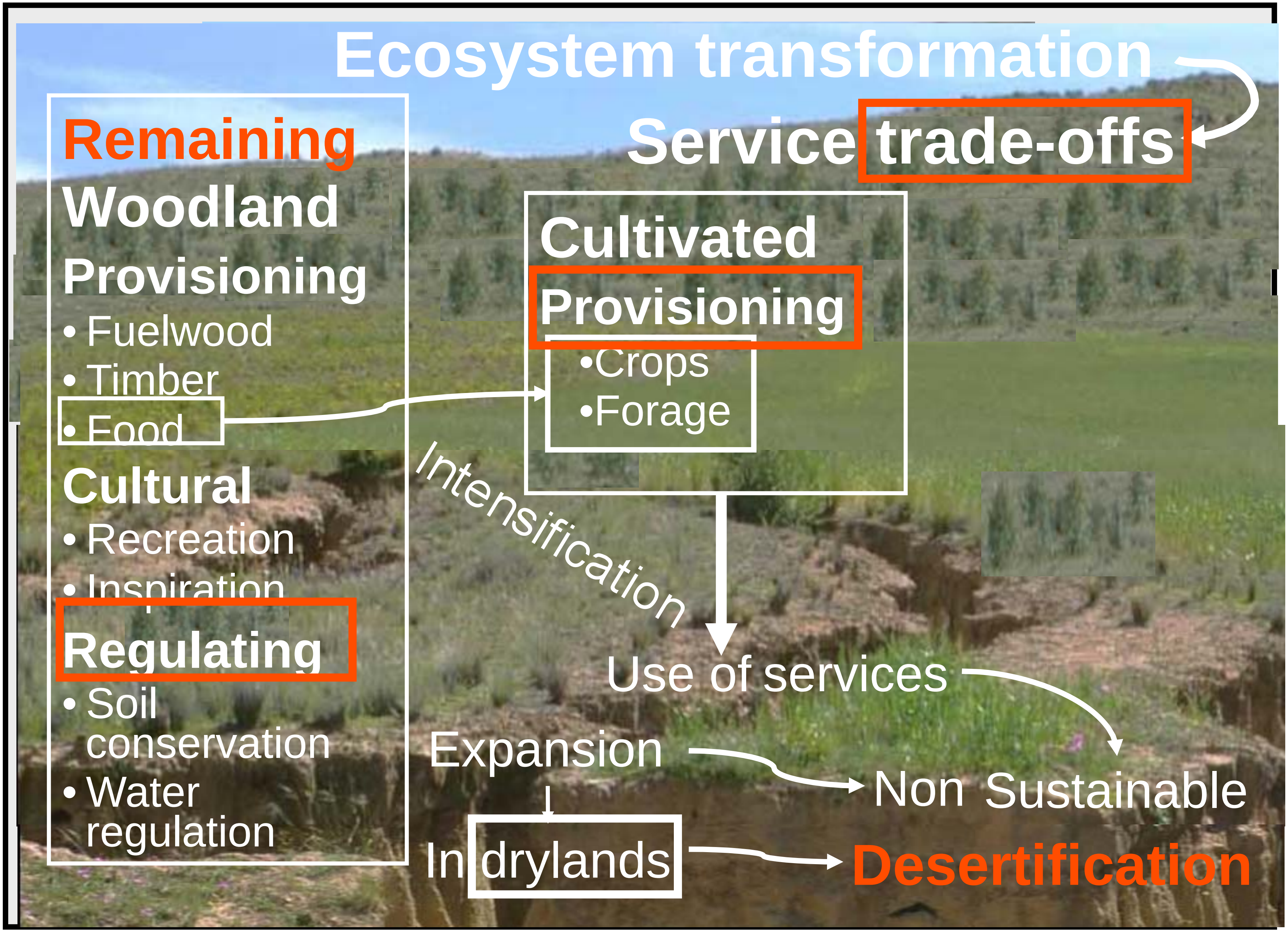
- Assess the consequences of dryland ecosystem **change** for **human well-being**
- Assess
  - The condition & trends in dryland **ecosystems**
  - i.e. the condition of the **services** they provide.

↓

Benefits people derive from ecosystems

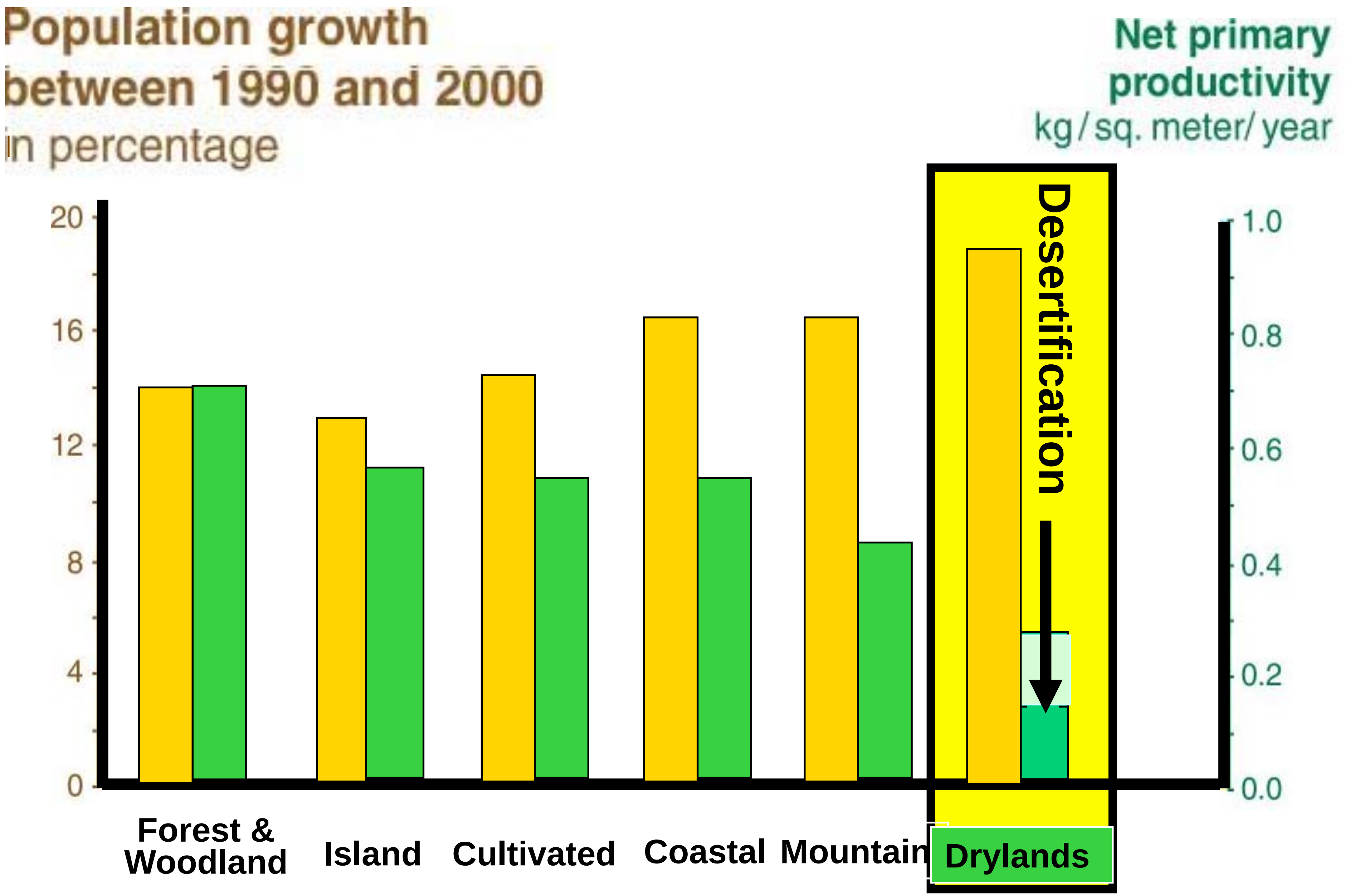


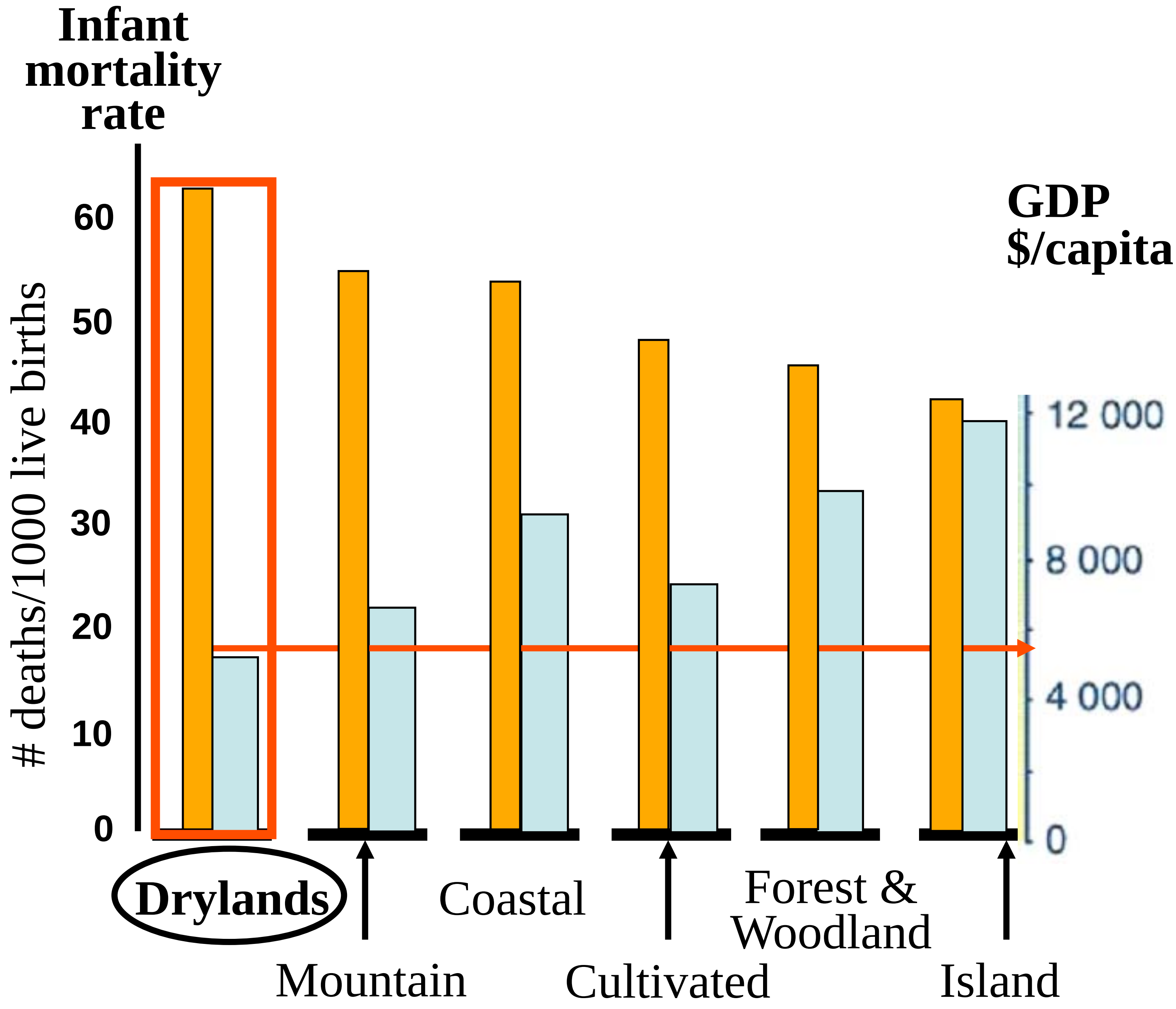
Ecosys
sformation
Service trade-offs
Improving Productivity in the Drylands
Slope
Dry woodland ecosystem
Cultivated ecosystem
Range ecosystem
valley

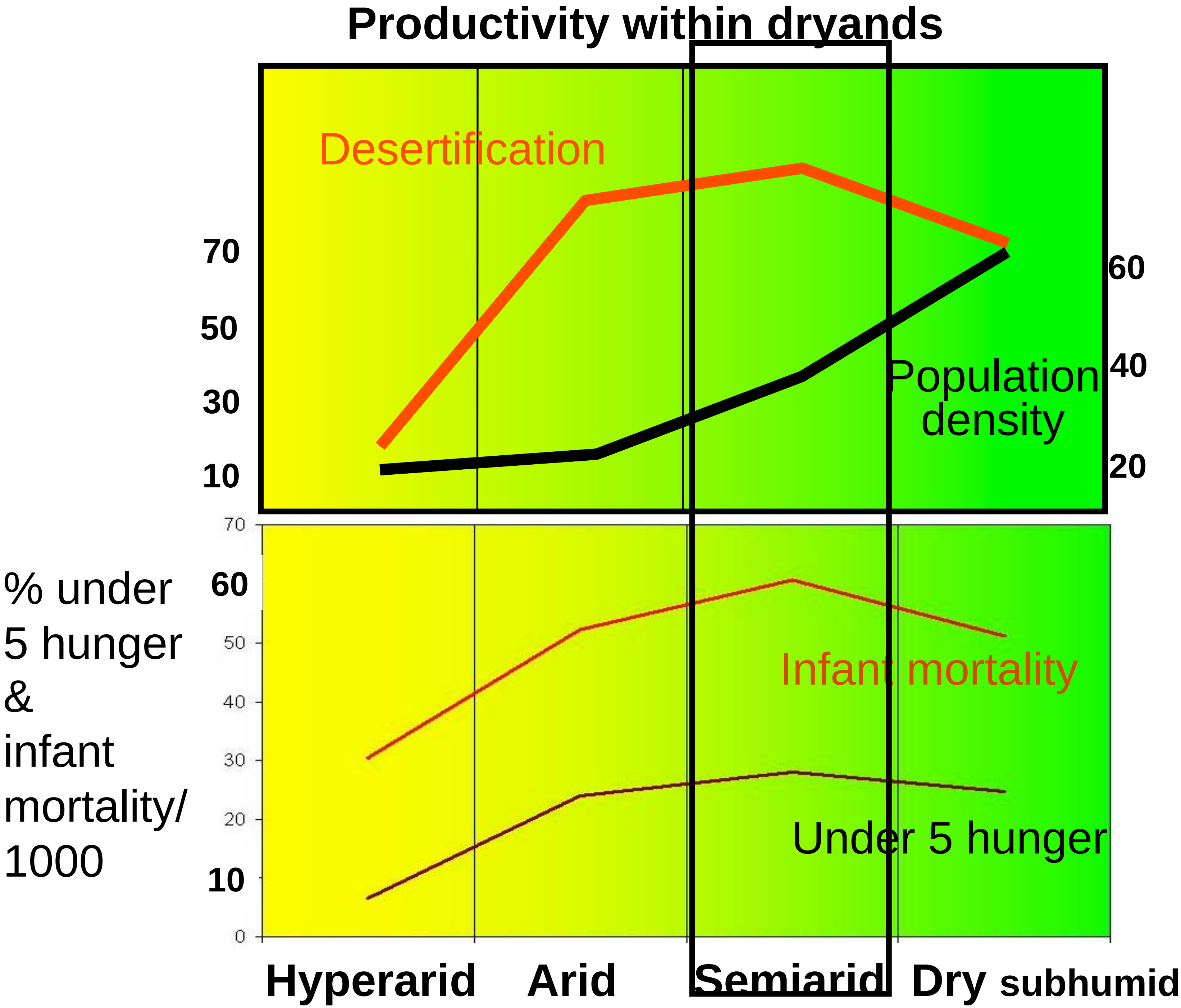


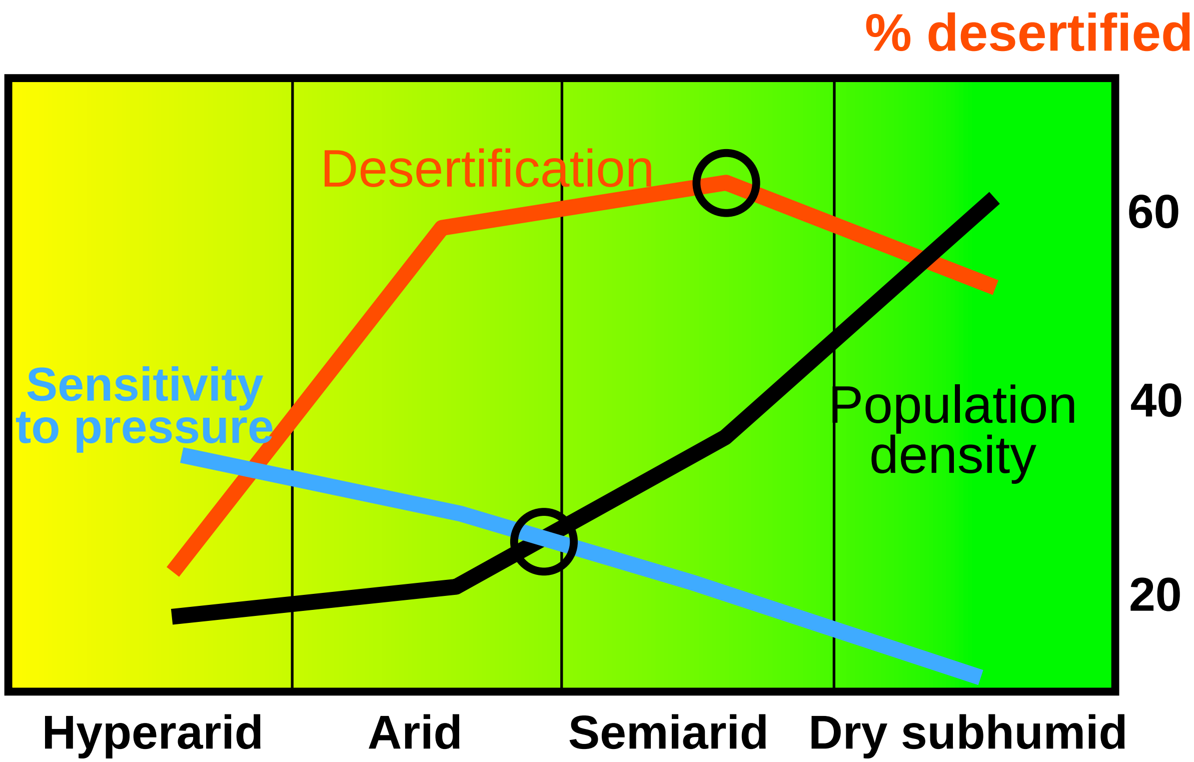
Ecosystem transformation
Service trade-offs
Remaining
Woodland
Provisioning
• Fuelwood
• Timber
• Food
Cultural
• Recreation
• Inspiration
Regulating
• Soil conservation
• Water regulation
Cultivated
Provisioning
•Crops
•Forage
Intensification
Use of services
Expansion
In drylands
Non Sustainable
Desertification

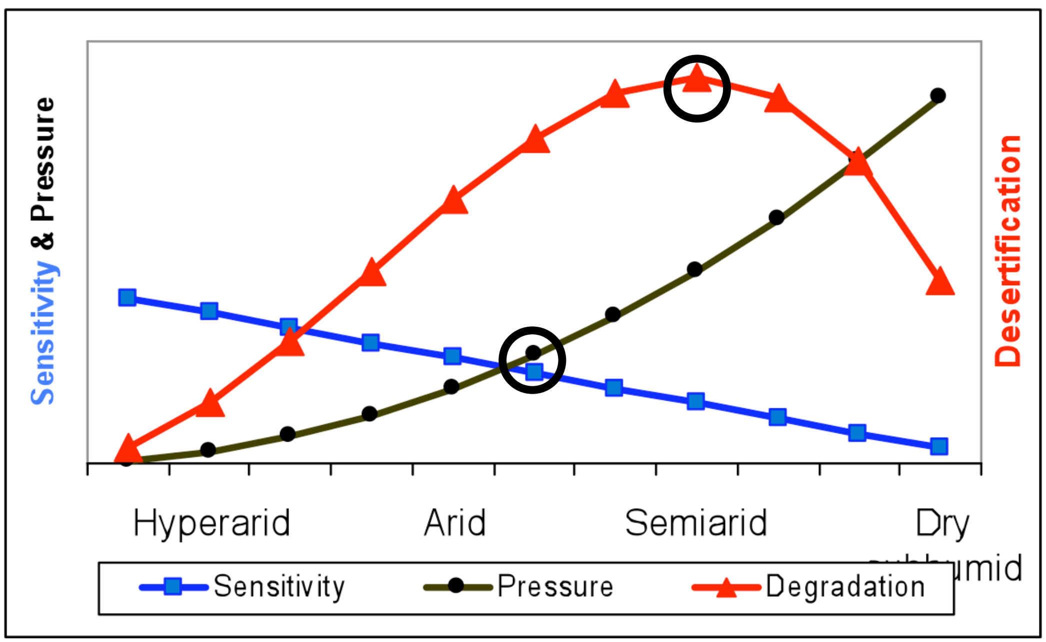
Productivity in dryands vs non-drylands




Infant mortality rate
deaths/1000 live births
60
50
40
30
20
10
0
GDP $/capita
12 000
8 000
4 000
0
Drylands
Mountain
Coastal
Cultivated
Forest & Woodland
Island


Productivity within dryands
Desertification
70
50
30
10
60
40
20
Population density
% under 5 hunger & infant mortality/ 1000
70
60
50
40
30
20
10
0
Infant mortality
Under 5 hunger
Hyperarid
Arid
Semiarid
Dry subhumid

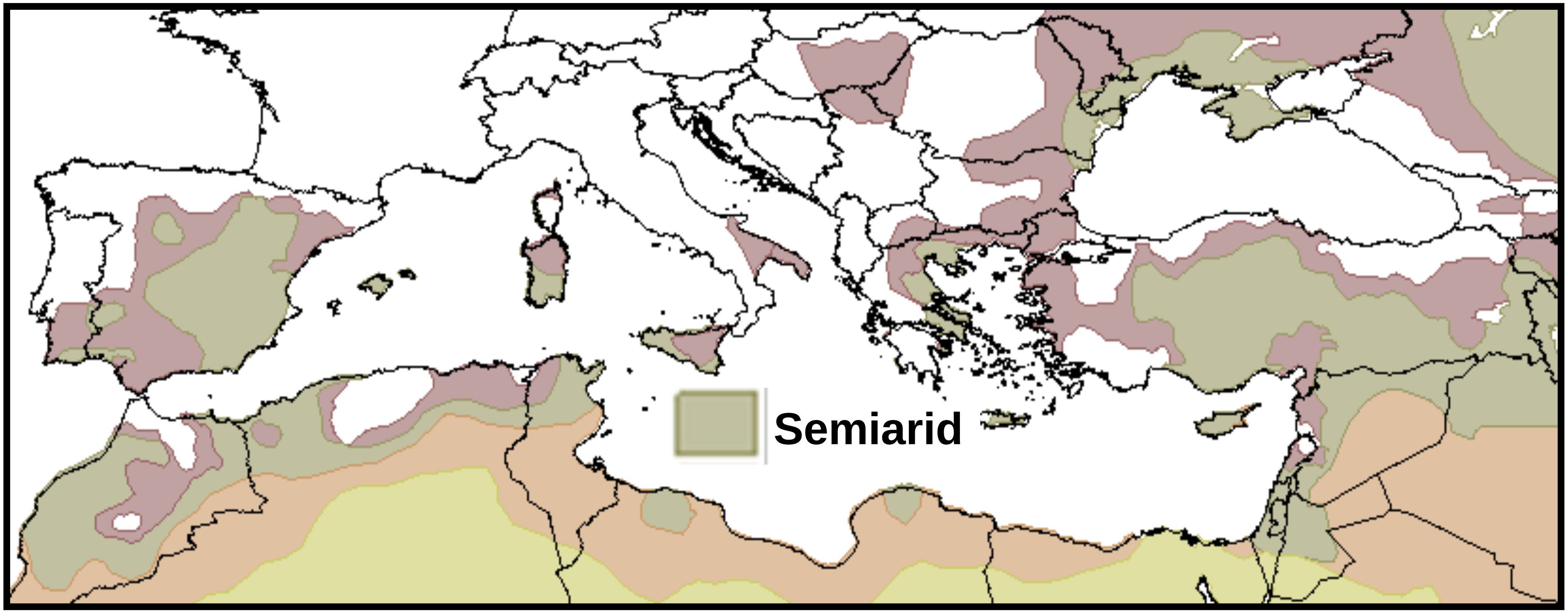




Desertification =

***f*(pressure X)**

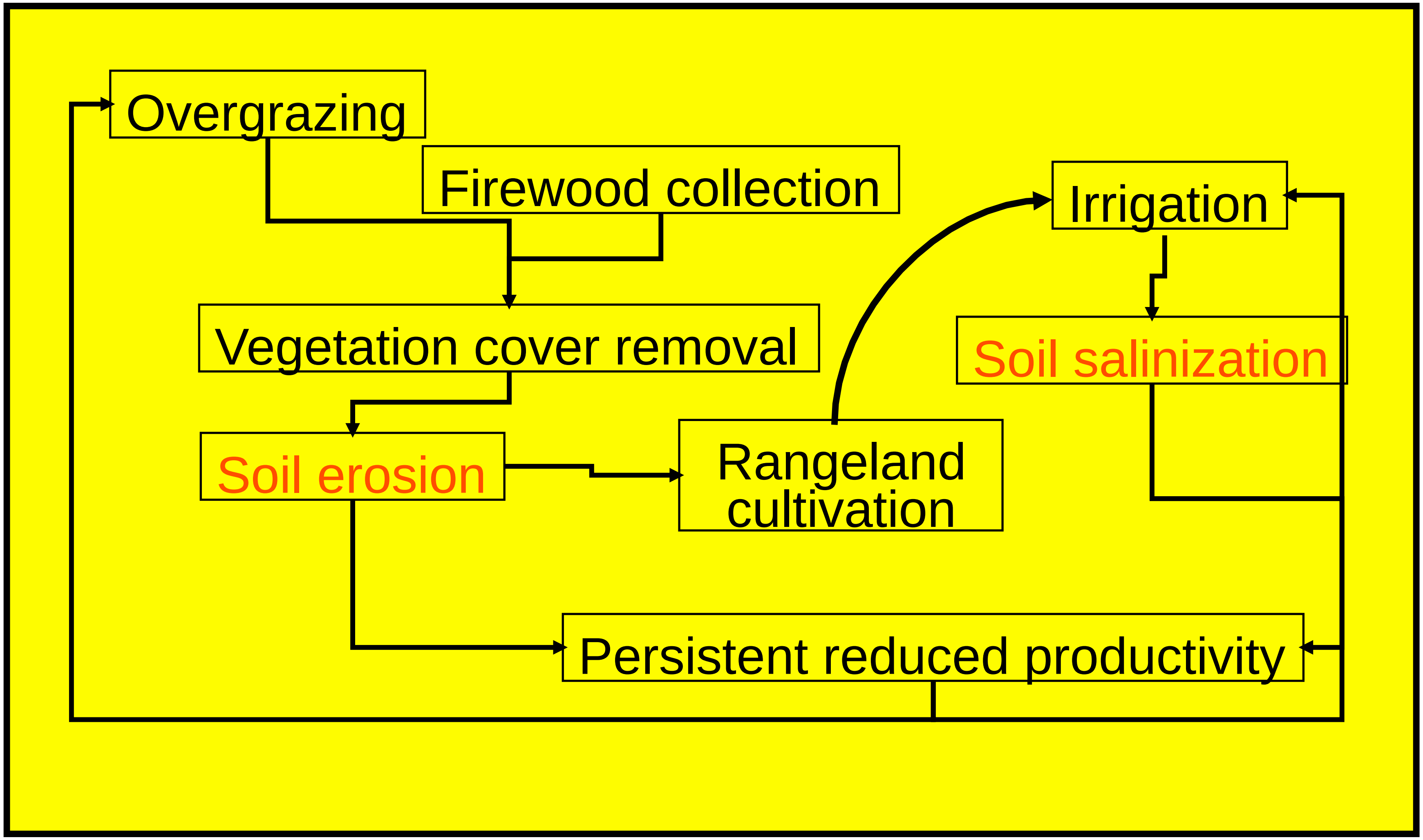
Mechanism of desertification - Human pressure

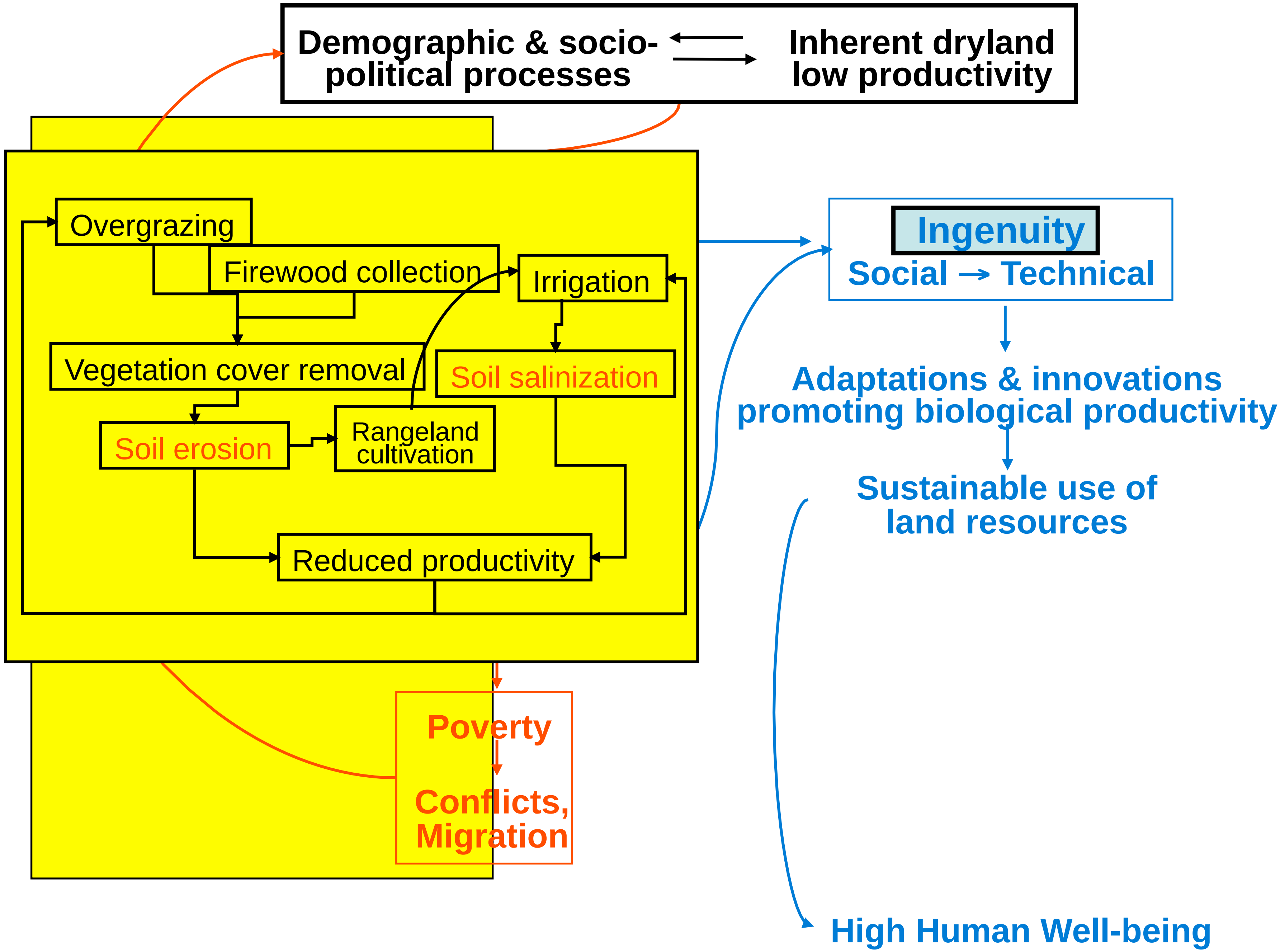


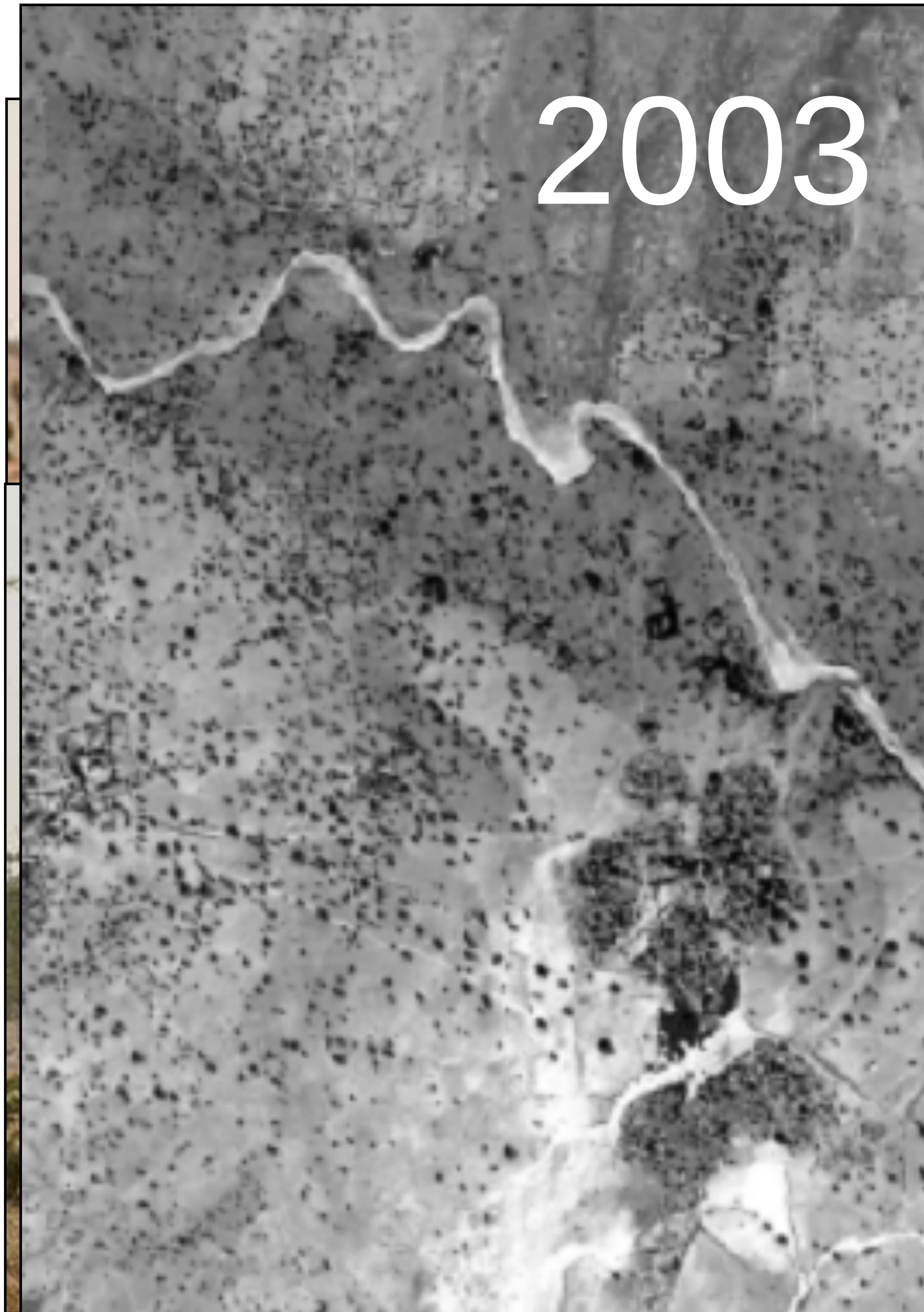
Large areas around Mediterranean → semiarid drylands

Hence most vulnerable to desertification

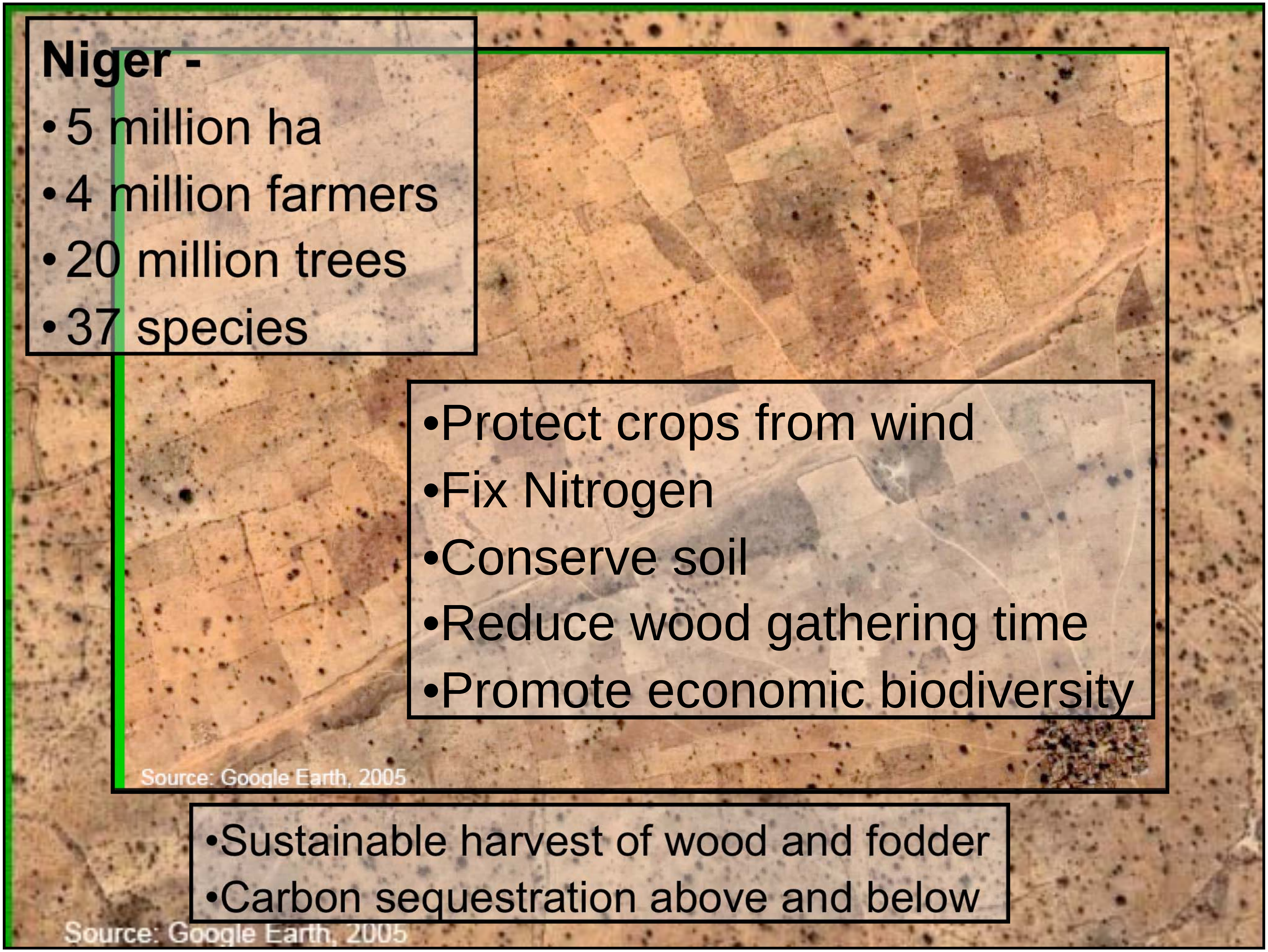
Mechanism of desertification - Human pressure

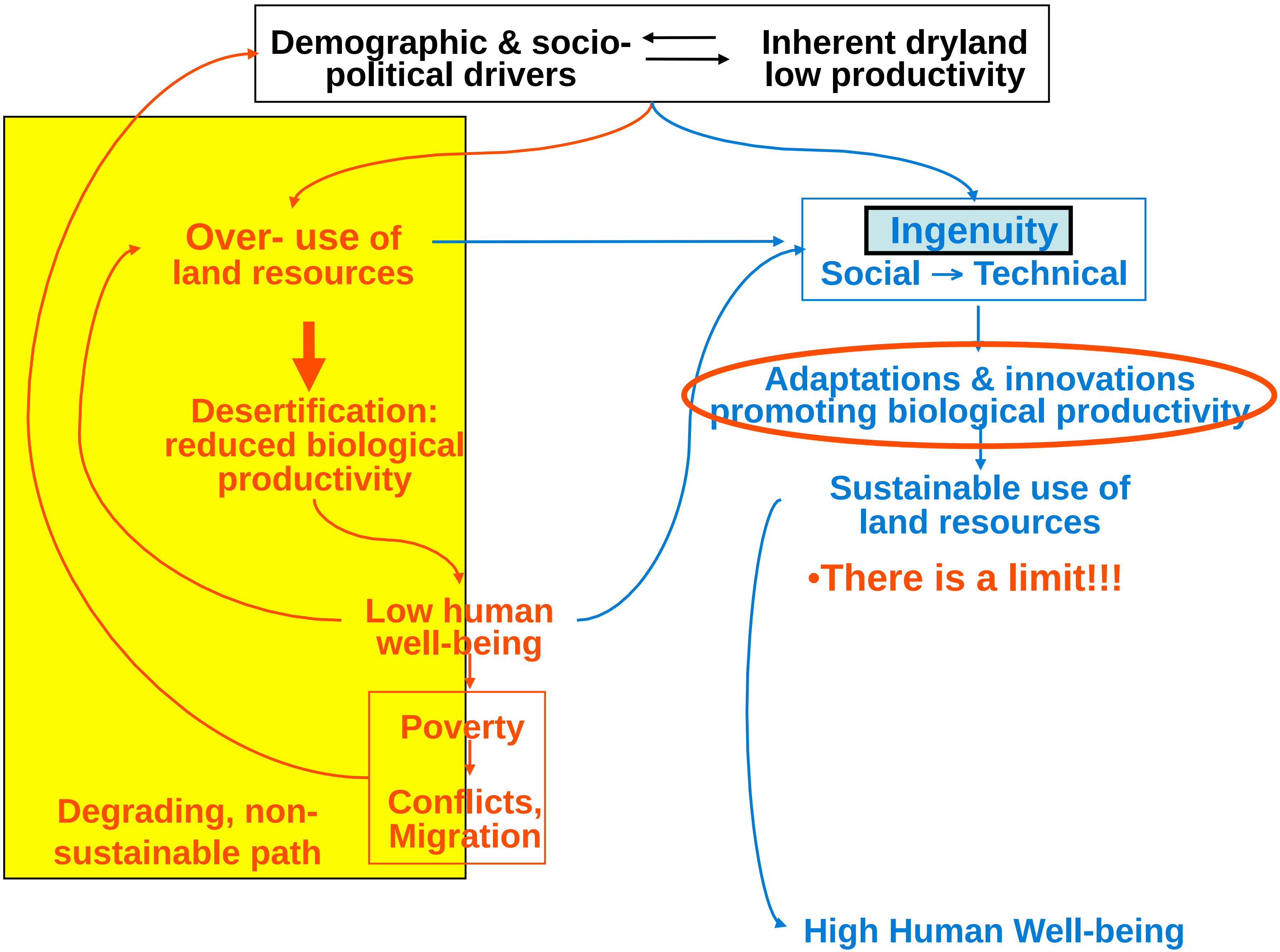

Overgrazing
Firewood collection
Irrigation
Vegetation cover removal
Soil salinization
Soil erosion
Rangeland cultivation
Persistent reduced productivity


Demographic & socio-political processes
Inherent dryland low productivity
Overgrazing
Firewood collection
Irrigation
Vegetation cover removal
Soil salinization
Soil erosion
Rangeland cultivation
Reduced productivity
Poverty
Conflicts, Migration
Ingenuity
Social → Technical
Adaptations & innovations promoting biological productivity
Sustainable use of land resources
High Human Well-being


2003

1975


Niger -
• 5 million ha
• 4 million farmers
• 20 million trees
• 37 species
•Protect crops from wind
•Fix Nitrogen
•Conserve soil
•Reduce wood gathering time
•Promote economic biodiversity
Source: Google Earth, 2005
•Sustainable harvest of wood and fodder
•Carbon sequestration above and below
Source: Google Earth, 2005



Demographic & socio-political drivers
Inherent dryland low productivity
Over- use of land resources
Desertification: reduced biological productivity
Low human well-being
Poverty
Conflicts, Migration
Degrading, non-sustainable path
Ingenuity
Social → Technical
Adaptations & innovations promoting biological productivity
Sustainable use of land resources
•There is a limit!!!
High Human Well-being

Prospects of agriculture **Global**

	M sq.km
Good quality cultivable land (2000)	**14.95**
Remaining for future cultivation[1]	**4.42**
Addition required by 2050 [2]	**8.90**
Missing good quality cultivable land	**4.48**

[1] Fischer et al. (2001) FAO [2] Tilman et al (2001) *Science*

Global population increase - drives pressures on drylands

Safriel & Adeel (2005) MA

Drylands **M sq.km**

	Dry subhumid & Semiarid		**Arid and hyperarid**	
Total area	**35.4**		**25.5**	
Already cultivated	**14.1**		**1.1**	
Urban, range & non-cultivable	**17.5**		**23.4**	
Remaining for cultivation	**3.8**	+	**1.0**	**= 5.1**

The **first** Green Revolution
(of the 60s)

Improved productivity

- High-yield seed varieties
- Fertilizers
- Pesticides
- Irrigation
- Infrastructure development

But -

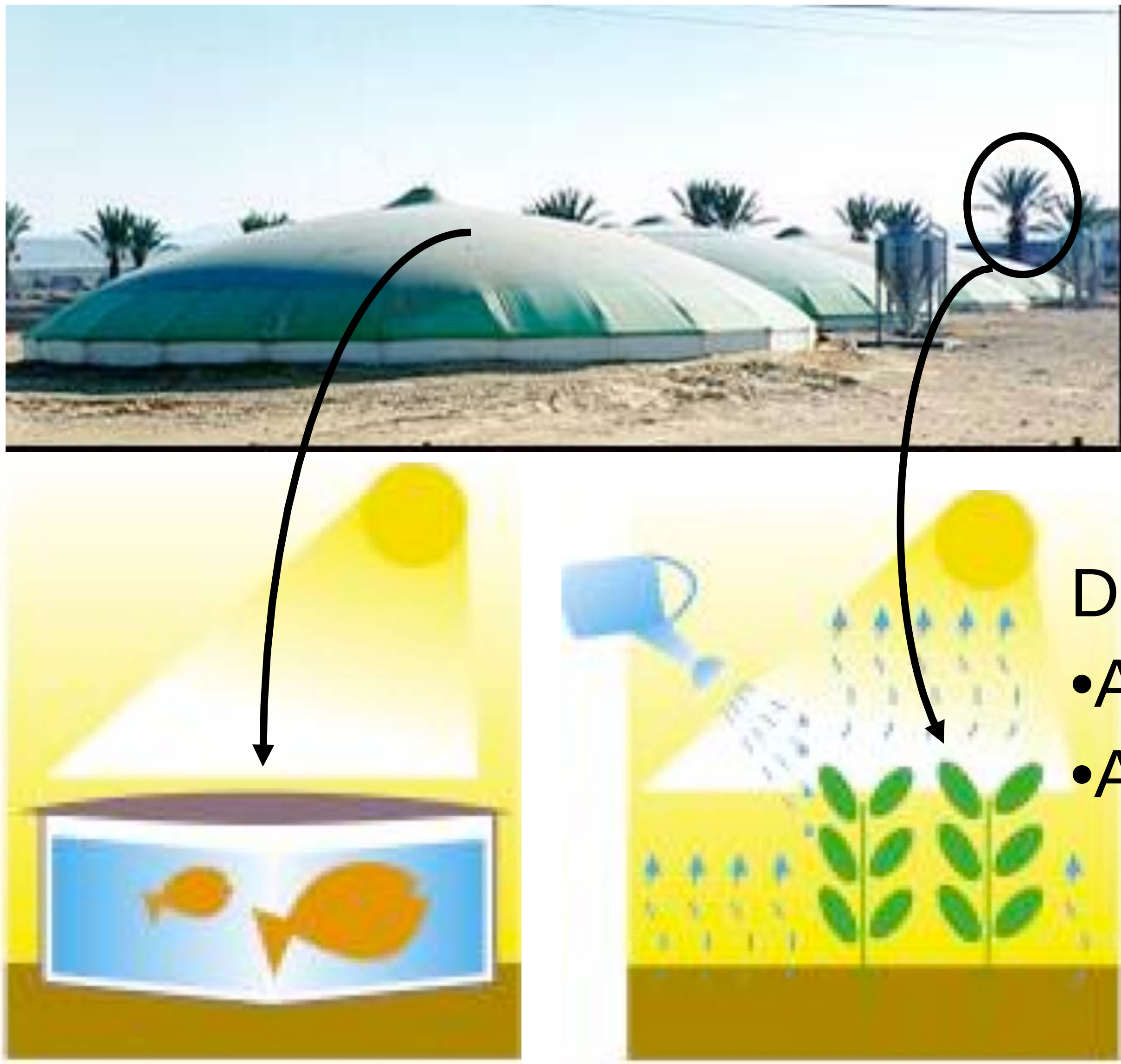
- Increased inequalities
- Reduced agro-biodiversity
- Pollution
- Salinization
- Dependency on external inputs
- Exposure to financial risks
- Increased plant vulnerability

A **second** Green Revolution for the drylands**?**

Improving dryland productivity

- Foster small-scale, low external input and low cost solutions
- Focus on local seed and livestock varieties
- Concentrate on local food systems
- Enhance land tenure
- Promote investments in successful local initiatives
- Mitigate against the negative impacts of international trade
- Reduce pressure on land and water resources

Replacing agriculture by aquaculture



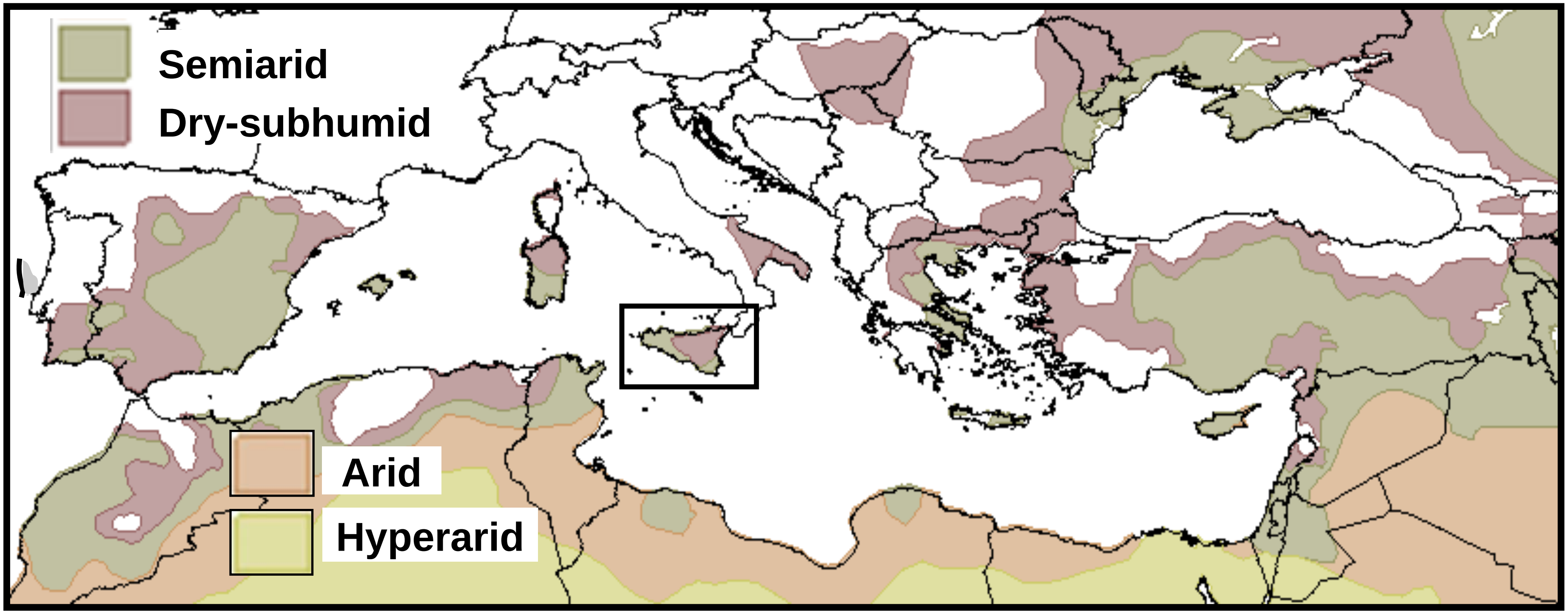
1 kg wheat –
750 litre of water
(Australia, semiarid)

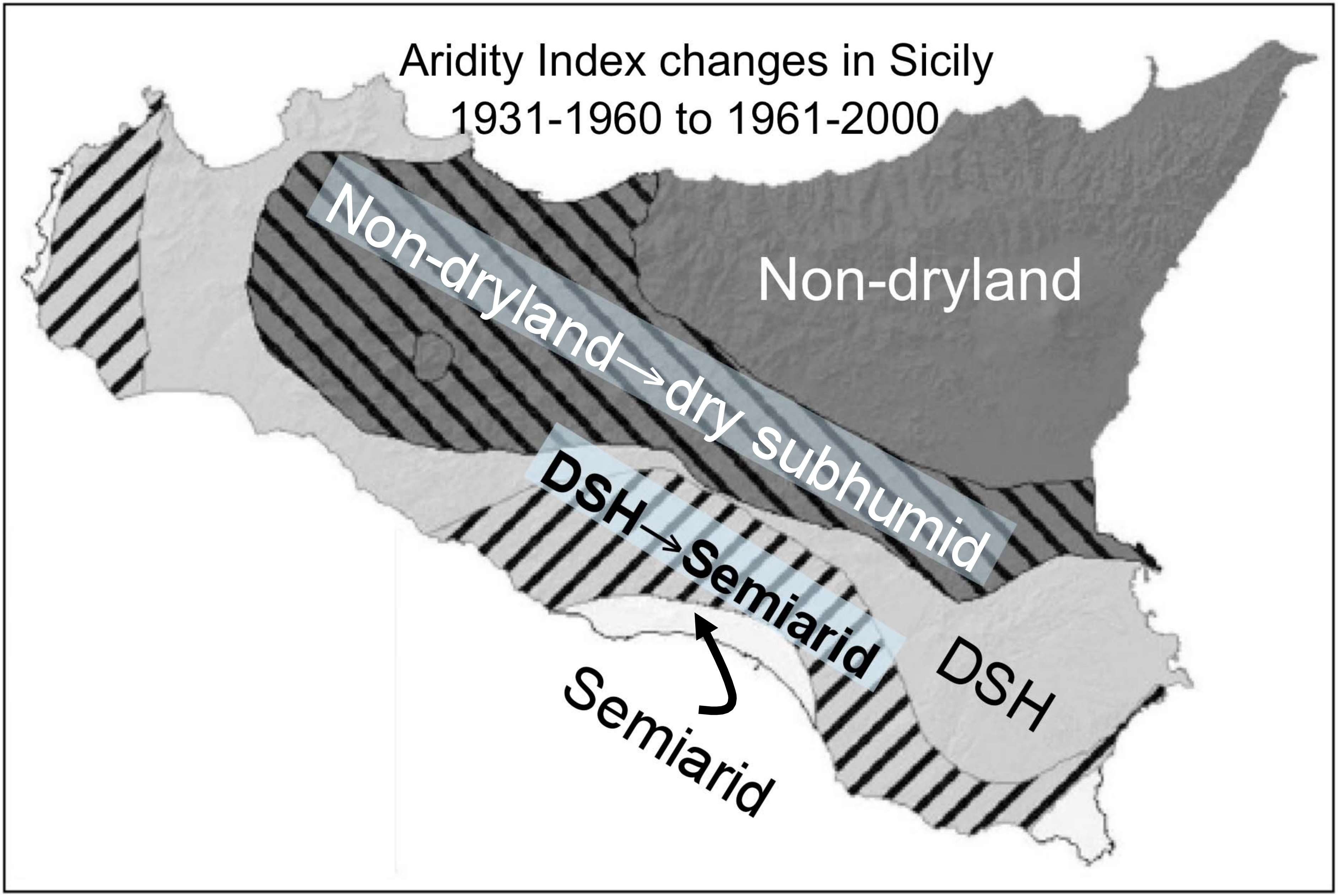
1 kg fish –
50 litre of water
(Israel, arid)

Does not compete on:

- Agricultural land
- Agricultural water

Dryland productivity and climate change





M. Sciortino *et al*. 2010 (submitted)

Improving Productivity in the Drylands

Developing dryland countries

Demographic control

↓

Reduce pressure on productivity in current drylands

Reduce rate of dryland expansion

Technology trasfer

Industrial countries

Living standard control

↓

Reduced emissions

↓

Climate change mitigation

Support local initiatives

- Foster small-scale, low external input and low cost solutions
- Focus on local seed and livestock varieties
- Concentrate on local food systems
- Focus on female agricultural producers
- Enhance land tenure

•Promote investments in successful local initiatives

- Reduce pressure on land & water resources