ENVIRONMENTAL POLICIES AND SOCIAL IMPACTS WITH REGARD TO LAND AND SOIL MANAGEMENT

by

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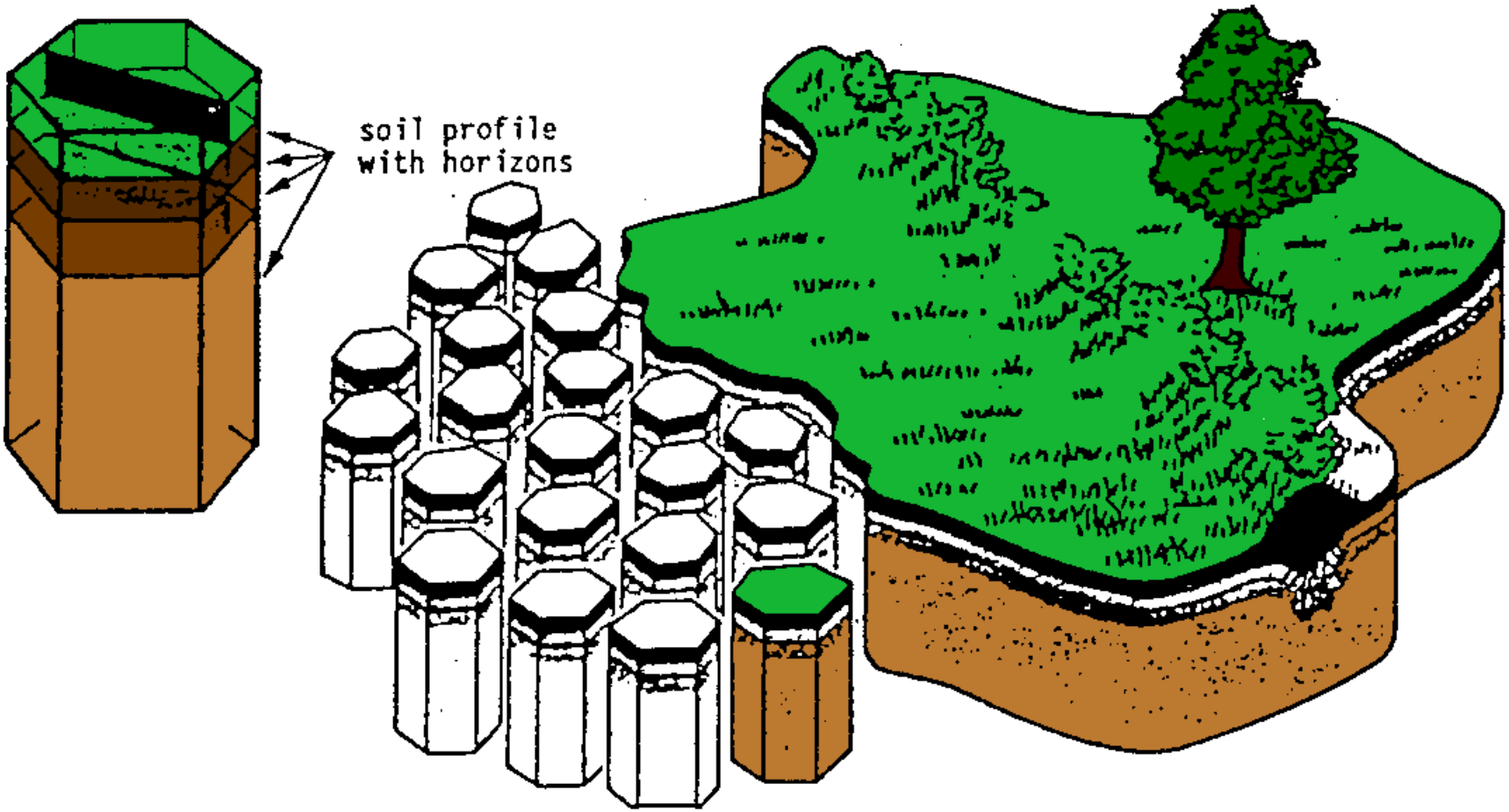
WHAT IS LAND AND SOIL MANAGEMENT?


soil profile
with horizons

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THERE ARE 6 MAIN USES OF LAND AND SOIL

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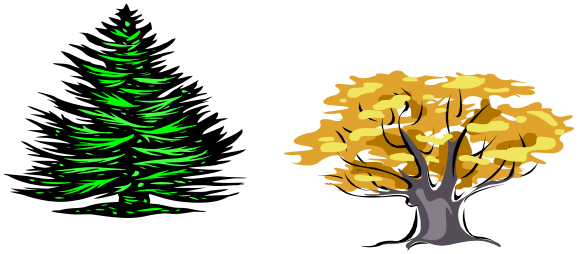
3 ECOLOGICAL FUNCTIONS AND USES:

1. PRODUCTION OF BIOMASS, ensuring food, fodder, renewable energy and raw materials

2. FILTERING, BUFFERING, and TRANSFORMATION between atmosphere, groundwater and plant cover protecting the environment

3. BIOLOGICAL HABITAT AND GENE RESERVE

VEGETATION



INPUT of solid, liquid and gaseous inorganic and organic compounds e. g. pollutants

SOIL

FILTRATION of soild and liquid compounds (mechanical)

UPTAKE
by plant roots

SOLUTION
by soil water

BUFFERING through adsorption and precipitation (physico-chemical)

TRANSFORMATION through alteration and decomposition (microbiological/biochemical)

OUTPUT
into the groundwater

GROUNDWATER

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2. FILTERING, BUFFERING, and TRANSFORMATION between atmosphere, groundwater and plant cover protecting the environment

3. BIOLOGICAL HABITAT AND GENE RESERVE

3 TECHNICAL, INDUSTRIAL AND SOCIO-ECONOMIC FUNCTIONS AND USES:

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1. PHYSICAL BASE FOR TECHNICAL, INDUSTRIAL AND SOCIO-ECONOMIC STRUCTURES AND THEIR DEVELOPMENT, e.g. industry, housing, transport, sports, recreation, dumping of refuse etc.
2. SOURCE OF RAW MATERIALS, WATER AND GEOGENIC ENERGY
3. GEOGENIC AND CULTURAL HERITAGE, forming an essential part of the landscape and concealing aleontological and archaeological treasures

THE SIX MAIN USES OF LAND AND SOIL

agricultural and

forest production

source of raw

materials

Infrastructure

geogenic and
cultural heritage,
forming

landscapes

filtering,
buffering,

transformation

gene reserve
and protection

WHAT ARE SOCIAL IMPACTS?

Social impacts can be caused by:

- **Natural** environmental processes, e.g. natural disasters, such as forest fires, extreme meteorological events, causing innundations and landslides, etc.
- **Human induced** environmental processes, such as depletion of natural resources, especially of soil and water, loss of biodiversity, sealing of land by urbanisation, industrialisation, tourism and climate change.

Social impacts caused by these processes are mostly complex, with environmental, technical, social, economic and even cultural implications.

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Two dimensions are of paramount importance:

- the dimension of space = the spatial scale of processes;
- the dimension of time = the time scale (pace, velocity) of processes

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In the following, we aim at social impacts caused by

- land degradation and desertification,
- water scarcity.

Land degradation and desertification are mainly caused by two types of unsuitable land use:

- competition in space and time between the six main uses of land and soil,

- unsustainable use of single soil functions . e.g. biomass production by agriculture.

COMPETITION BETWEEN THE 6 SOIL FUNCTIONS

agricultural and

forest production

source of raw

materials

Infrastructure

geogenic and
cultural heritage,
forming

landscapes

filtering,
buffering,

transformation

gene reserve
and protection

COMPETITION BETWEEN THE SIX MAIN USES OF SOIL AND LAND

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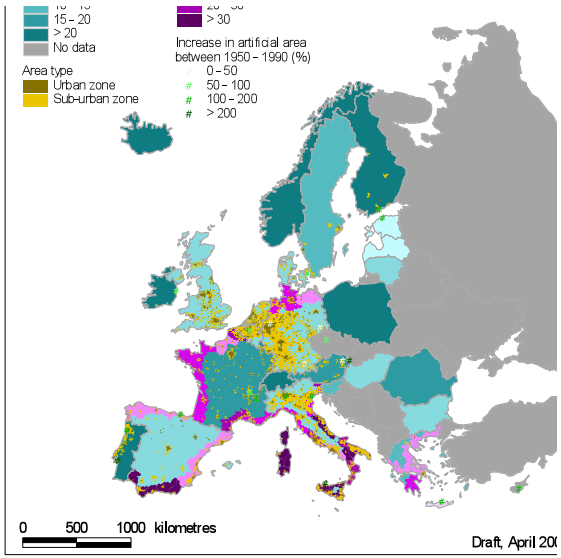
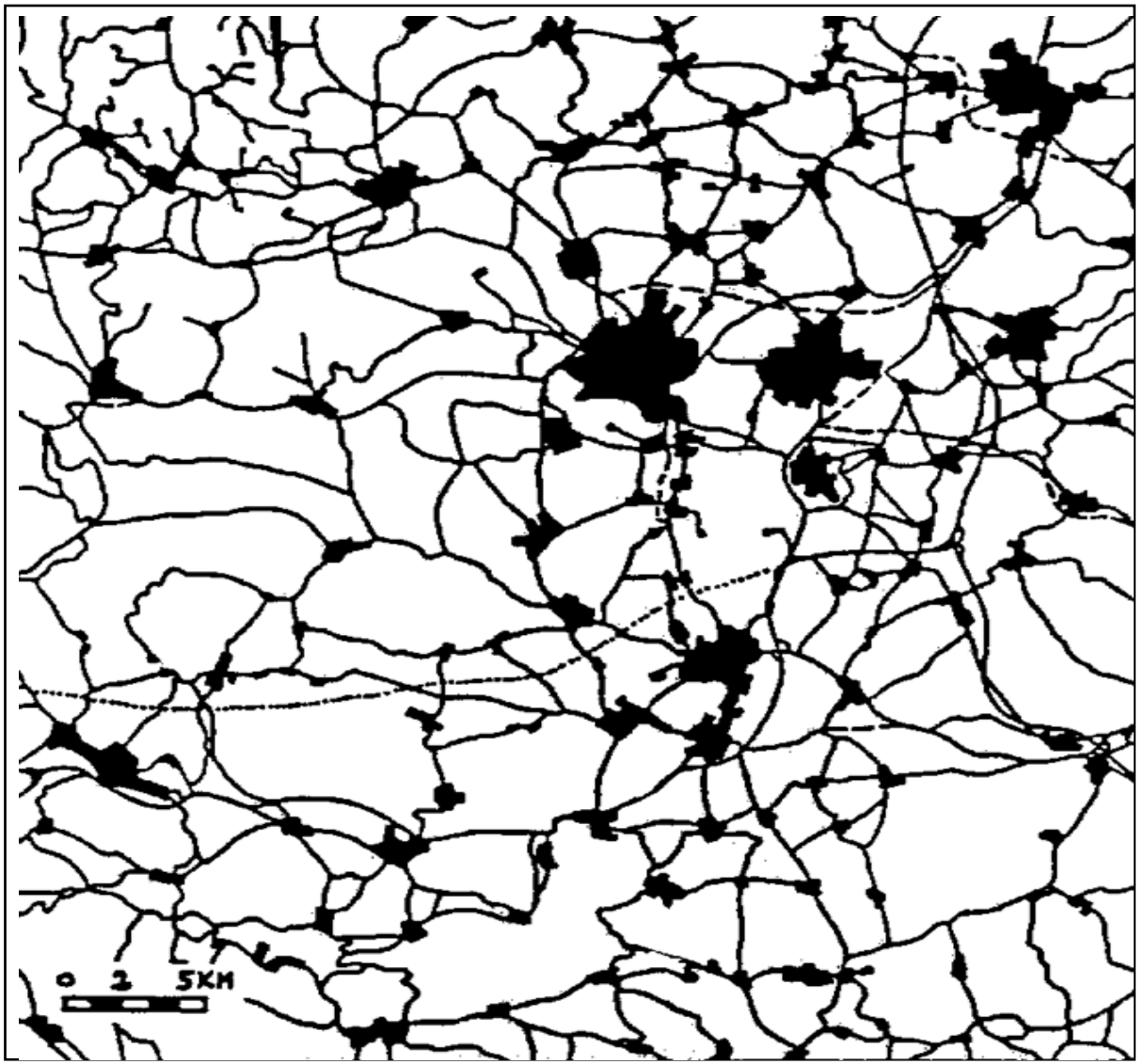
- Exclusive competition between the use of land for infrastructure, source of raw materials and geogenic and cultural heritage on the one hand and the agricultural and forest production, filtering, buffering and transformation activities as well as the soil as a gene reserve on the other;
- Intensive interactions between infrastructural land use and its development and agriculture and forestry, filtering, buffering and transformation as well as soil as a gene reserve;
- Intensive competition between the three ecological soil and land uses themselves.

European natural resources

Europe’s built environment


15 – 20
> 20
No data
Area type
Urban zone
Sub-urban zone
> 30
Increase in artificial area
between 1950 – 1990 (%)
0 – 50
50 – 100
100 – 200
> 200
0 500 1000 kilometres
Draft, April 20



Sealing of soils and landscapes by settlements and roads
(Example: south-western part of Baden-Württemberg, Germany)

SOCIAL IMPACTS CAUSED BY SEALING = URBANISATION, INDUSTRIALISATION AND TOURISM

1. Ecological-technical problems:

- no rainwater infiltration, only surface runoff (danger of flooding);
- high evaporation and water losses to the atmosphere;
- increased temperature levels through storage of radiation energy and reflection;
- loss of natural landscapes and biodiversity;

CONTRIBUTING TO DESERTFICATION

URBANISATION contd.

- production and accumulation of refuse and emission of dust and gases
- high demand of water in competition with other uses, e.g. agriculture, etc.

2. Social, economic and cultural constraints:

- loss of livelihood through loss of crop and pasture land
- emergence of new social groups
- competition between local population and tourists in water use and the use of terrestrial and aquatic landscapes etc.

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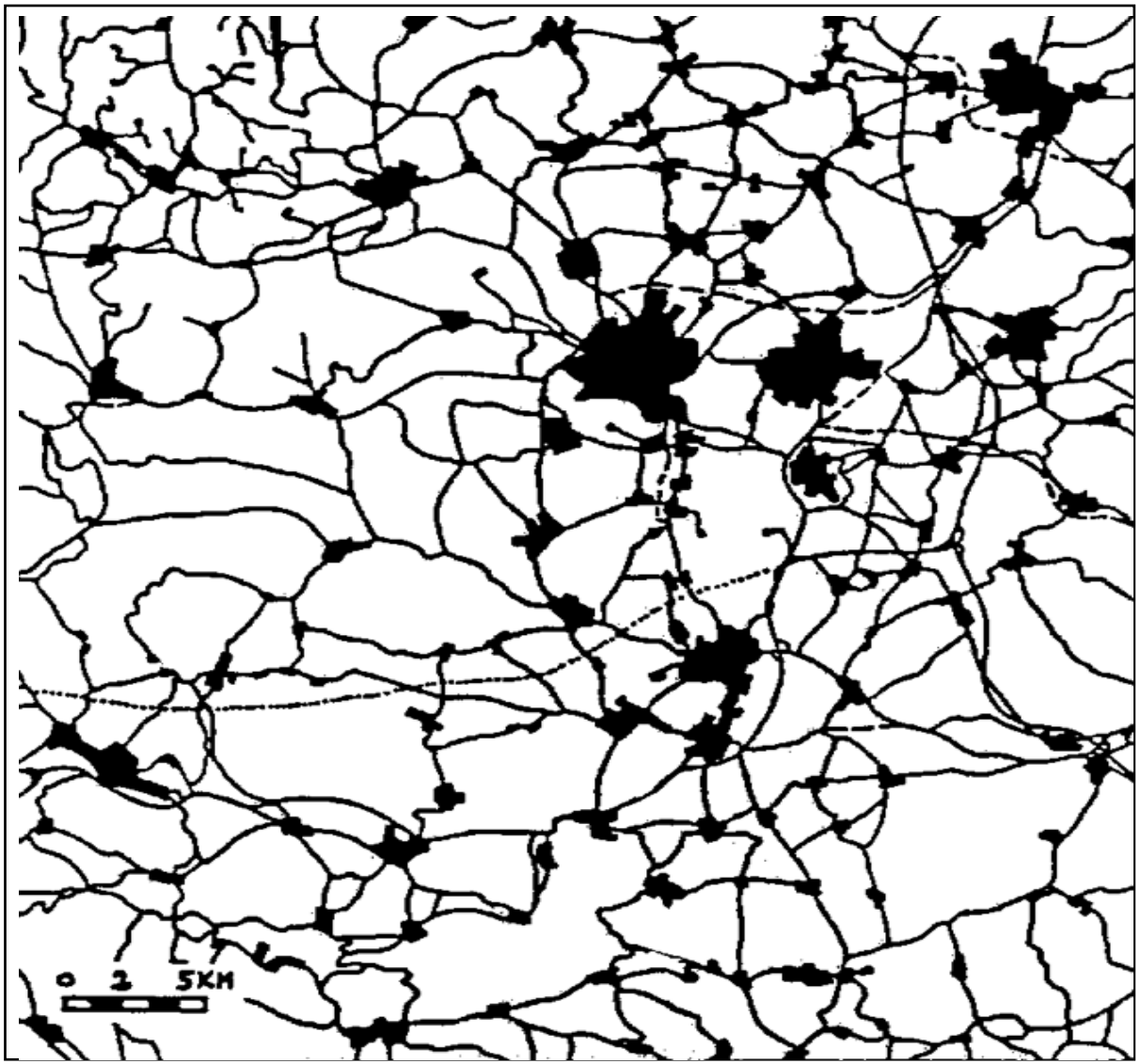

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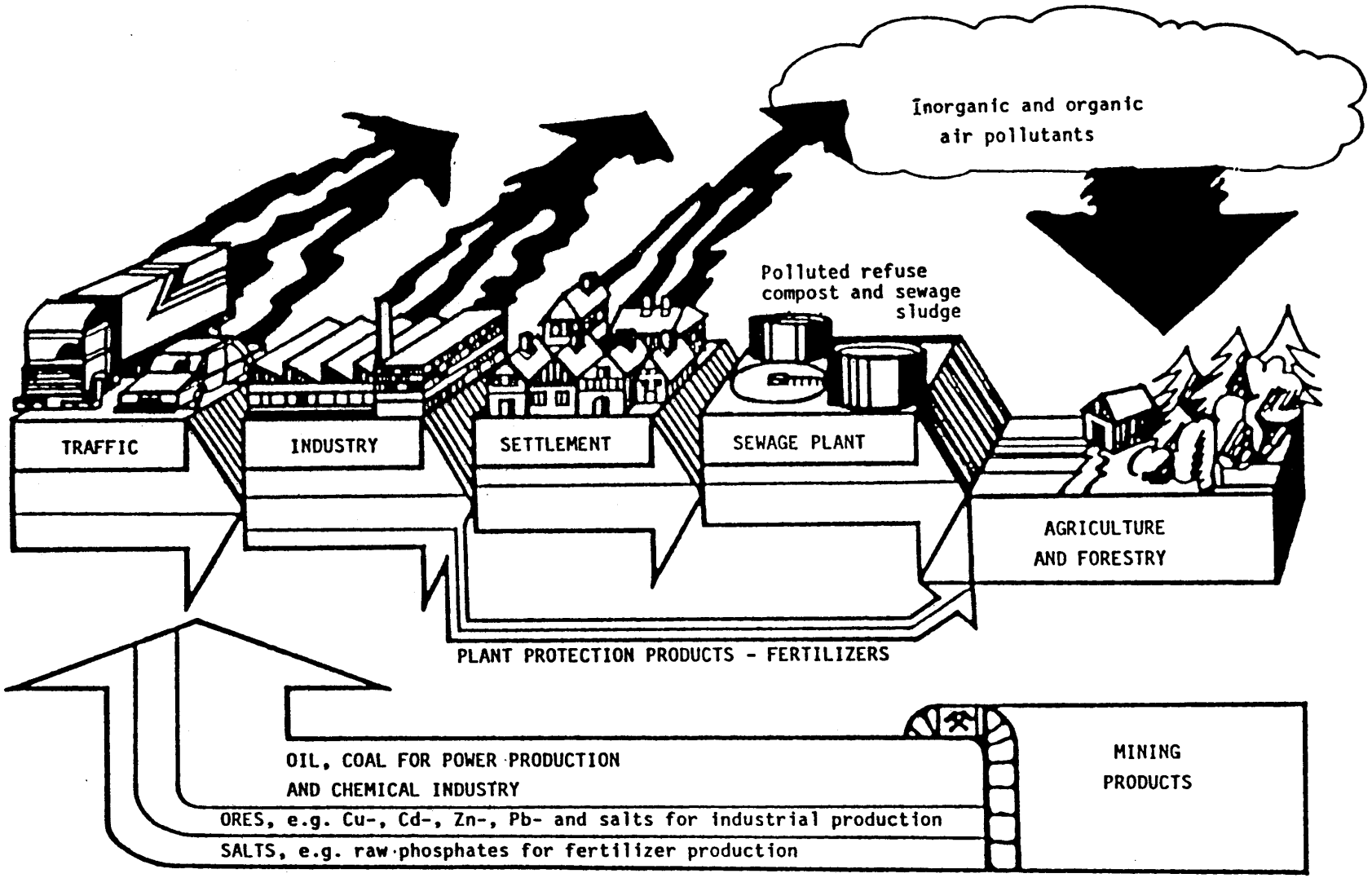
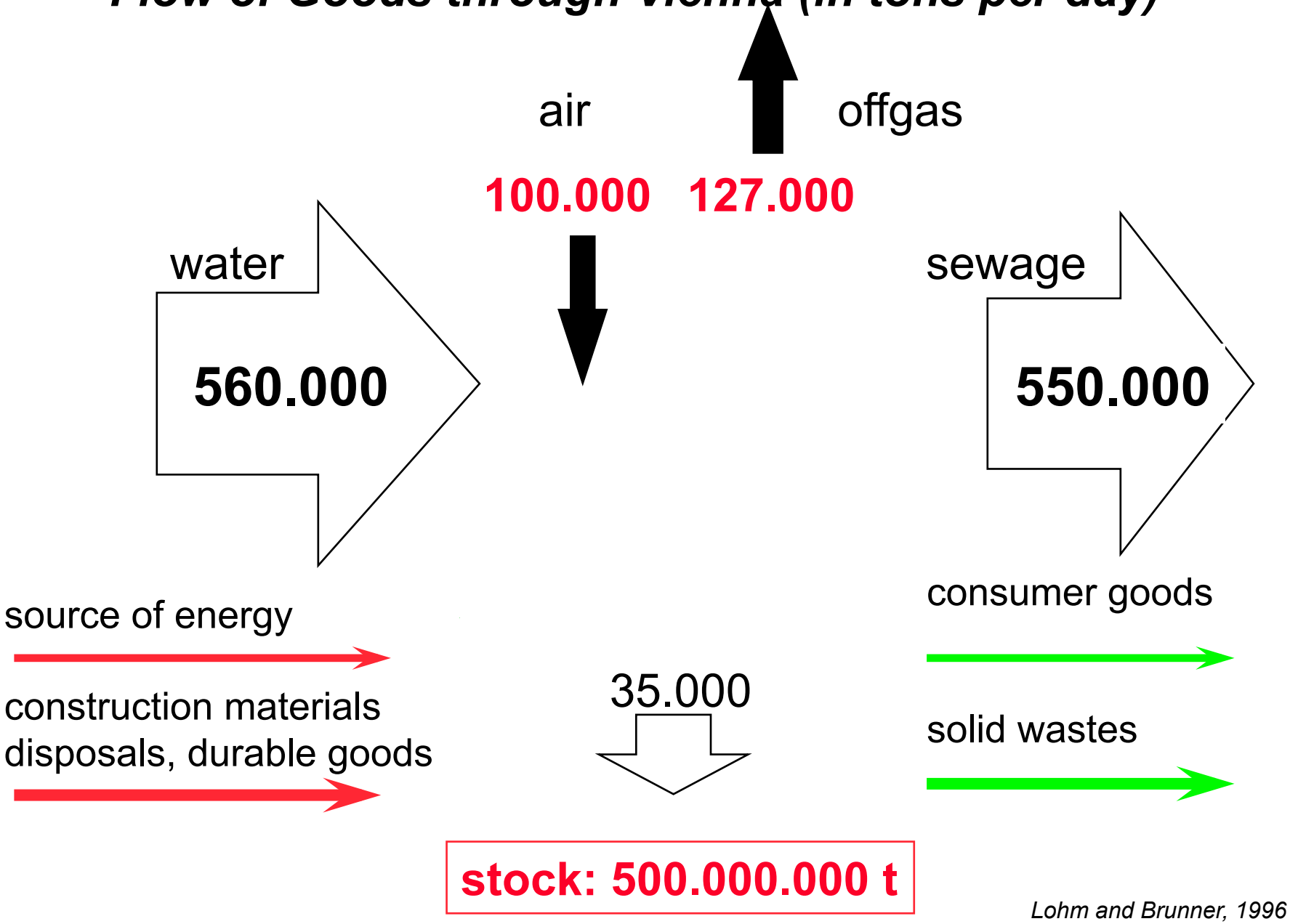
(Example: south-western part of Baden-Württemberg, Germany)



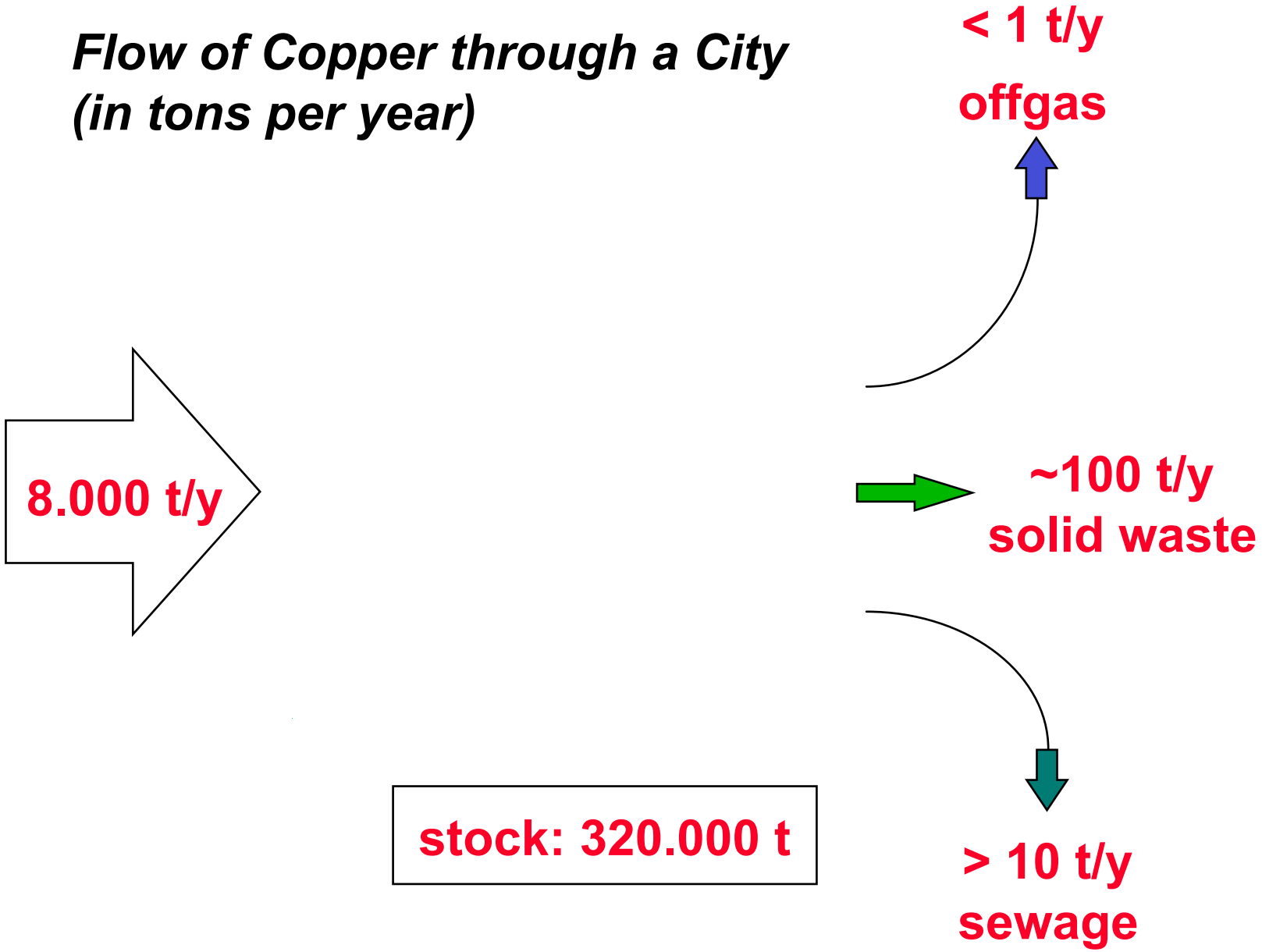
Soil pollution through excessive use of fossil energy and raw materials (Blum 1988)

Flow of Goods through Vienna (in tons per day)

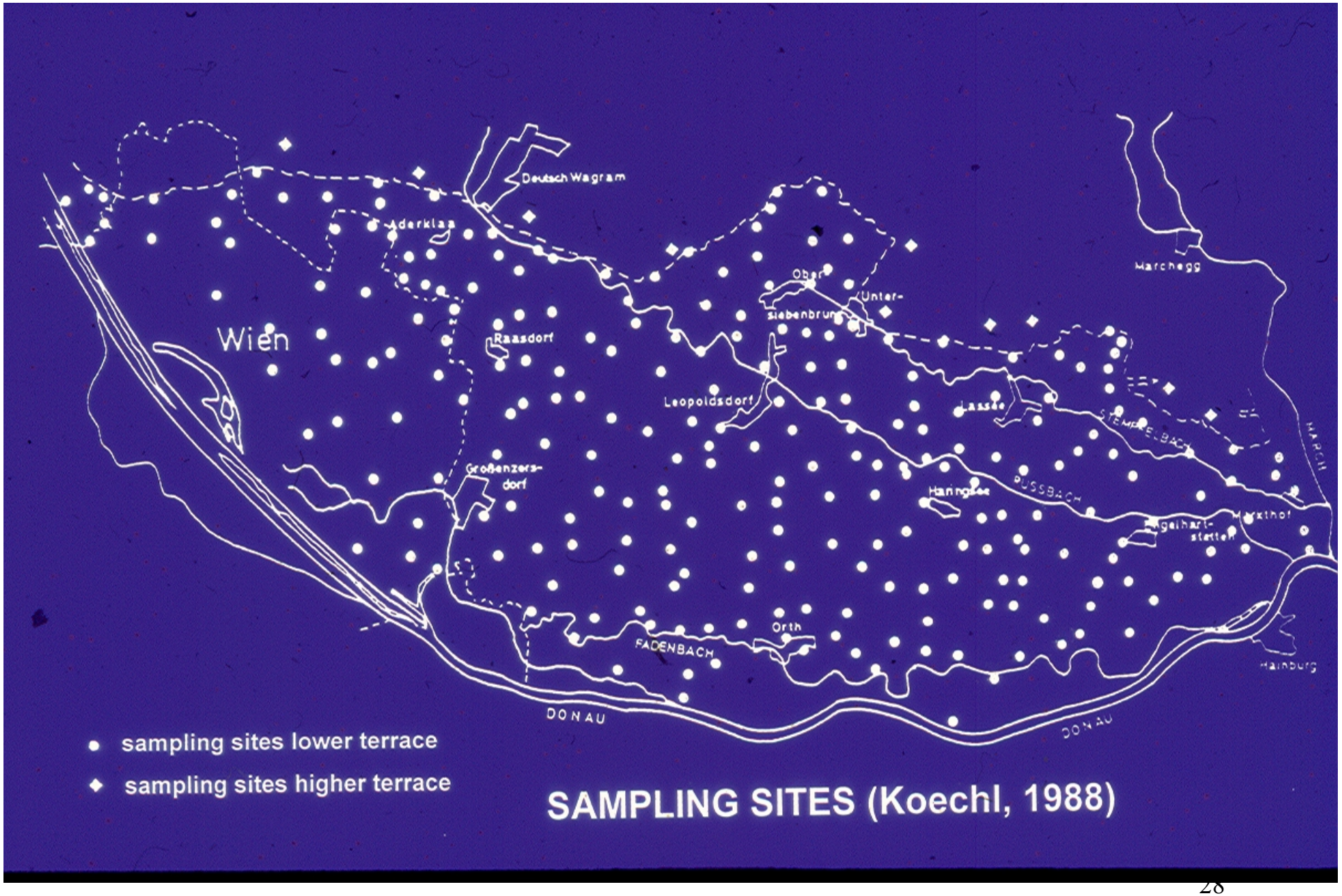


Lohm and Brunner, 1996

Flow of Copper through a City
(in tons per year)



Lohm and Brunner, 1996


Deutsch Wagram
Aderklaa
Wien
Raasdorf
Leopoldsdorf
Großenzers-
dorf
Ober-
Siebenbrunn
Unter-
Siebenbrunn
Marchegg
Lassee
STEMPFELBACH
MARCH
PUSSBACH
Haringsee
Engelhart-
stetten
Orth
FADENBACH
Hainburg
DONAU
DONAU
sampling sites lower terrace
sampling sites higher terrace
SAMPLING SITES (Koechl, 1988)

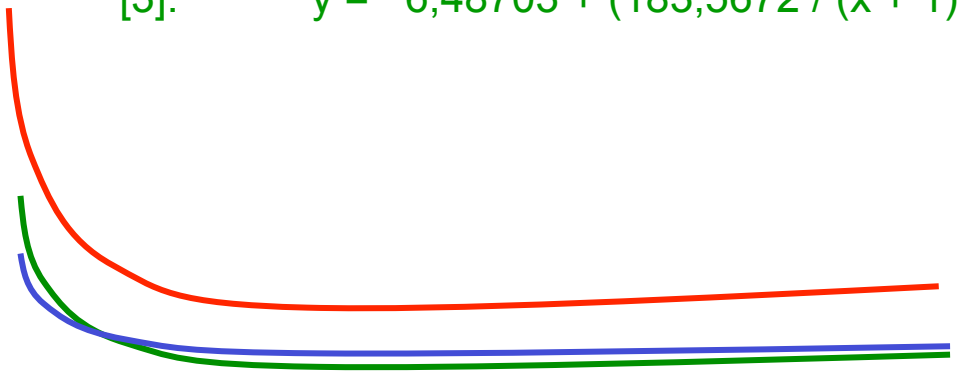
Changes of heavy metal content in tropsoils (0-20 cm) between metropolitan Vienna (Reichsbruecke) and the eastern state border (Koechl, 1988)

mg/kg Boden

[1]: $y = 33{,}69184 + (274{,}8812 / (x + 1)) + 0{,}01072605\ x^2$ $r = 0{,}55$ **

[2]: $y = 14{,}00818 + (98{,}1907 / (x + 1)) + 0{,}00357659\ x^2$ $r = 0{,}41$ **

[3]: $y = 6{,}48703 + (183{,}5672 / (x + 1)) + 0{,}00462333\ x^2$ $r = 0{,}51$ **



[1] Zinc

[2] Copper

[3] Lead

km

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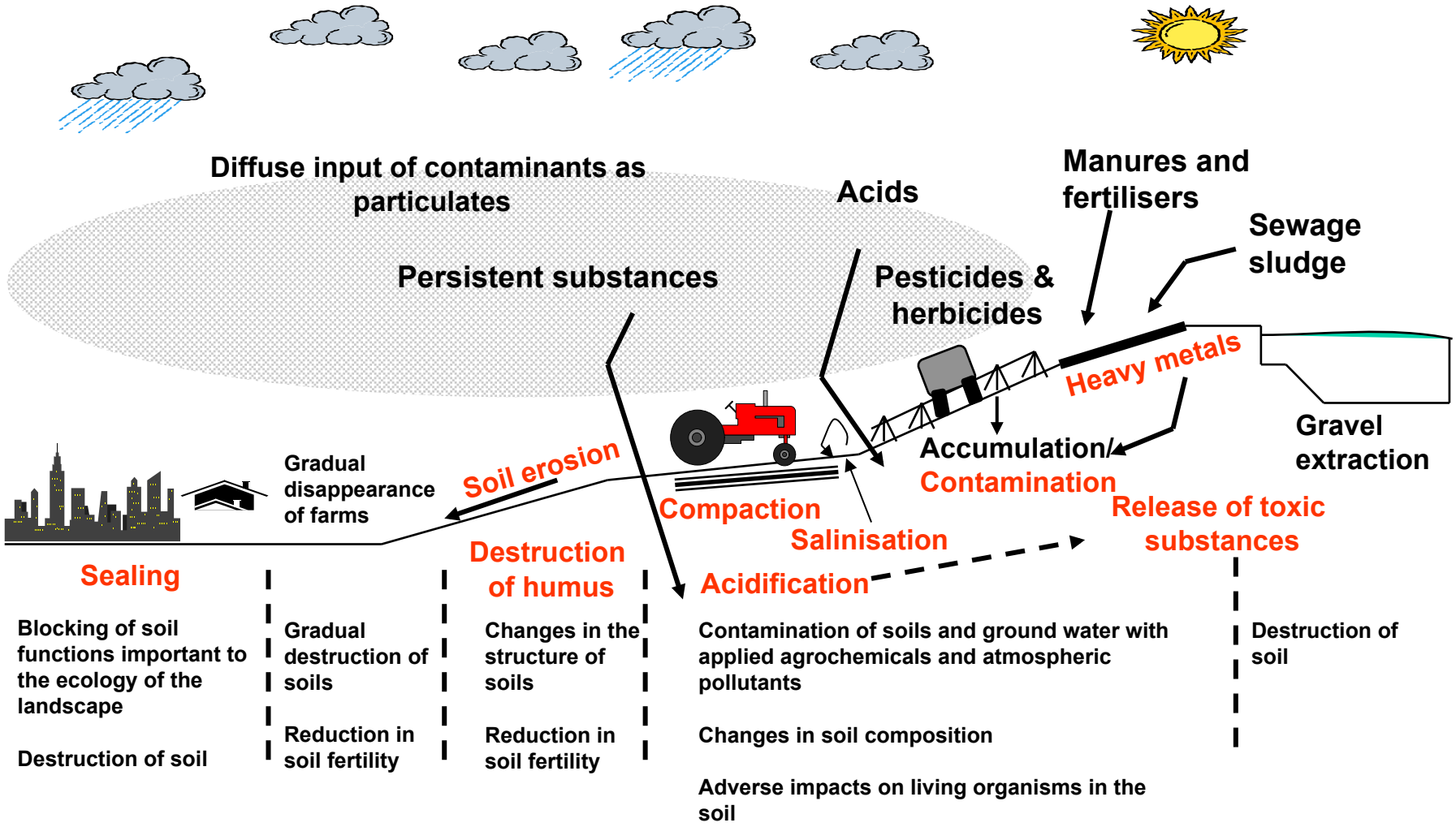
IMPACTS OF UNSUSTAINABLE AGRICULTURAL LAND USE

The impact of human activities on soil



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THREATS TO GROUND WATER, SURFACE WATER AND COASTAL AND ESTUARINE ENVIRONMENTS

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CONFLICTS THROUGH THE DEMAND OF WATER FOR DIFFERENT AGRICULTURAL PRODUCTION LINES:

- FOOD AND FODDER (FOOD SECURITY)
- BIOFUELS (ETHANOL AND BIODIESEL)

Competition for water, example water use in Spain (D. Barcelo 2008):

for 1 kg maize = 770 l water

for 3 kg maize = 2.3 m³ water

3 kg maize = 1 l ethanol

1 m³ water = 0.4 €

2.3 m³ water = ~ 1 €

1 l ethanol = 1 € for water use only!

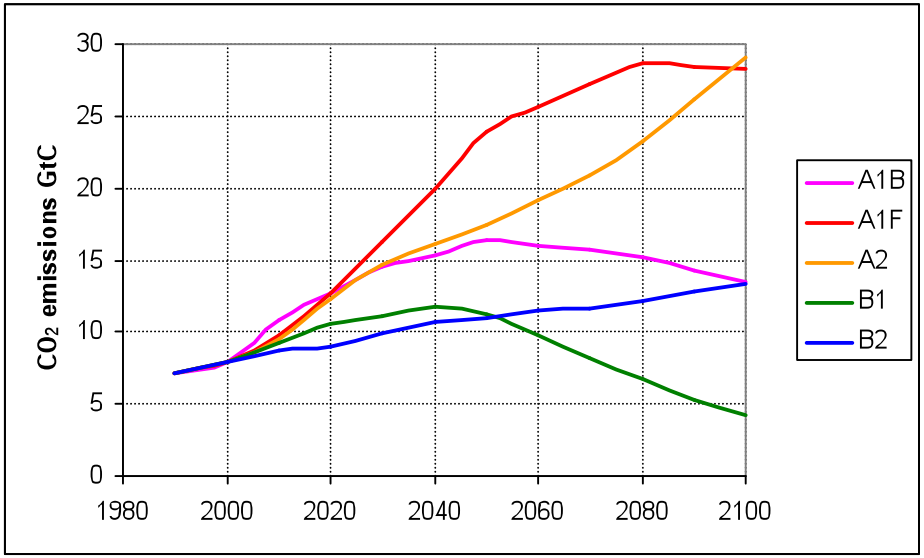
1 tank SUV = 100 l ethanol = 300 kg maize

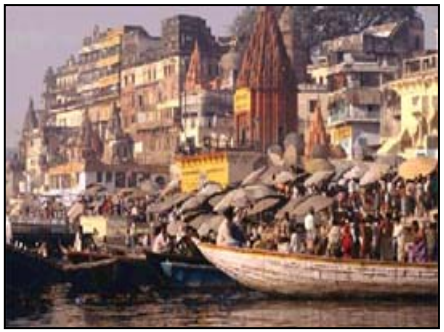
300 kg maize = nutrition of 1 person/year

Water scarcity – land and soil management under climate change conditions

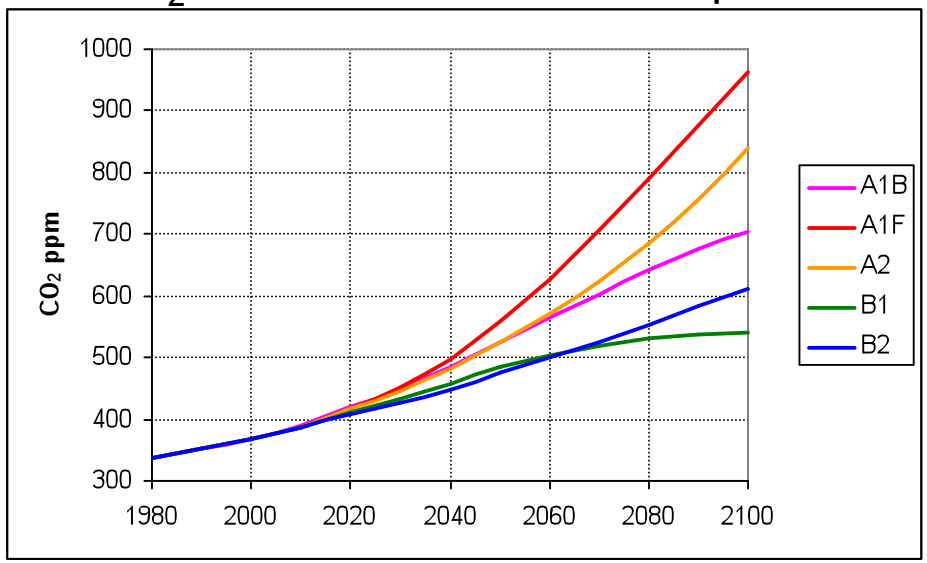
IPCC SRES Scenarios to 2100

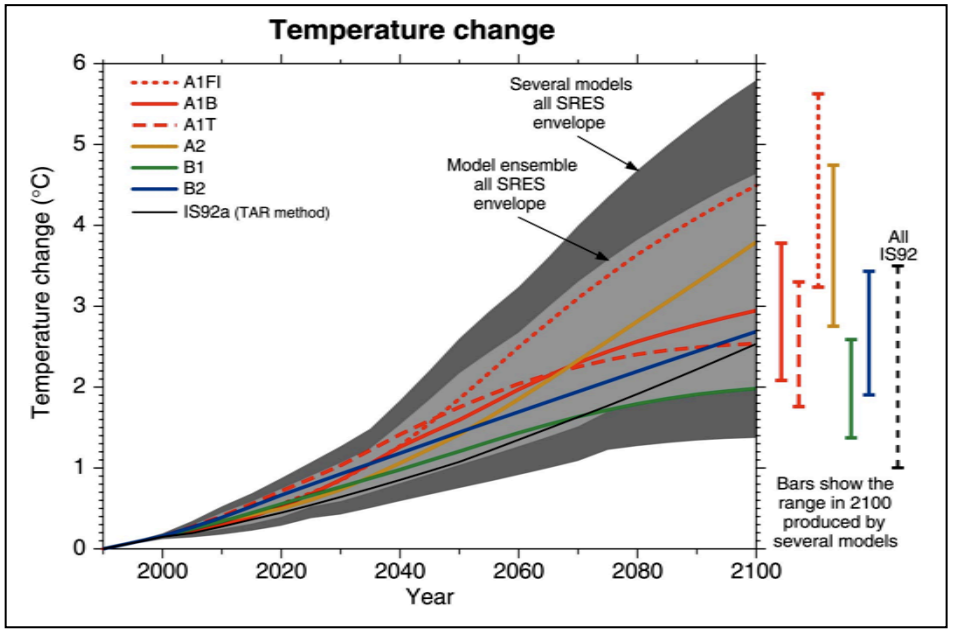
CO_2 emissions





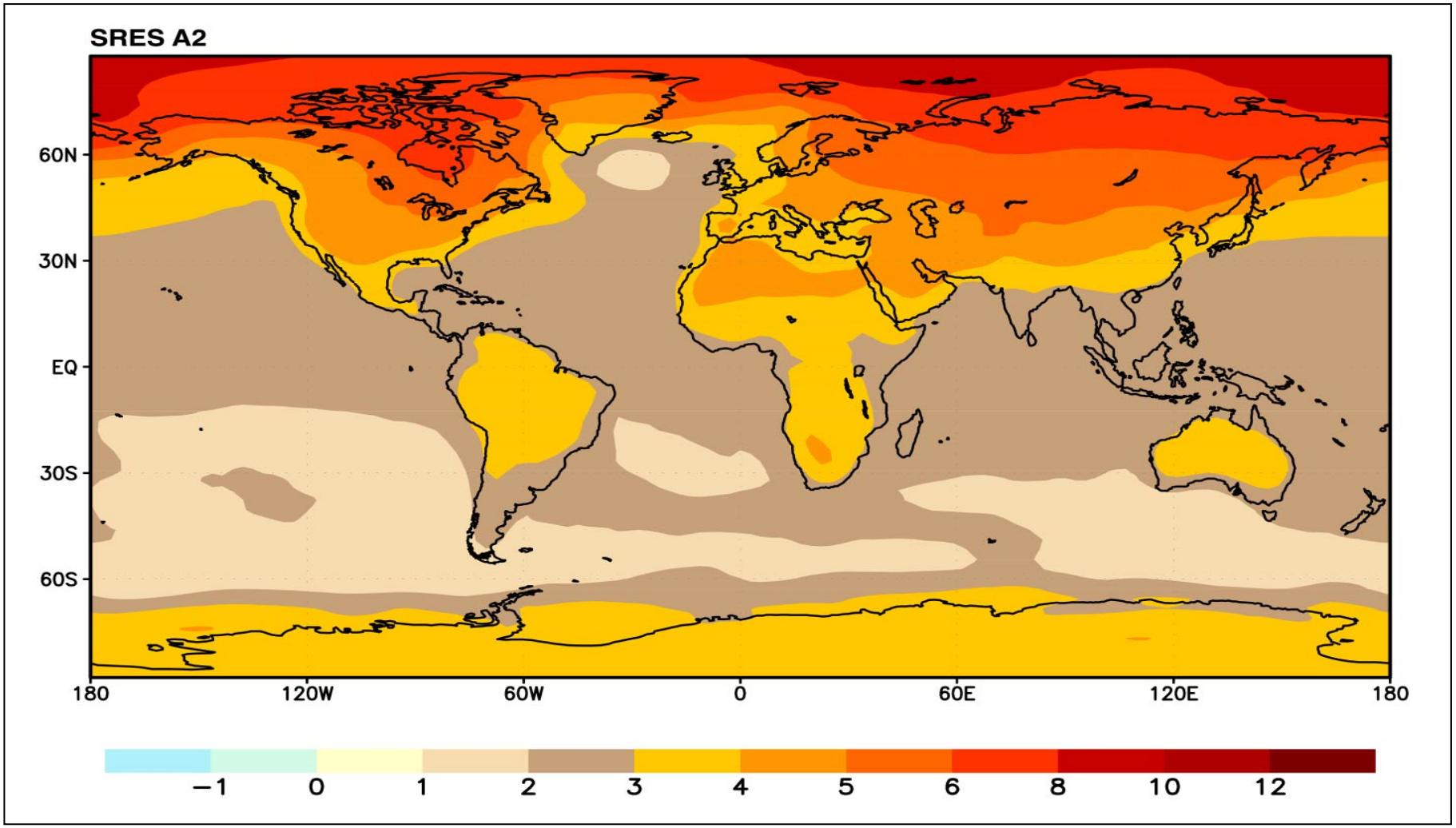
CO_2 abundance in the atmosphere





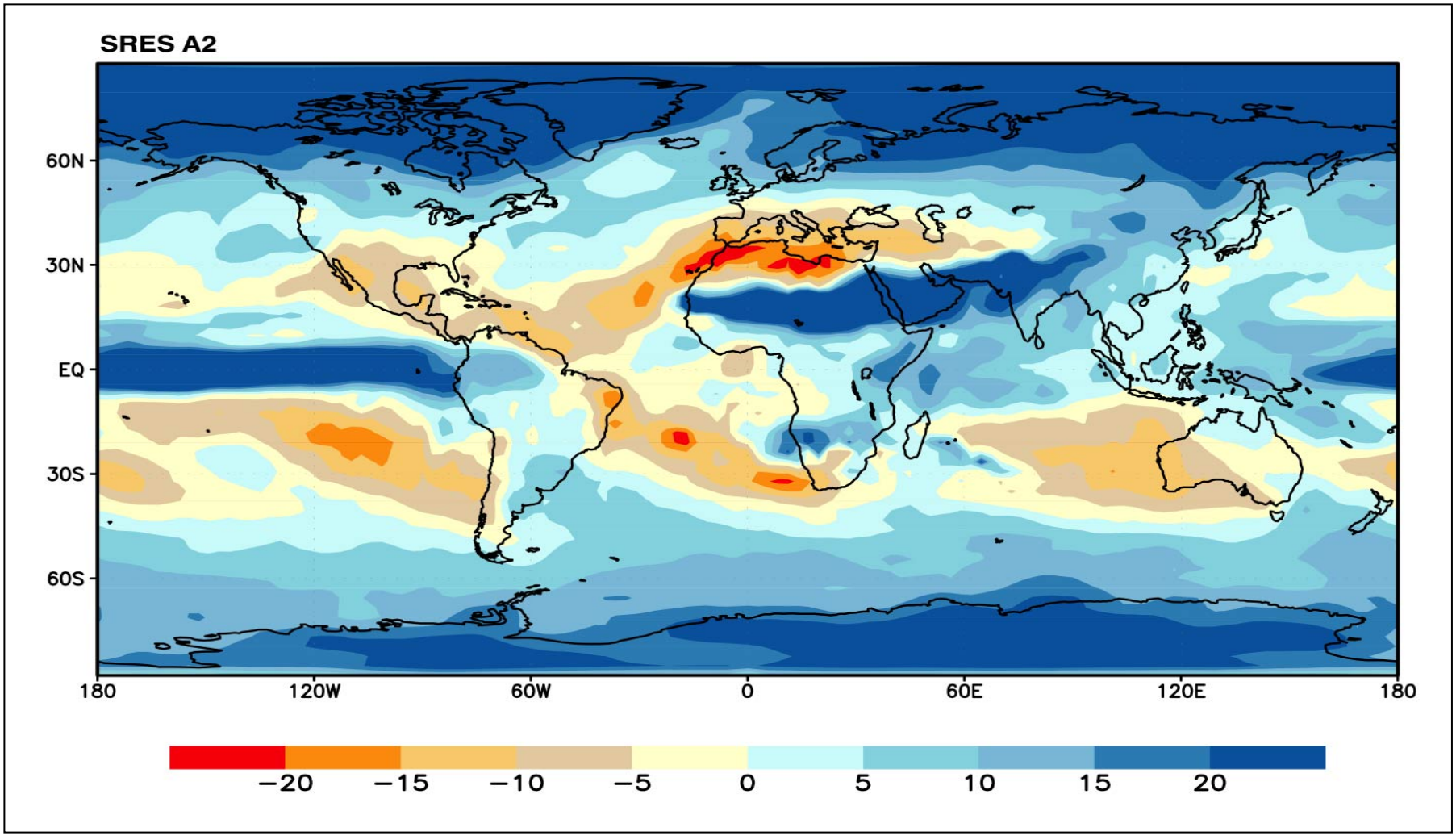
Source: IPCC, 2001

Annual mean temperature change: 2071 to 2100 relative to 1990



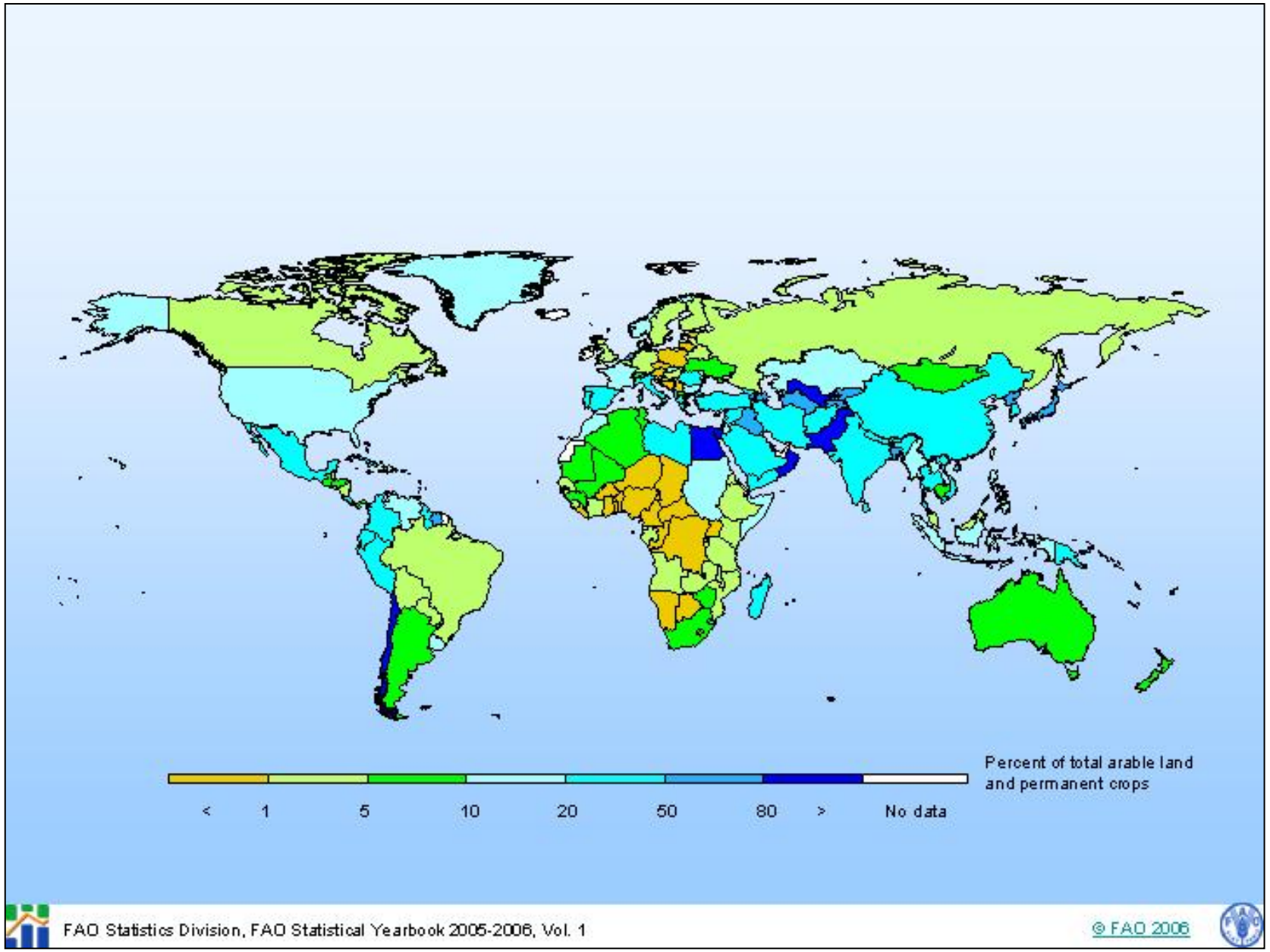
Source: IPCC, 2001.

Annual mean precipitation change: 2071 to 2100 relative to 1990 (Hadley Center)



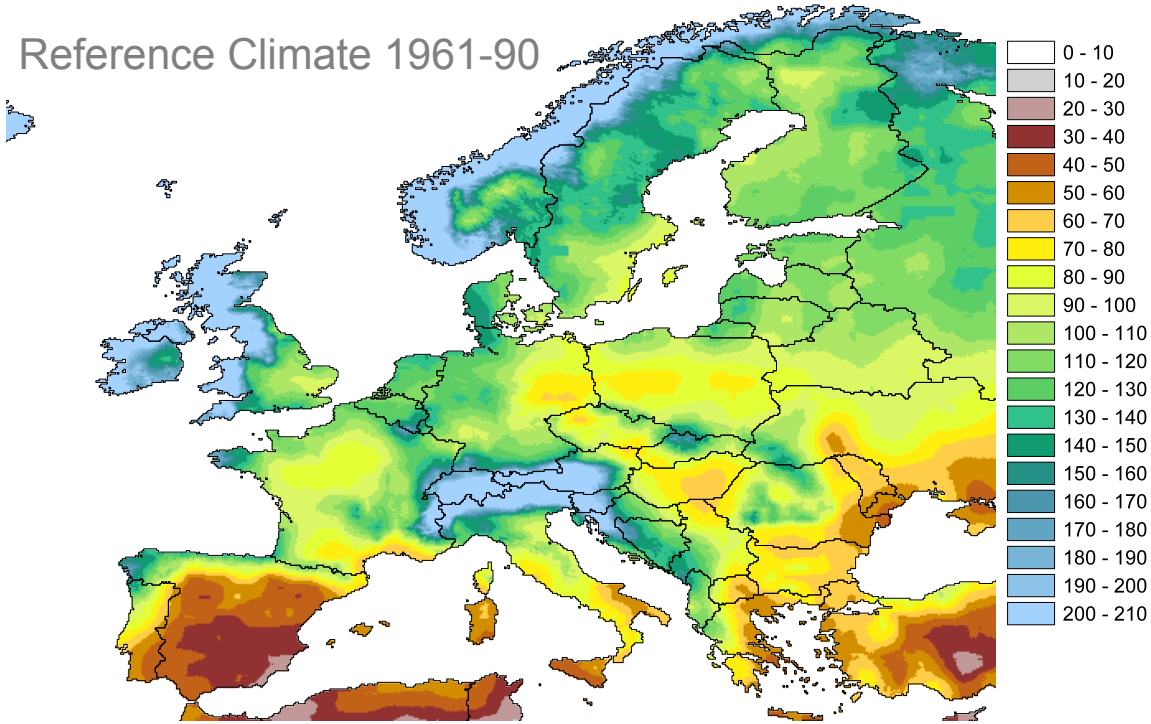
Source: IPCC, 2001.

Share of Irrigated Land in Arable Land (2003)



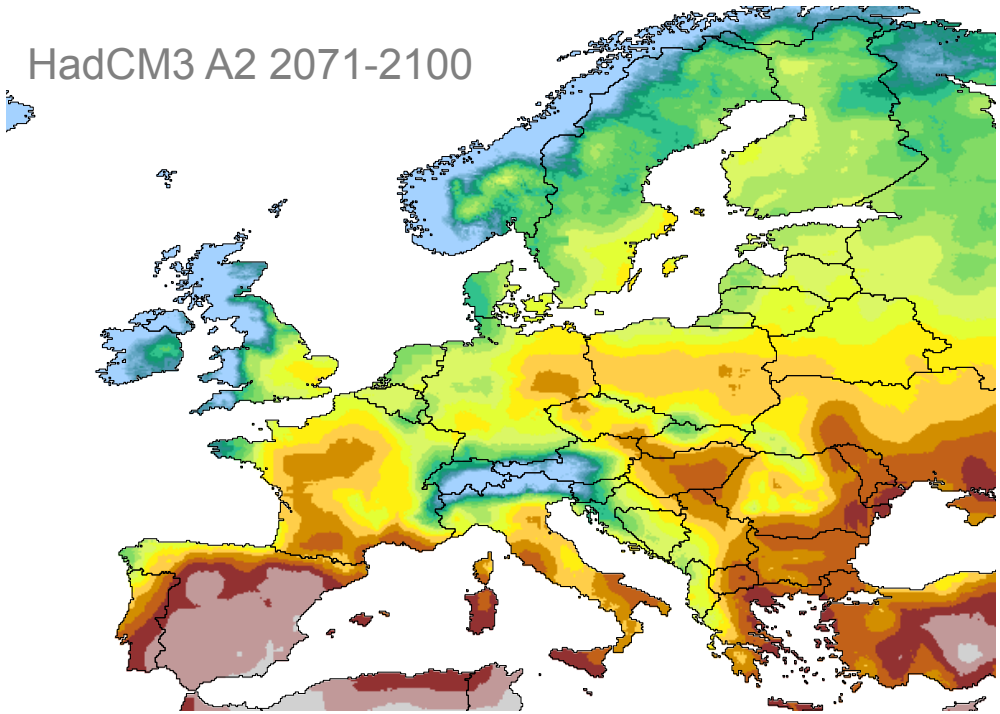
Moisture Index – Present and 2080s

Reference Climate 1961-90

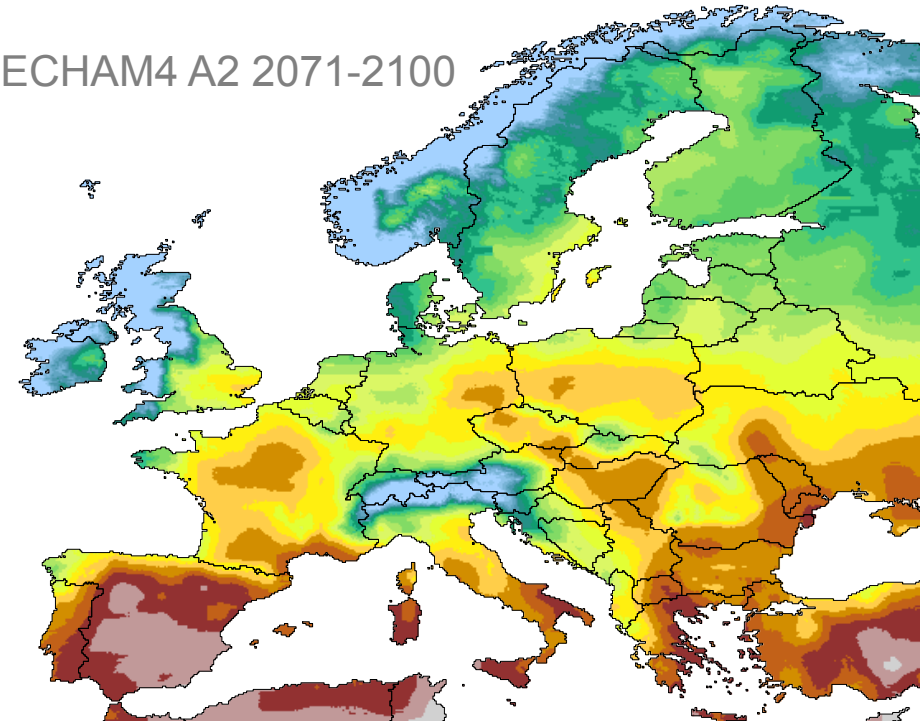


Moisture Index =
100 * Precipitation / Potential Evapotranspiration

HadCM3 A2 2071-2100



ECHAM4 A2 2071-2100



CLASSIFICATION OF IMPACTS IN ORDER OF URGENCY

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1. IRREVERSIBLE*) DAMAGE/THREAT:

- water scarcity
- soil loss through sealing, extraction of materials, mining and erosion (by water/wind);
- intensive pollution by heavy metals, xenobiotics, radioactive compounds;
- advanced acidification or salinisation;
- deep-reaching compaction.

2. REVERSIBLE*) DAMAGE/THREAT:

- soil pollution by biodegradable organic compounds (mineralization, metabolisation);
- compacting, glazing and other deterioration of top soil structure.

*) Definition of reversibility/irreversibility based on the time span of 100 years (~ 4 human generations).

How to implement environmental policies?

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Sustainable use of land resources means spatial and/or temporal harmonisation of all land uses in a given area, avoiding or minimising irreversible impacts.

This is not a scientific but a political issue (top down - bottom up decisions).

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INDICATORS = INFORMATION

for understanding and managing complex systems.

Indicators can be cultural, social, economic, ecological or technical information.

INDICATORS FOR SUSTAINABLE LAND USE AND ENVIRONMENT PROTECTION

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- **Direct and indirect ecological, technical, socio-economic and cultural indicators can be distinguished.**

- **Examples:**

  - **ecological:** soil quality, groundwater quality, biodiversity, human health
  - **technical:** access to the land, availability of tools
  - **socio-economic:** economic wealth, access to social resources
  - **cultural:** educational level

CRITERIA FOR INDICATORS

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- policy relevant, focussing on real demand and less on the supply of data;
- analytically sound,based on science and revealing a clear cause-response relationship;
- easy to interpret and understandable for farmers at the grass-root level (stakeholders), as well as for decision makers and politicians;
- easily measurable and therefore feasible and cost effective in data collection, processing and dissemination.

CONCLUSIONS AND OUTLOOK

1. Unsustainable land use is causing social impacts through:
   - unbalanced use of land through severe competition between different uses in space and time;
   - unsustainable use of specific land functions, both with irreversible impacts.
2. Social impacts are complex and have ecological, technical, social, economic and cultural implications.
3. Often, it is not the dimension of space but the dimension of time = the pace of processes, which triggers social impacts.
4. In order to alleviate social impacts, bridging between science and decision making should be improved, transferring information from those who have it to those who need it.
5. Information in the form of indicators can contribute to the mitigation of social impacts, allowing for the formulation of environmental policies.

THANK YOU