SOIL AND FOOD SECURITY UNDER GLOBAL CHANGE

by

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## THE DIMENSIONS OF FOOD SECURITY

<table>
<thead>
<tr>
<th>FOCUS AREA</th>
<th>TOPICS</th>
<th>SUBJECTS</th>
<th>SOCIAL AND POLITICAL DIMENSIONS</th>
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<tbody>
<tr>
<td>Availability/ Sustainability</td>
<td>▪ Environmental opportunities/constraints</td>
<td>Natural resources</td>
<td>Food production</td>
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<td>(production)</td>
<td>▪ Cultural, social and economic opportunities/constraints</td>
<td>Climate, land, soil, water</td>
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<td>▪ Technological opportunities/constraints</td>
<td>Human resources</td>
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<td>religion, cultural assets</td>
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<td>Plant/animal</td>
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<td>Food processing and conservation</td>
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<td>Agrochemicals</td>
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<td>ACCESSIBILITY</td>
<td>▪ Physical accessibility</td>
<td>Storage</td>
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<td>Transport</td>
<td>Food markets and economy</td>
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<td>▪ Cultural, social and economic accessibility</td>
<td>Conservation</td>
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<td></td>
<td>▪ Physiological accessibility</td>
<td>Market</td>
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<td>Quality/safety</td>
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<td>Religion, cultural assets</td>
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<td>Food habits</td>
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<td>Pricing system</td>
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<td>Policies</td>
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<td>Income generation</td>
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<td>Nutrition</td>
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<td>Health</td>
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WORLD SOIL SUITABILITY FOR SUSTAINING LIFE

~ 12 % of the land surface suitable for crop production;

~ 24 % can be used for grazing

~ 31 % produce forests

~ 33 % unsuitable for any kind of sustainable use

(Buringh, 1998; FAO 1995)
Global map of land quality

Inherent Land Quality Assessment

Blum and Eswaran, 2004
## Global Land Quality with Regard to Land Surface and Population Distribution

<table>
<thead>
<tr>
<th>Land Quality Class</th>
<th>Total Land Surface</th>
<th>World Population:</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2,4 %</td>
<td>6,1 %</td>
</tr>
<tr>
<td>II, III</td>
<td>9,5 %</td>
<td>19,0 %</td>
</tr>
<tr>
<td>IV, V, VI</td>
<td>33,8 %</td>
<td>53,6 %</td>
</tr>
<tr>
<td>VII</td>
<td>9,0 %</td>
<td>11,5 %</td>
</tr>
<tr>
<td>VIII, IX</td>
<td>45,3 %</td>
<td>13,1 %</td>
</tr>
</tbody>
</table>

Blum and Eswaran, 2004
### Percent of land area in major biomes as a function of land quality

<table>
<thead>
<tr>
<th>BIOMES</th>
<th>LAND QUALITY CLASS (Percent of ice-free land surface)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td>Tundra</td>
<td>15.62</td>
</tr>
<tr>
<td>Boreal</td>
<td>2.03</td>
</tr>
<tr>
<td>Temperate</td>
<td>2.14</td>
</tr>
<tr>
<td>Mediterranean</td>
<td>0.30</td>
</tr>
<tr>
<td>Desert</td>
<td></td>
</tr>
<tr>
<td>Tropical</td>
<td>0.25</td>
</tr>
<tr>
<td>Total</td>
<td>2.38</td>
</tr>
</tbody>
</table>

Blum and Eswaran, 2004
WHAT IS GLOBAL CHANGE?
SIX MAIN FORMS OF GLOBAL CHANGE THREATENING SOIL USE AND FOOD SECURITY:

1. increase in world population and change in spatial distribution;
2. loss of fertile soils through urbanisation, industrialisation and further human impacts;
3. changes in life style and demands for food;
4. increasing demands for bioenergy;
5. changes in world economy;
6. climate change.
1 Increase of world population and changes in its spatial distribution

- every year ~ 80-85 millions more = need for
  - more space;
  - more food;
  - more energy.

- every year 100-150 millions move from rural into urban areas or are born there:
  - loss of rural livelihoods (loss of subsistence farming);
  - increased pressure on the local, regional and world food markets
GROWTH OF WORLD POPULATION SINCE 8000 B.C. IN MILLION

<table>
<thead>
<tr>
<th>Year</th>
<th>World Population</th>
<th>Annual Rate of Growth in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>8000 B.C.</td>
<td>2 – 20</td>
<td>&lt;0,1</td>
</tr>
<tr>
<td>1 A.D.</td>
<td>200 – 300</td>
<td>&lt;0,1</td>
</tr>
<tr>
<td>1500</td>
<td>400 – 500</td>
<td>&lt;0,1</td>
</tr>
<tr>
<td>1730</td>
<td>700</td>
<td>&lt;0,1</td>
</tr>
<tr>
<td>1820</td>
<td>1000</td>
<td>0,2</td>
</tr>
<tr>
<td>1850</td>
<td>1200</td>
<td>0,5</td>
</tr>
<tr>
<td>1900</td>
<td>1600</td>
<td>0,6</td>
</tr>
<tr>
<td>1950</td>
<td>2500</td>
<td>0,8</td>
</tr>
<tr>
<td>1990</td>
<td>5300</td>
<td>1,8</td>
</tr>
<tr>
<td>2000</td>
<td>6000</td>
<td>1,5</td>
</tr>
</tbody>
</table>

(J.R. McNeill, 2003)
2 Losses of fertile soils through urbanization, industrialisation and further human impacts
Global map of land quality

Inherent Land Quality Assessment

Blum and Eswaran, 2004
The impact of human activities on soil

- Blocking of soil functions important to the ecology of the landscape
- Destruction of soil
- Gradual disappearance of farms
- Sealing
- Diffuse input of contaminants as particulates
- Manures and fertilisers
- Sewage sludge
- Gravel extraction
- Acidification
- Contamination of soils and ground water with applied agrochemicals and atmospheric pollutants
- Changes in soil composition
- Adverse impacts on living organisms in the soil
- Changes in the structure of soils
- Reduction in soil fertility
- Accumulation/Contamination
- Release of toxic substances
- Soil erosion
- Destruction of humus
- Compaction
- Salinisation
- Heavy metals

EU-JRC-IES-Ispra/Italy
3 Changes in life style and demands for food

- demand for more individual living space = increase of urbanization;
- waste of food in industrialized countries and excessive food consumption, leading to obesity;
- need for more grain because of increasing consumption of animal protein/meat etc.)
Grain for the production of animal protein:

- for 1 kg of chicken meat ~ 2-3 kg of grain
- for 1 kg of pork ~ 4-5 kg of grain
- for 1 kg of beef ~ 7-10 kg of grain
In compensation of all these demands, the average yields of cereals should be raised from 2.64 Mg/ha in the year 2000, to 3.60 Mg/ha in the year 2025, and to 4.30 Mg/ha in the year 2050, without taking into consideration other foodstuffs (Lal, 2006).
Increasing demands for bioenergy [biogas, biofuel (biodiesel, ethanol), fiber]
BIOFUELS WORLDWIDE – PREVISION FOR 2012
(acc. to FAO/OECD)

13% of all grain } for ethanol
35% of all sugar cane } production

16% of all vegetable oil for biodiesel

Quotation: Pascal Lamy, Dir.Gen. WTO, Feb. 2011 in Berlin (Germany)
Changes in world economy and emerging economic trends in food production and marketing

- increasing costs for agricultural land;
- increasing production costs (energy, fertilizers, pesticides, agricultural machinery etc.);
- new financial instruments for agricultural production and marketing of agricultural products (speculative performances, e.g. hedging, derivates, causing volatilisation of prices, etc.);
- land take in foreign countries = „land grabbing“ for agricultural production.
DRIVING FORCES OF LAND AND SOIL DEGRADATION - DIMENSIONS OF SPACE AND TIME

Cultural, Social and Economic Driving Forces

- WTO (GATT) economic and social theories, property rights, price of energy
- Market conditions, transport systems, social security, educational systems
- Land tenure, family structure, family income, health care

DIMENSION OF SPACE

World

Ecological and Technical Driving Forces

- Climate change, change in biodiversity
- Macroclimate altitude, topography, biodiversity, soil distribution pattern, technical infrastructure
- Microclimate, topography, soil quality, water resources, biodiversity

Short-, medium- and long-term temporal scales

DIMENSIONS OF SPACE AND TIME

Country /Region

Farm, Household
6. Climate change
(temperature, precipitation, wind) and soil and land management
Climate change is causing

- global warming:
  - exceedence of temperature thresholds;
  - increased crop water requirements
  - increased incidence of pests and diseases, invasive plant and animal species;
- alteration in precipitation patterns, soil moisture conditions and surface runoff;
- increased occurrence of extreme weather events;
- increased climate variability
IPCC SRES Scenarios to 2100

**CO₂ emissions**

![Graph showing CO₂ emissions from different scenarios from 1980 to 2100.]

**CO₂ abundance in the atmosphere**

![Graph showing CO₂ ppm from different scenarios from 1980 to 2100.]

Source: IPCC, 2001
Annual mean temperature change: 2071 to 2100 relative to 1990

Annual mean precipitation change: 2071 to 2100 relative to 1990 (Hadley Center)
Share of Irrigated Land in Arable Land (2003)
SUMMARY AND CONCLUSIONS

1. Through global change, food security will be under threat;

2. These threats will be different for specific world regions and with predominantly negative consequences for many countries in development;

3. Adverse impacts on food production will be caused by:
   - further losses of productive agricultural land by sealing, erosion and other threats;
   - decrease of water resources;
   - increasing costs of energy and fertilizers;
   - severe changes in biodiversity (in and above soil).
4. Adverse impacts will also occur regarding:
   - human health and living conditions in specific world regions;
   - feedback processes between soil and the atmosphere, accelerating climate change.

5. Possible causes of global change derive from world views on the relationship humans-nature, questionable economic and social theories and the increasing globalization of decisions regarding the production and marketing of agricultural/biological commodities without considering regional/local ecological, social and economic conditions.
6. Any mitigation of global change and its impacts on food security must be based on a reorientation of world views and consequently adequate reactions by the world economy, by establishing new economic rules and steering operations.

7. Knowledge about soils will play an increasingly important role in mitigating adverse effects by furthering the sustainable production of food in the future.
THANK YOU!