Welcome
to China

Welcome
to Beijing

Welcome to
the Seminar

A Brief Introduction

Family Name: LI **Given Name:** Rui

Organization: Institute of Soil and Water Conservation （ISWC）， NWUAF , CAS/MWR

Research Field: Regional SWC/Envronment

RS/GIS Applications for land resources, suivey and evaluation. Soil erosion

Soil erosion monitoring and assessing

Possition / Titles: Retired professor

President , World Asssociation of Soil and Water Conservation (WASWAC)

Lectures

13:30 – 15:00 **Overview on Soil / Water Conservation in the world**

Video 1– Soil erosion research in the world (Professor LAL)

Introduction of World Association of Soil and Water Conservation

15:00 – 15:20 **Tea break**

15:20 – 16:50 **Overview on Soil / Water Conservation in China**

Regional Effects of Grain for Green Program (Re-vegetation)

Video 2-- Soil and Water conservation (John Liu)

The first session

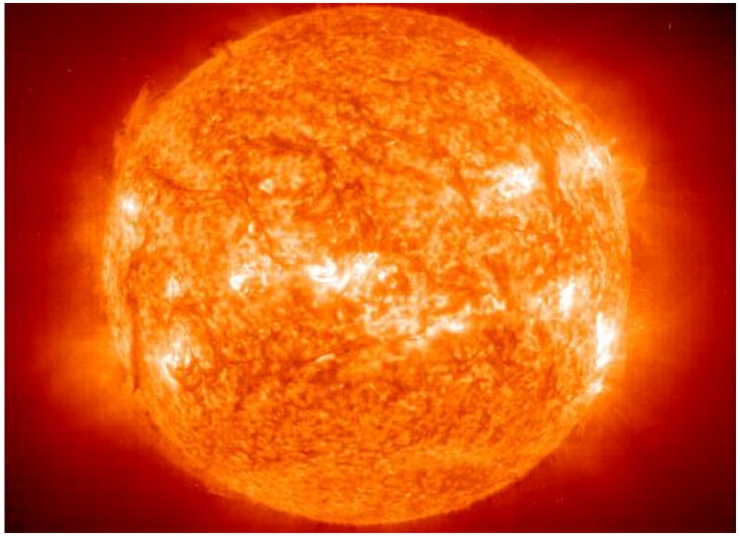
Overview of Global Soil and Water Conservation

LI RUI

Institute of Soil and Water Conservation (CAS&MWR)

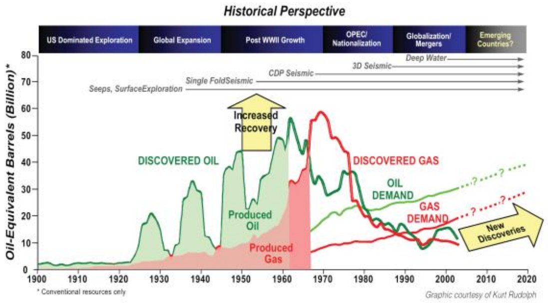
Northwest Sci-Tech University of Agriculture and Forestry

Unstable Earth



Climate change

Population explosion



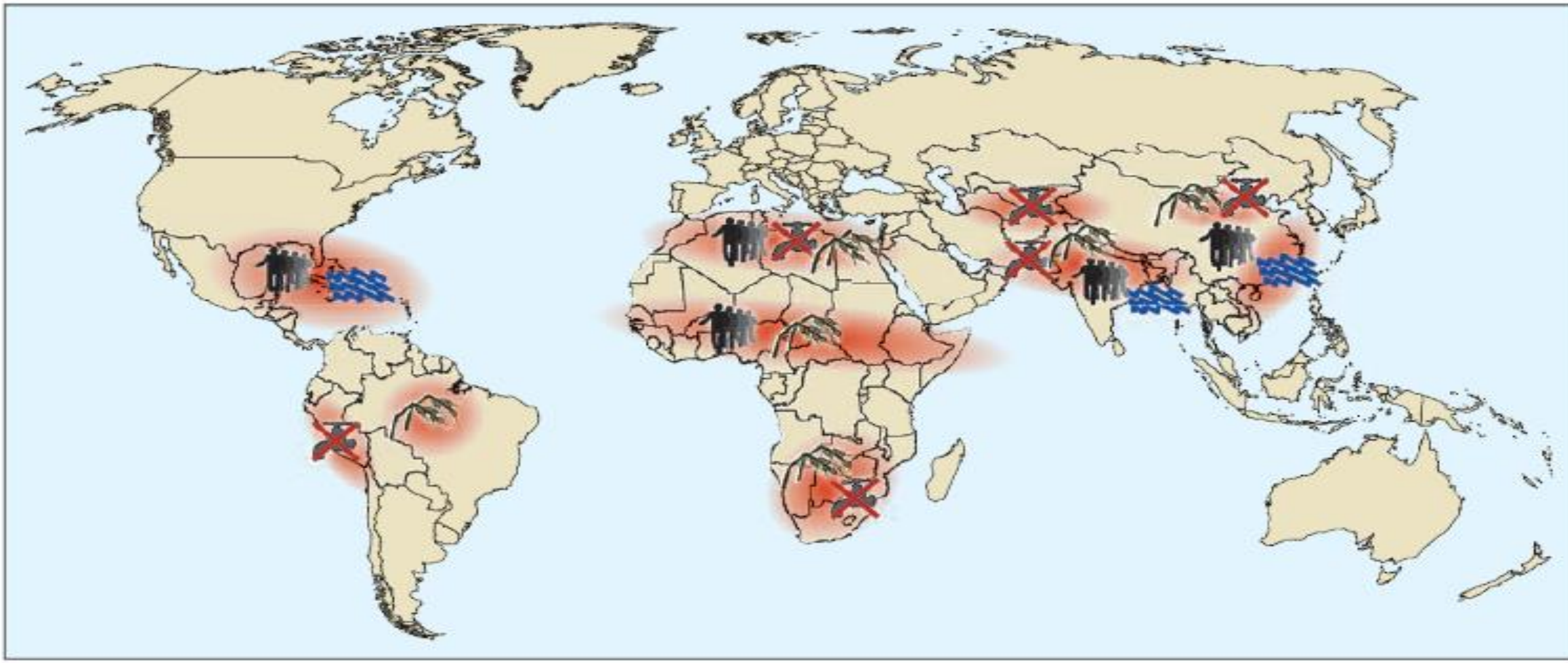
Energy crisis

Natural disaster

Economic crisis

Some Areas Suffering Climate changing

Source: German Scientific Committee on Global Environment Isues,2007



Conflict constellations in selected hotspots

Climate-induced degradation of freshwater resources 缺水

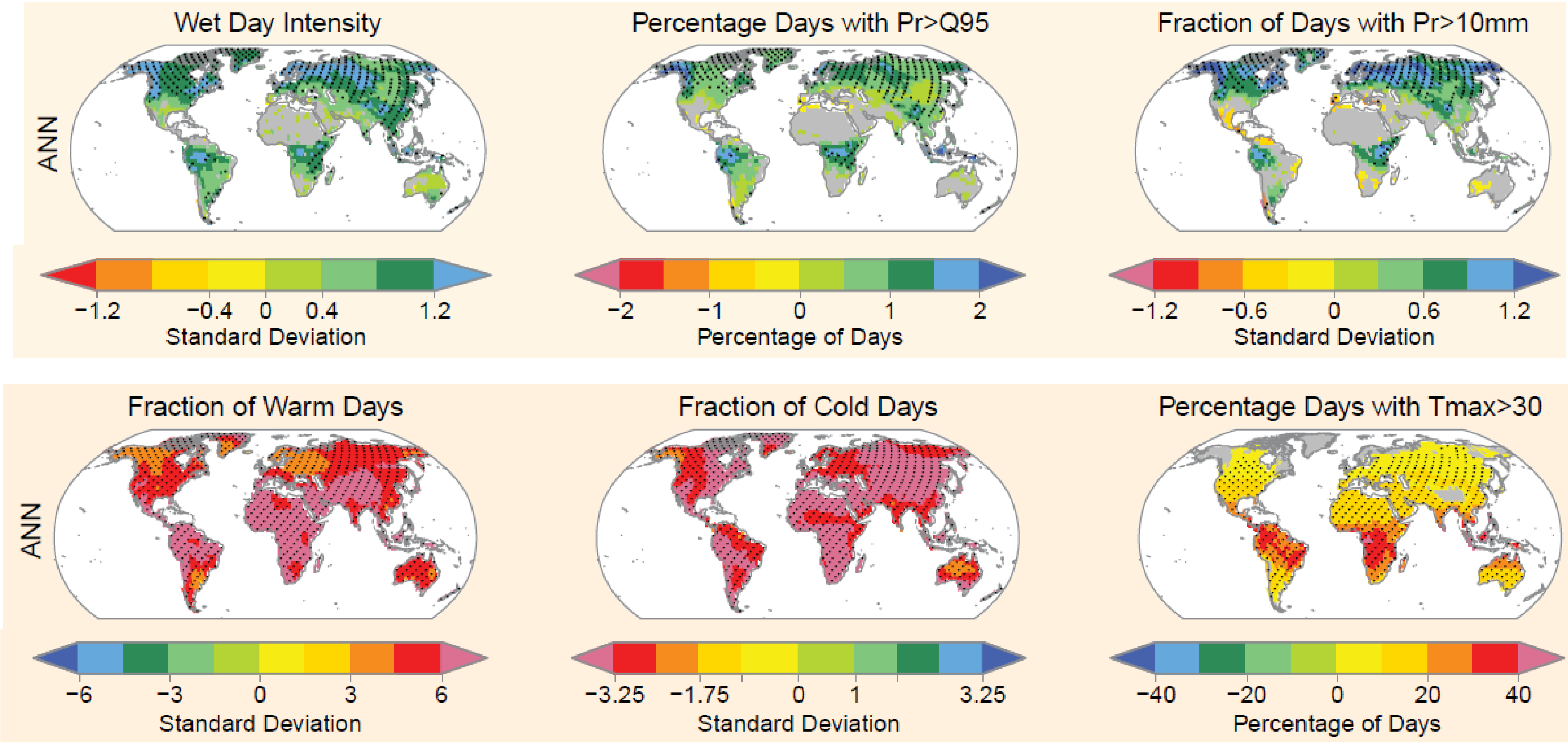
Climate-induced decline in food production 缺粮

Hotspot 热点区

Climate-induced increase in storm and flood disasters 洪水

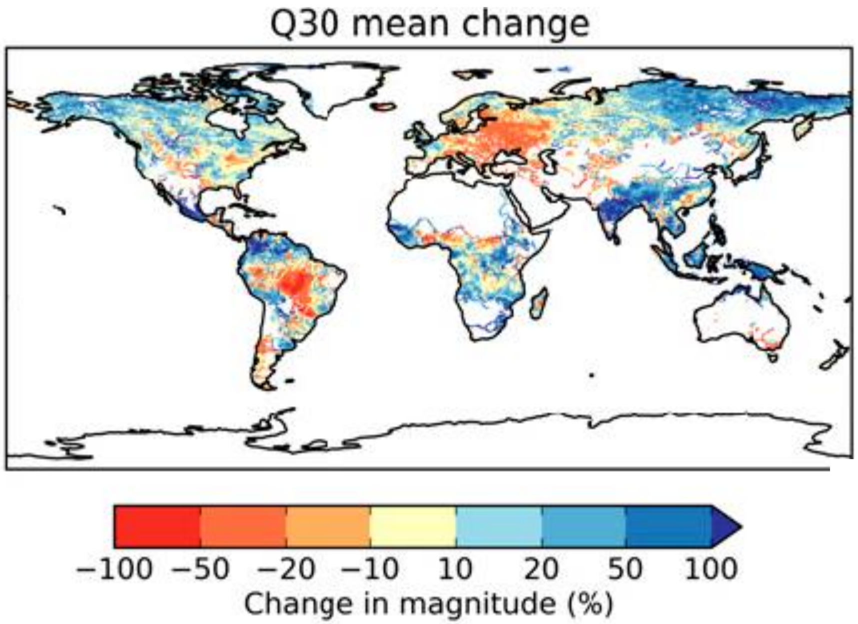
Environmentally-induced migration 环境移民

Extreme climate events have also changed significantly

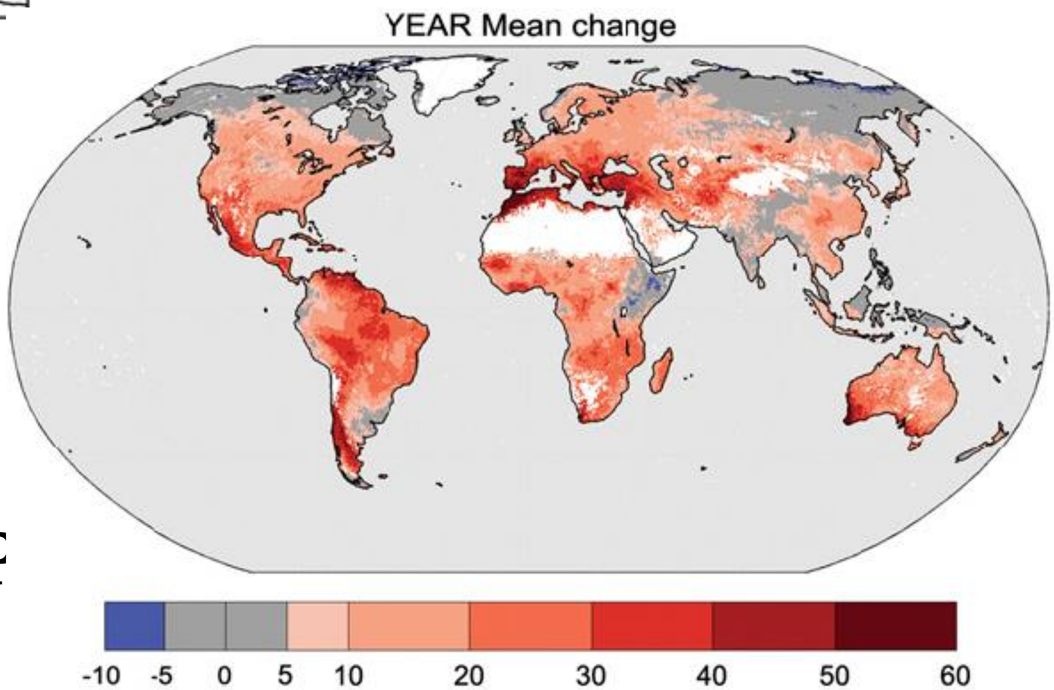


Projected annual changes for 2081-2100 with respect to 1980-1999, based on 14 GCMs contributing to the CMIP3.

Hydrological extreme events enhanced

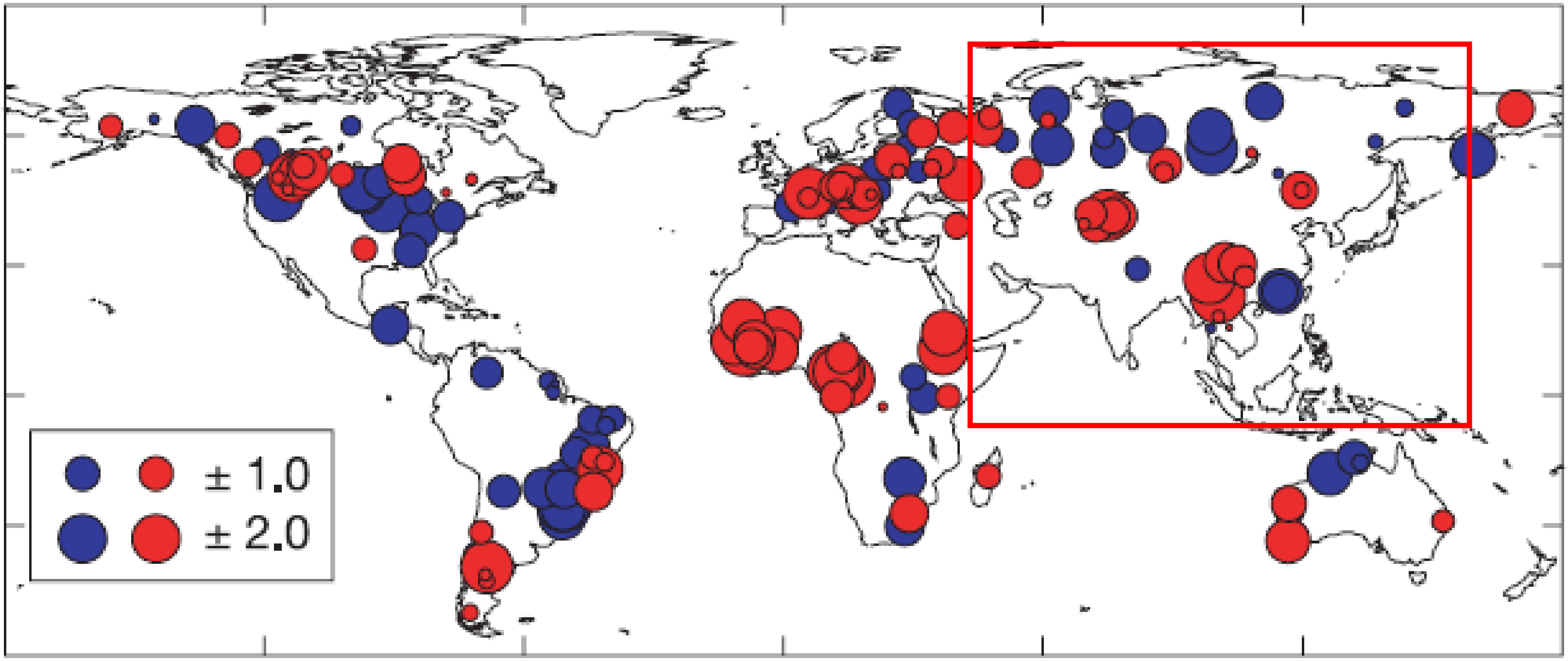


Flood (Dankers et al. PNAS 2013)



Drought (Prudhomme et al. P

Current runoff changes over the world



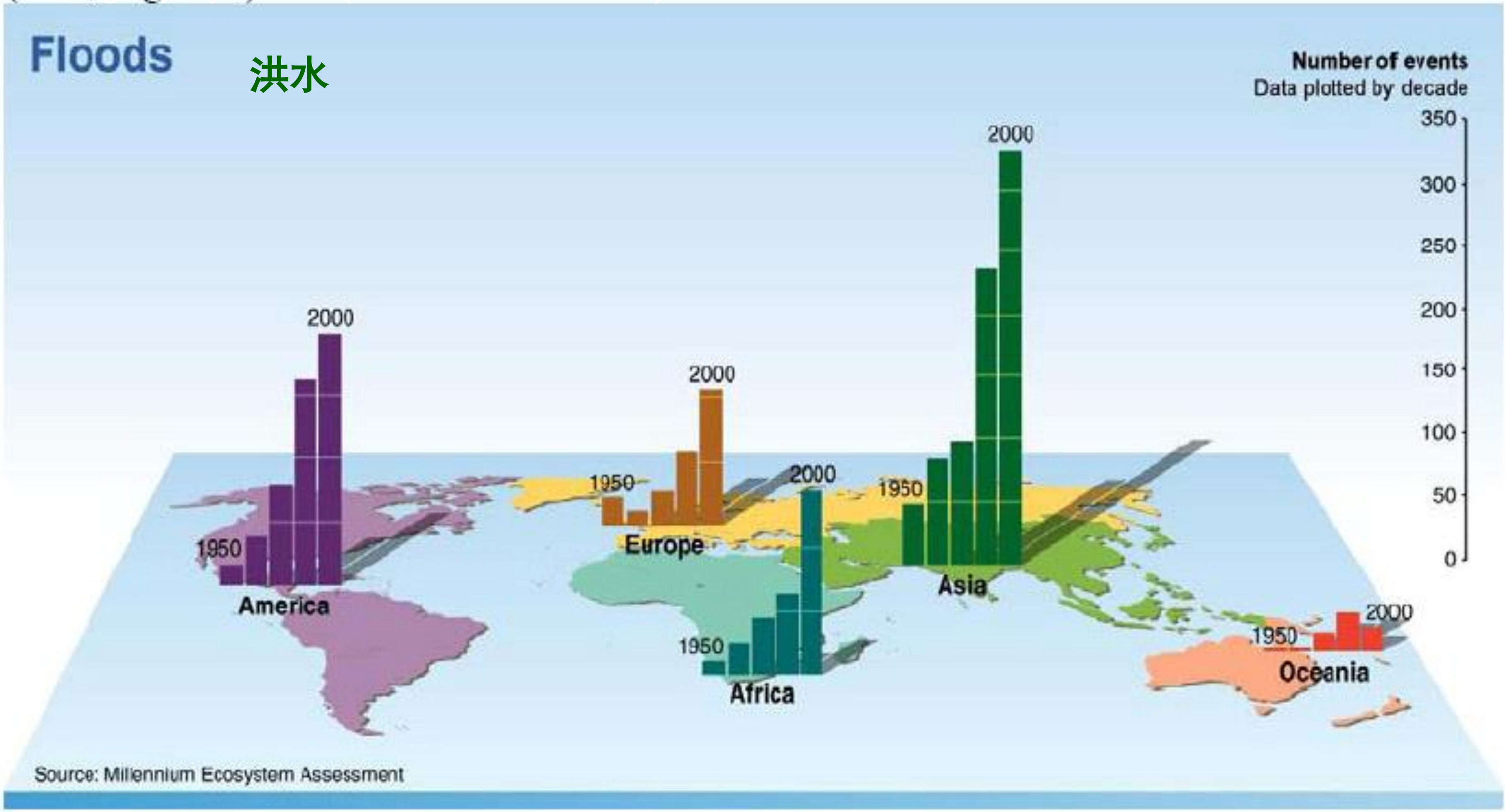
Global distributions of trend (*Z*) in streamflow from 1900–70 to 1971–98

The current changes in runoff has great spatial variations

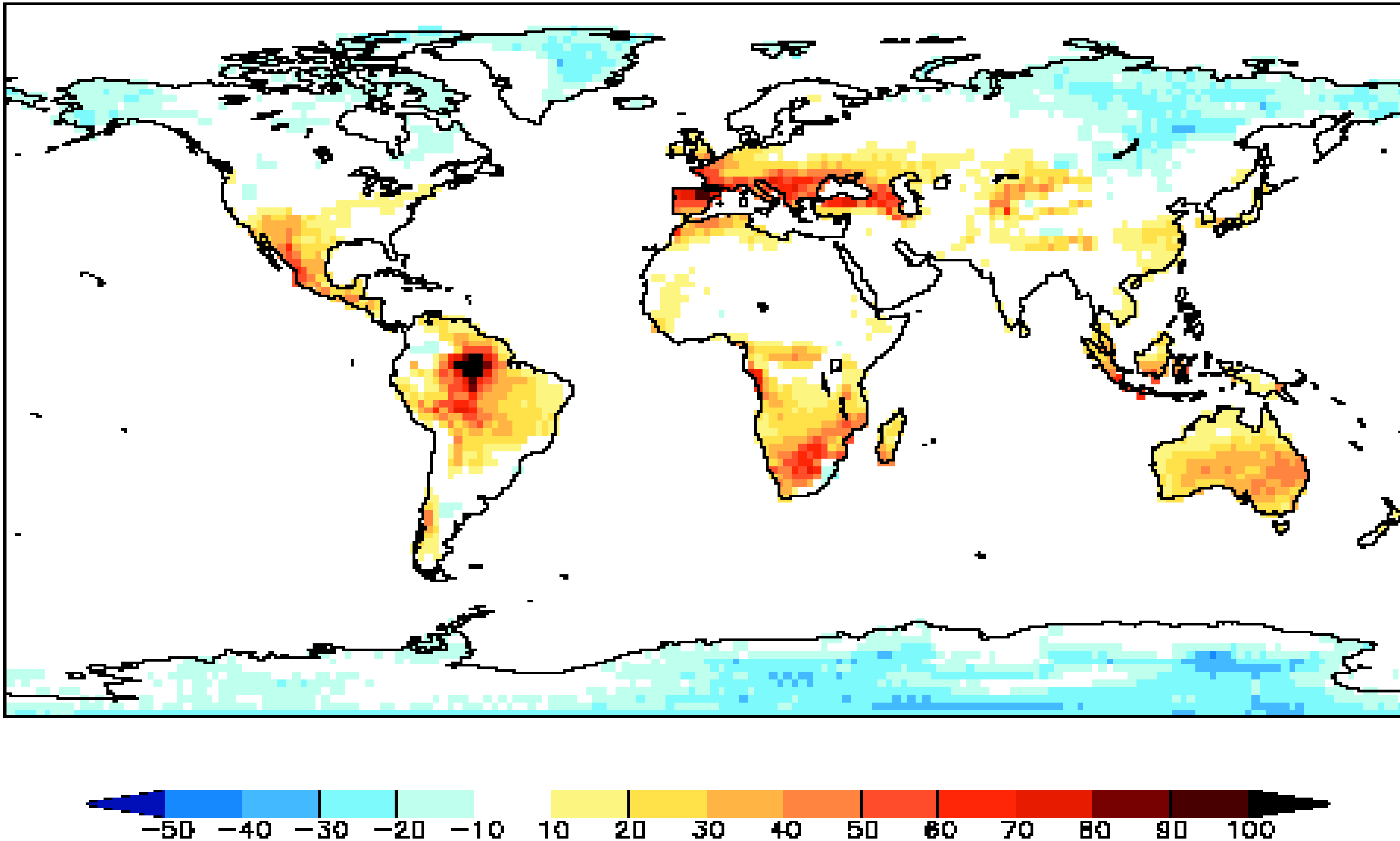
Milly, et al. 2005. Nature

Flood Events in the World

Appendix Figure A.7. Number of Flood Events by Continent and Decade Since 1950 (C16. Fig 16.6)

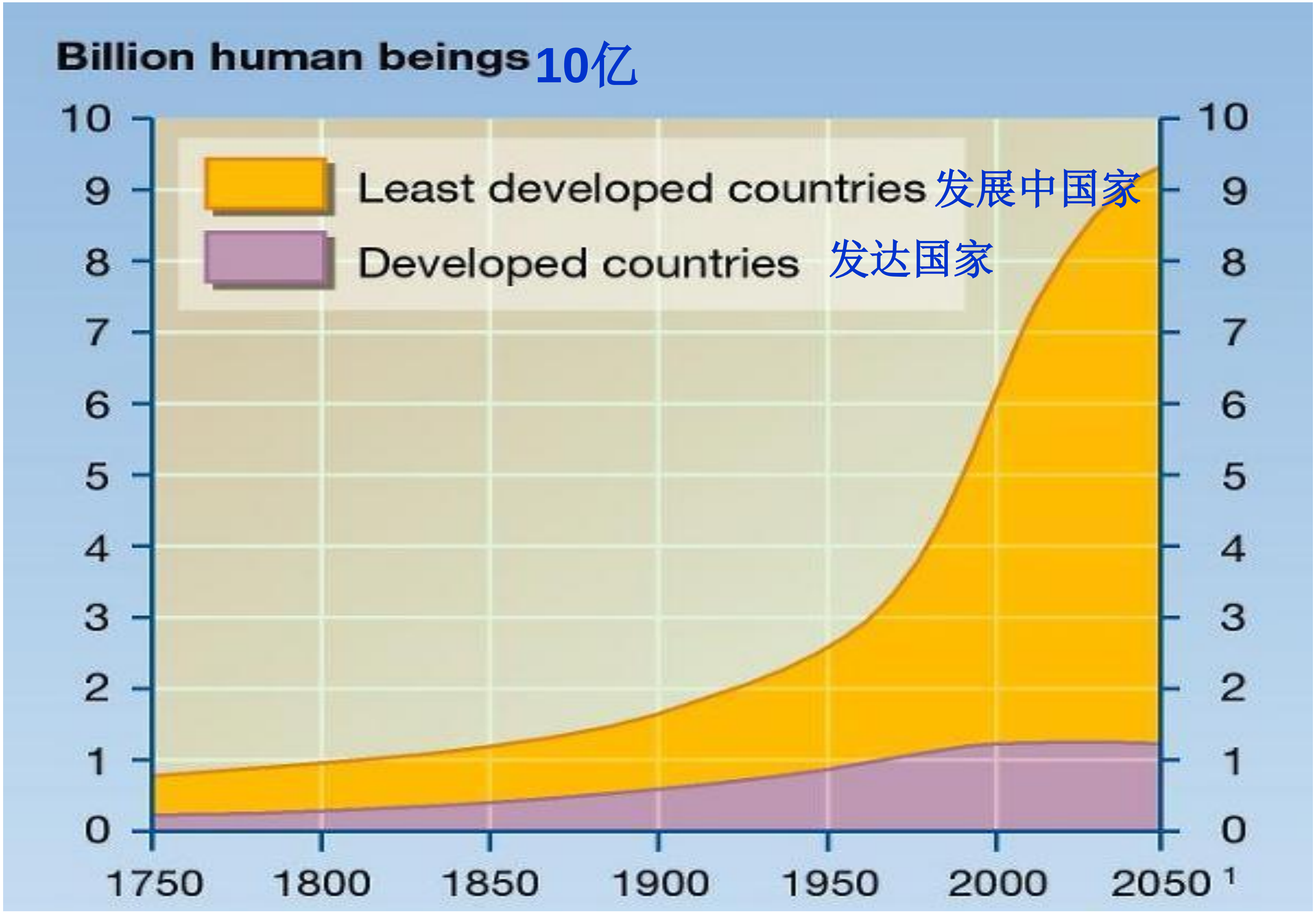


Trend of Drought in the world



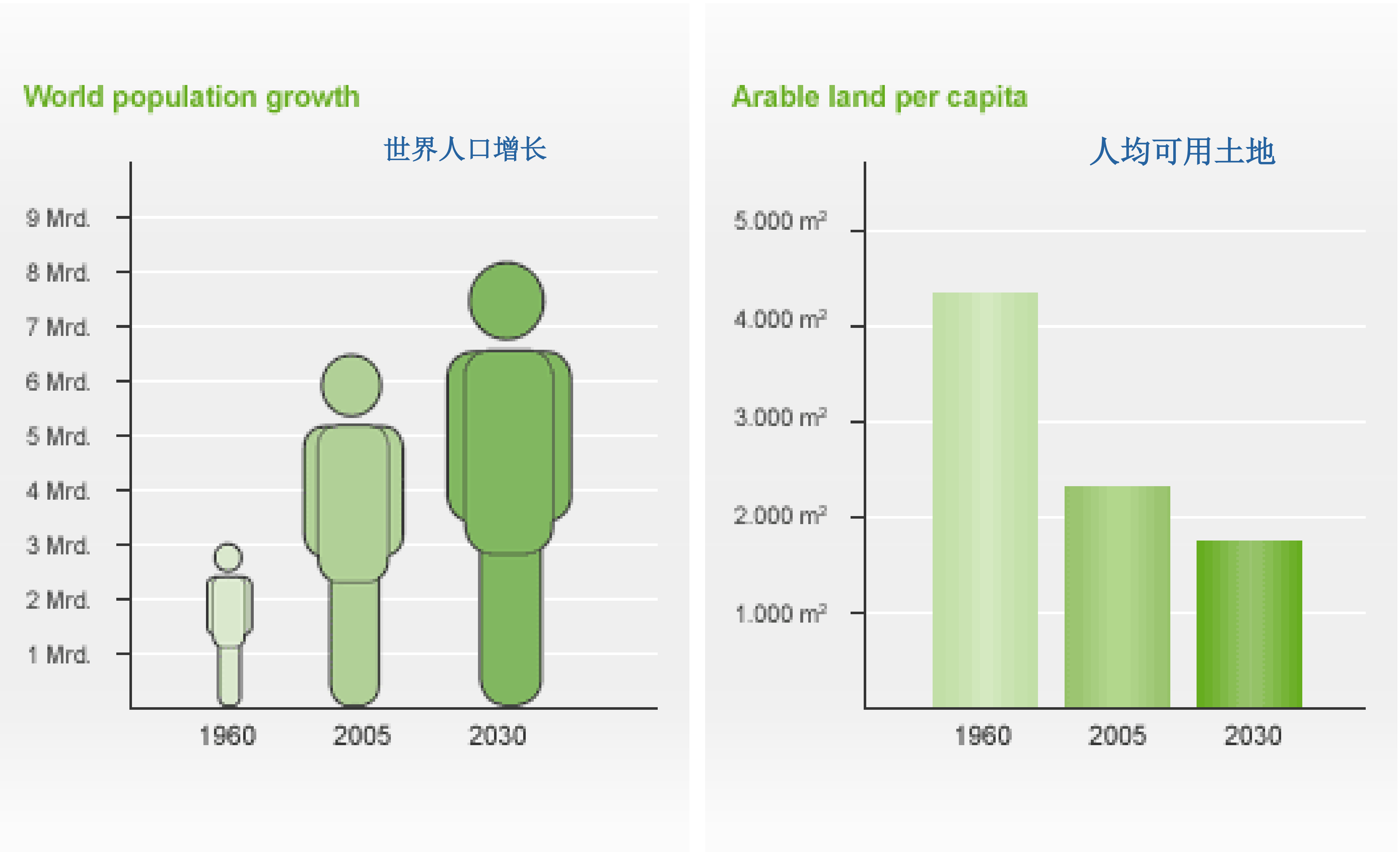
Percentage change in average duration of longest dry period, 30-year average for 2071-2100 compared to that for 1961-1990.

Population increasing

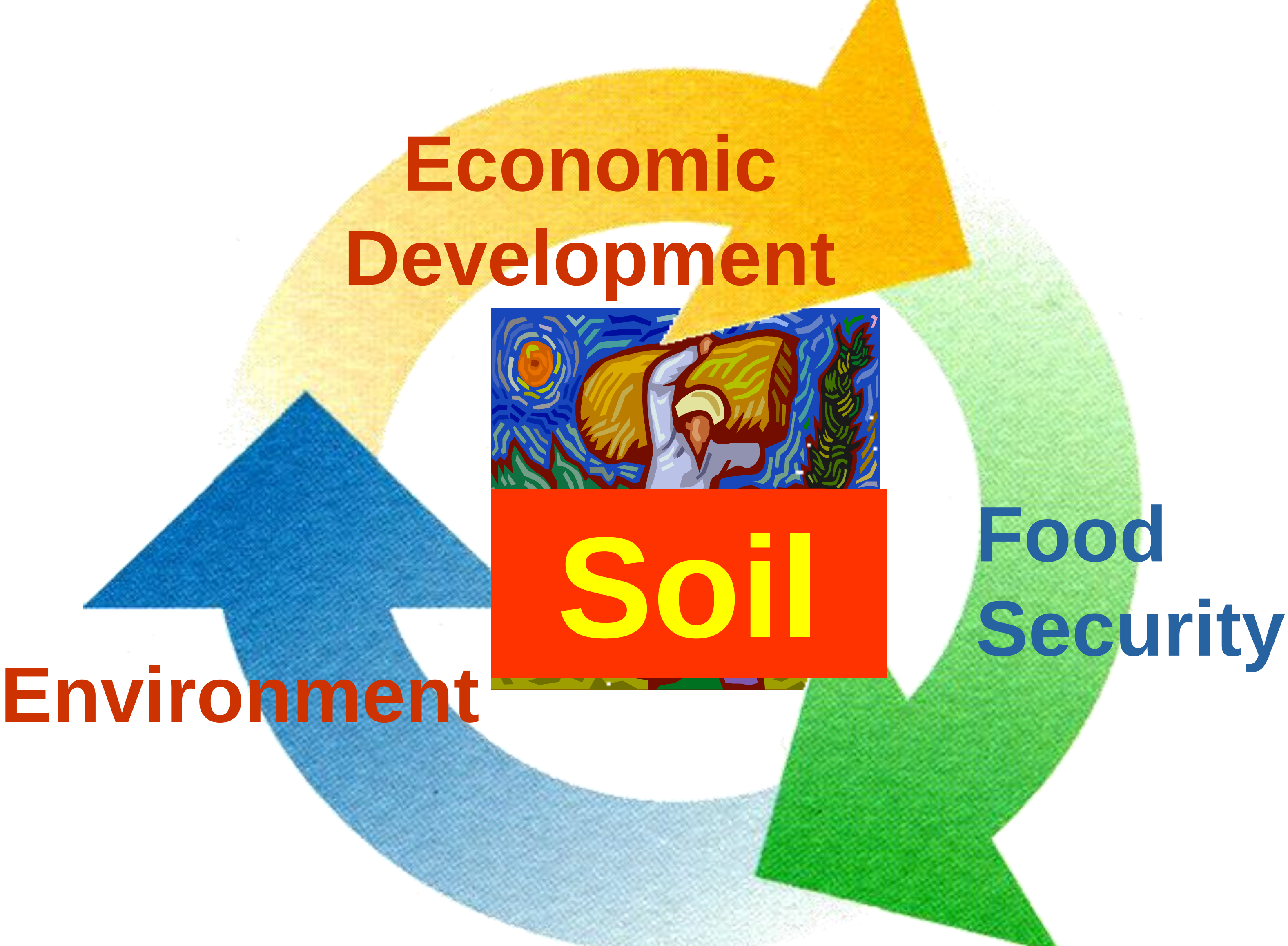


World Food need in 2050

Global agriculture – a success story despite of shrinking land resources
全球农业 — 还是一个成功的事实，尽管土地资源相对严重缩减



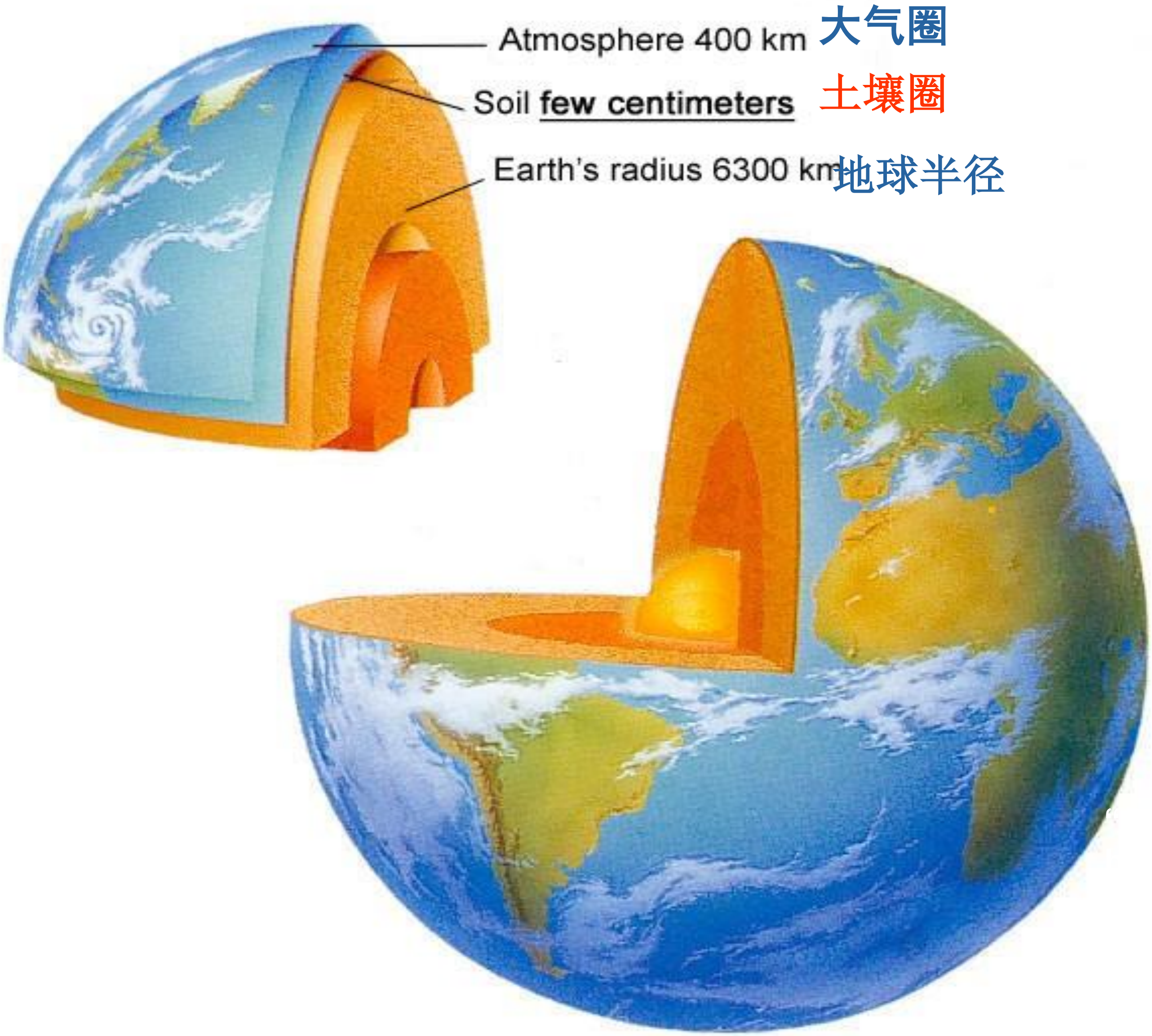
Source: FAO **Hurni, 2009**



«Human beings can survive if the loss of <u>OIL</u> reserves, but cannot survive if the loss of <u>SOIL</u> resources»

人类失去油储备尚可生存，如果失去了土壤资源将无以生存。

Lester Brown, Earth Institute， April 2011



The wounding Earth's fragile skin

(Kaiser,2004)

Global Current Land Degradation of Differnt Types

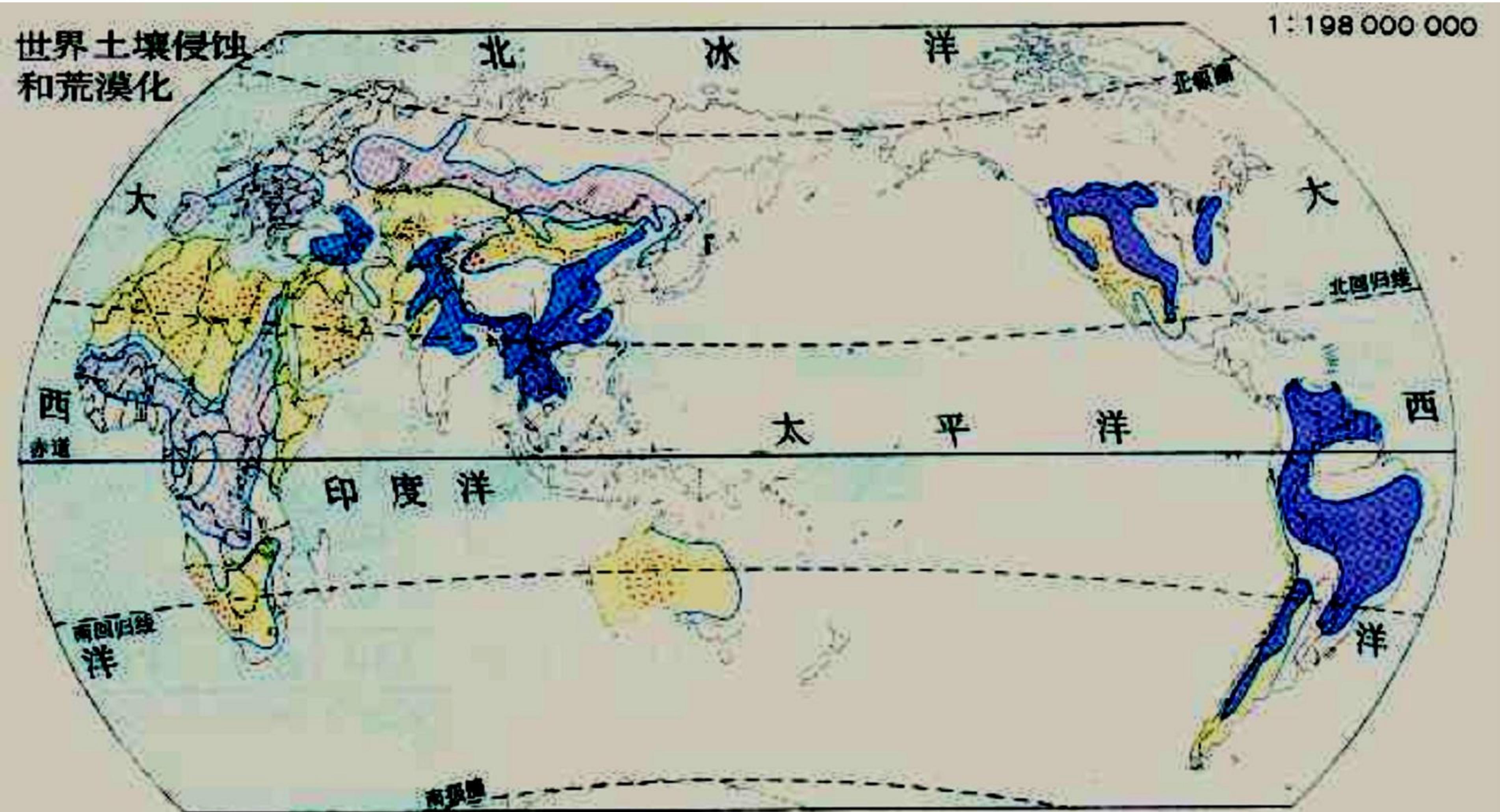
	Light	Moderate	Strong + extreme	Total
Water	343	527	224	1094
Wind	269	254	26	549
Chemical degradation	93	103	43	239
Loss of nutrients	52	63	20	135
Salinization	35	20	21	76
Pollution	4	17	1	22
Acidification	2	3	1	6
Physical degradation	44	27	12	83
Total	749	911	305	1965

Global Current Soil Degradation in Differnt Land Use

	Agricultural land			Permanent pasture			Forest and woodland		
	Total[1]	Degraded	%	Total[1]	Degraded	%	Total[1]	Degraded	%
Africa	187	121	65	793	243	31	683	130	19
Asia	536	206	38	978	197	20	1273	344	27
S. America	142	64	45	478	68	14	896	112	13
C. America	38	28	74	94	10	11	66	25	38
N. America	236	63	26	274	29	11	621	4	1
Europe	287	72	25	156	54	35	353	92	26
Oceania	49	8	16	439	84	19	156	12	8
WORLD	1475	562	38	3212	685	21	4048	719	18

[1] Source: FAO, 1990

The Map of Soil Erosion and Desertification



Severe eroded >100 T/ha.a
Moderate eroded 10-100 T/ha.a
Slight eroded< 10 T/ha.a

Desertification area
Desert area

Global Current Soil Erosion Area (10^4 km^2)

Class / type	L	M	H	VH	Total
Water Erosion	343.0	526.8	217.2	6.6	1093.6
Wind Erosion	268.6	253.5	24.3	1.9	548.3
Total	611.6	780.3	241.5	8.5	1641.9

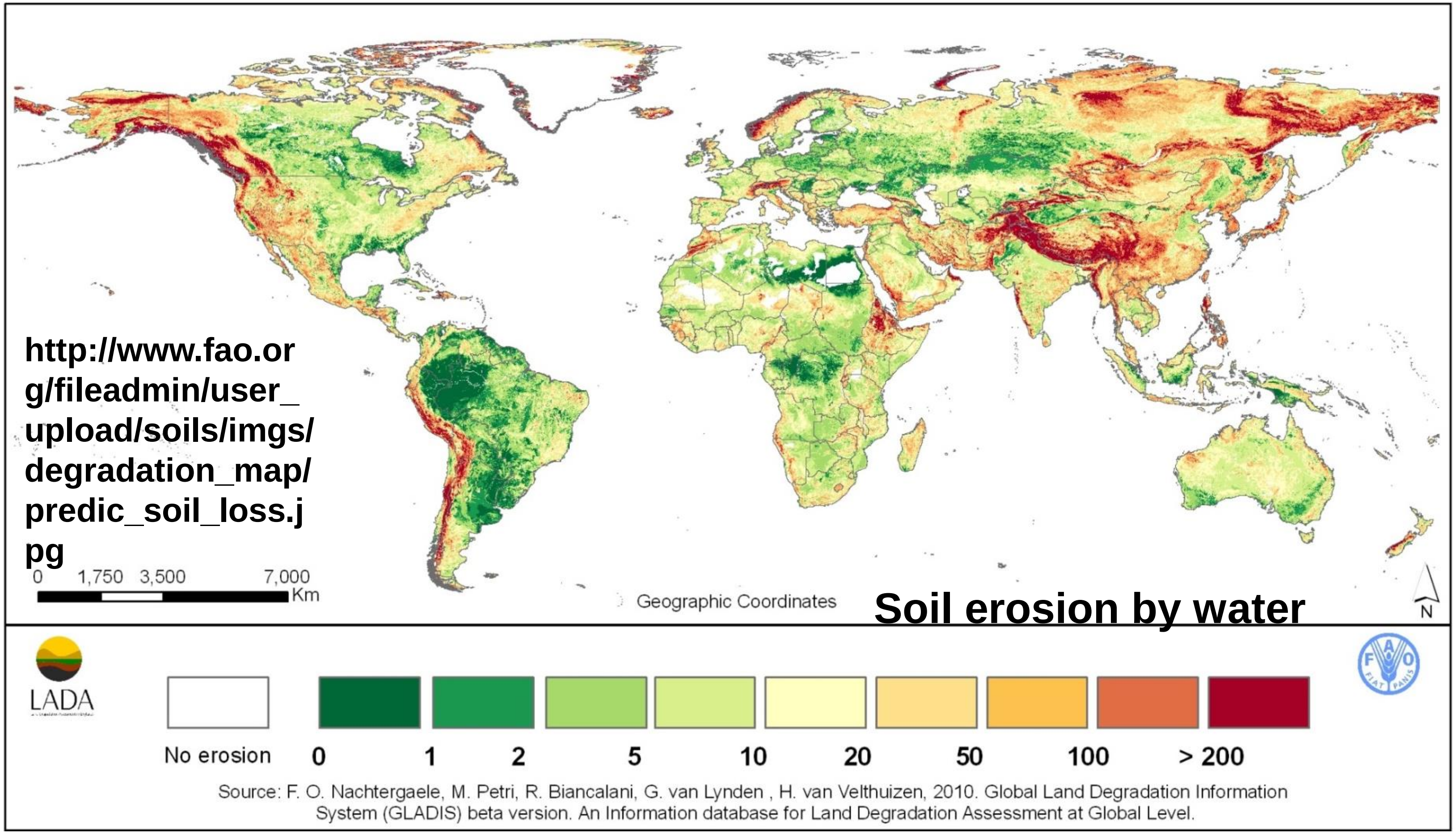
Global Current Soil Erosion

	Light	Moderate	Strong + Extreme	Total	Percentage of degraded soils	Dryland zone[1]	Humid zone[1]
Africa	58	67	102	227	46 %	122	105
Asia	124	242	73	441	59 %	165	276
S. America	46	65	12	123	51 %	35	88
C. America	1	22	23	46	74 %	38	68[2]
N. America	14	46	-	60	63 %		
Europe	21	81	12	114	52 %	48	66
Oceania	79	3	+	83	81 %	70	13
WORLD	343	526	223	1094	56 %	478	615

[1] Dryland zone is defined as the climatic region with an annual precipitation/evapotranspiration ration of 0.65 or less (UNEP, 1992a). The humid zone has a ratio of more than 0.65.

[2] North + Central America

Soil erosion by water



Many result in severe landscape deterioration by gullies and ravines or the silting up of dams downhill. It is the overall effect of accelerated erosion that is largely negative as most of the displaced soil and nutrients end up in rivers or dams and finally are largely lost in the sea.

Global Current Soil Erosion by Water

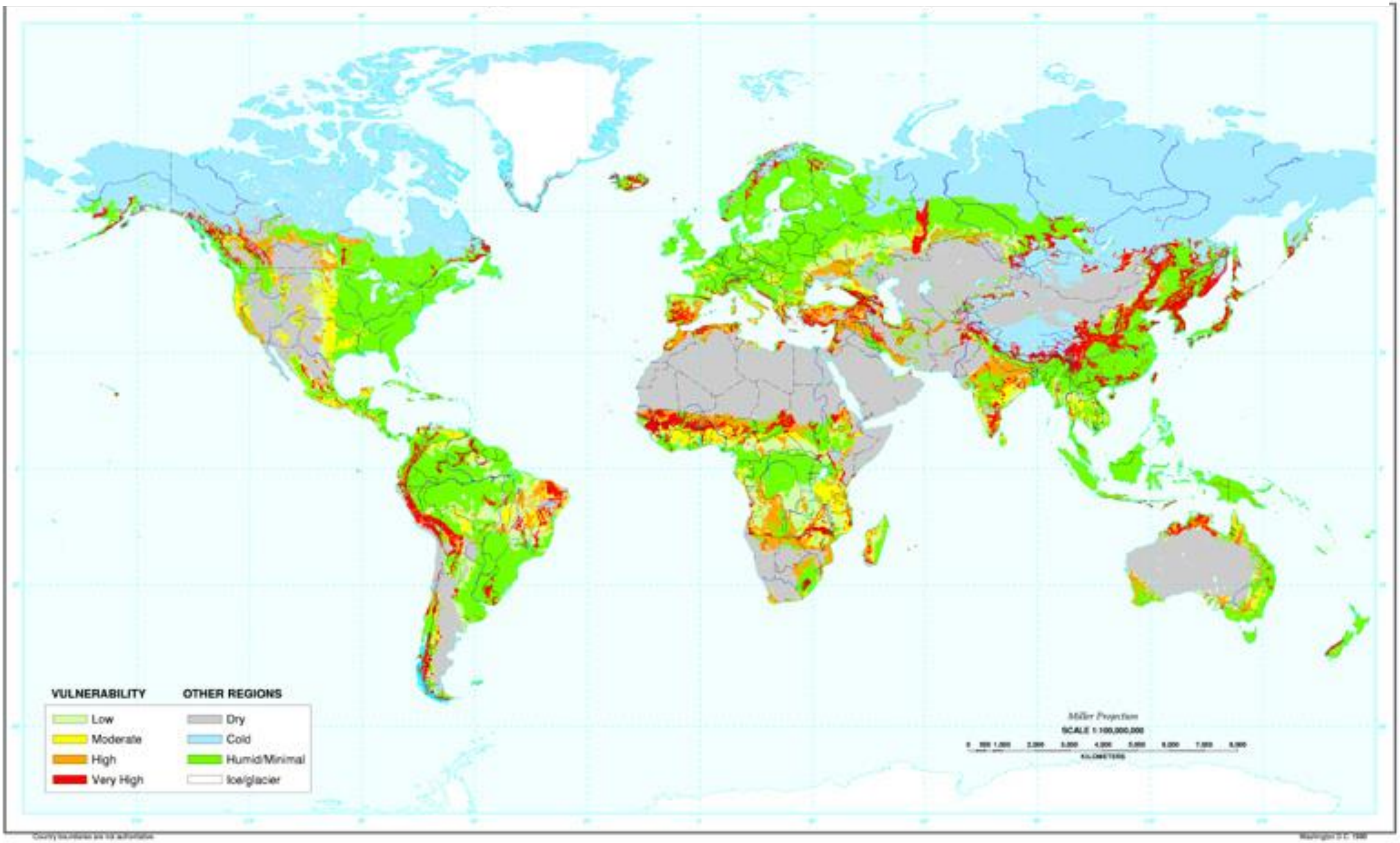
Table 1. Global and continental extent of Water Erosion in M ha

<table>
<tr><th></th><th>Light</th><th>Moderate</th><th>Strong + Extreme</th><th>Total</th><th>Percentage of degraded soils</th><th>Dryland zone[1]</th><th>Humid zone[1]</th></tr>
<tr><td>Africa</td><td>58</td><td>67</td><td>102</td><td>227</td><td>46 %</td><td>122</td><td>105</td></tr>
<tr><td>Asia</td><td>124</td><td>242</td><td>73</td><td>441</td><td>59 %</td><td>165</td><td>276</td></tr>
<tr><td>S. America</td><td>46</td><td>65</td><td>12</td><td>123</td><td>51 %</td><td>35</td><td>88</td></tr>
<tr><td>C. America</td><td>1</td><td>22</td><td>23</td><td>46</td><td>74 %</td><td rowspan="2">38</td><td rowspan="2">68[2]</td></tr>
<tr><td>N. America</td><td>14</td><td>46</td><td>-</td><td>60</td><td>63 %</td></tr>
<tr><td>Europe</td><td>21</td><td>81</td><td>12</td><td>114</td><td>52 %</td><td>48</td><td>66</td></tr>
<tr><td>Oceania</td><td>79</td><td>3</td><td>+</td><td>83</td><td>81 %</td><td>70</td><td>13</td></tr>
<tr><td>WORLD</td><td>343</td><td>526</td><td>223</td><td>1094</td><td>56 %</td><td>478</td><td>615</td></tr>
</table>

[1] Dryland zone is defined as the climatic region with an annual precipitation/evapotranspiration ration of 0.65 or less (UNEP, 1992a). The humid zone has a ratio of more than 0.65.

[2] North + Central America

The Map of Wind Erosion in world



http://soils.usda.gov/use/worldsoils/landdeg/papers/ersnpaper.html

Global Current Soil Erosion by Wind

Table 2. Global and continental extent of Wind Erosion in M ha

	Light	Moderate	Strong	Total	Percentage of degraded soils	Dryland zone[1]	Humid zone[1]
Africa	88	89	9	186	38	186	1
Asia	132	75	15	222	30	206	16
S. America	26	16	-	42	17	28	14
C. America	+	4	1	5	7	38[2]	1[2]
N. America	3	31	1	35	36		
Europe	3	38	1	42	19	39	3
Oceania	16	-	+	16	16	16	+
WORLD	269	254	26	548	28	513	36

[1] Dryland zone is defined as the climatic region with an annual precipitation/evapotranspiration ration of 0.65 or less (UNEP, 1992a). The humid zone has a ratio of more than 0.65.

[2] North + Central America

BACKGROUND

_L_and degradation and desertification threatens over 1 billion people in more than 110 countries around the world

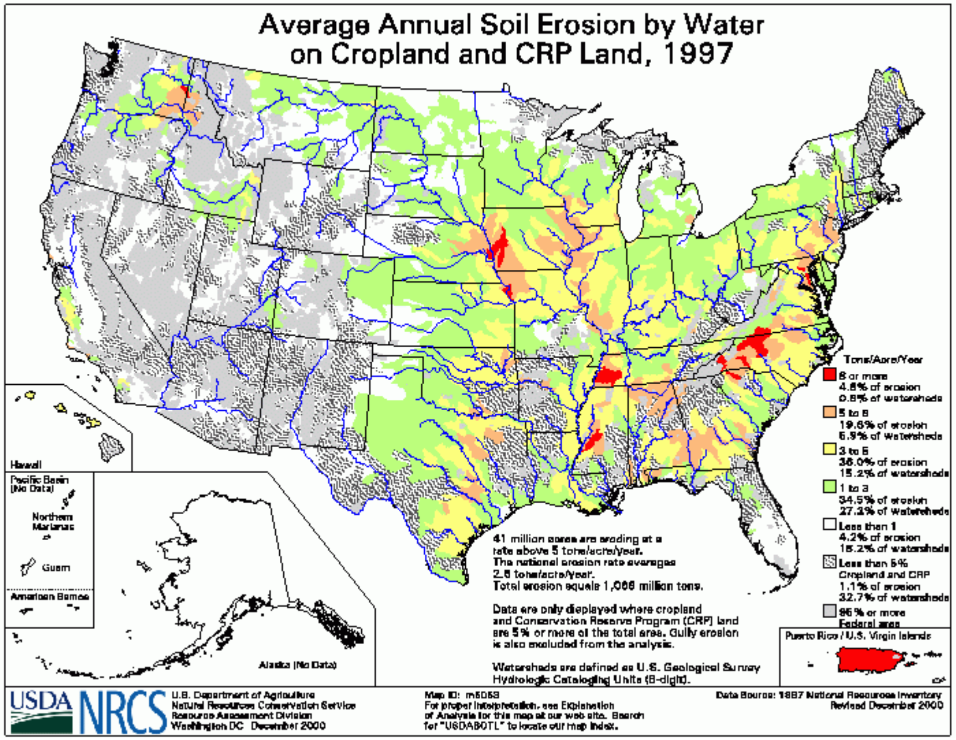
土地退化和荒漠化威胁到110个国家10亿人口

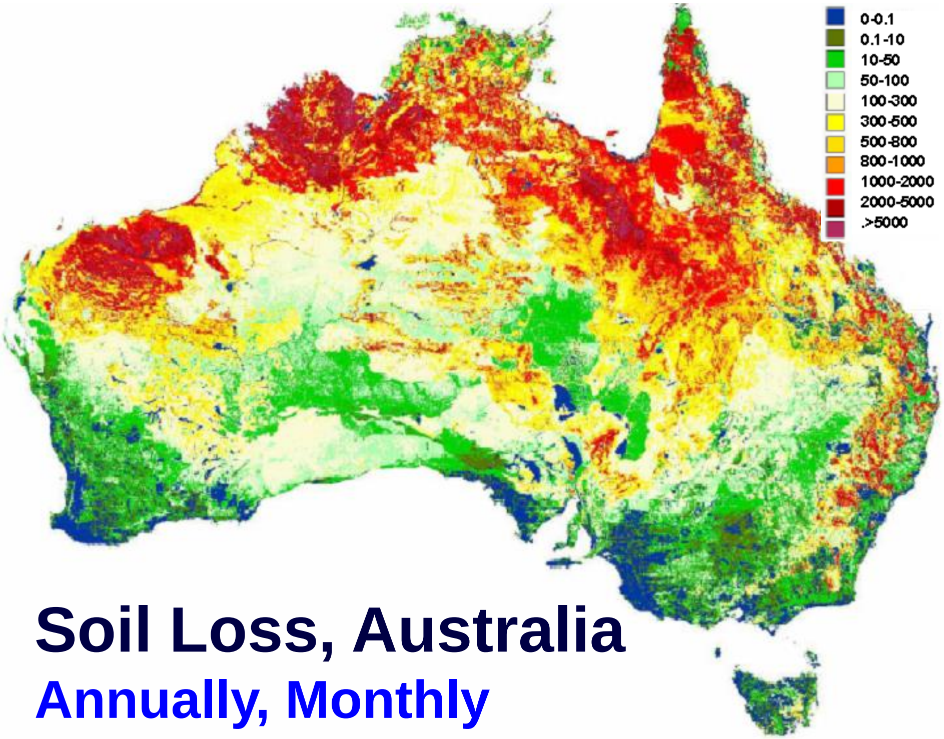
(The Global Mechanism, UNCCD)

Desertification makes 12 million hectares of land useless for cultivation every year

每年因荒漠化有1200万公顷耕地不能再耕种。

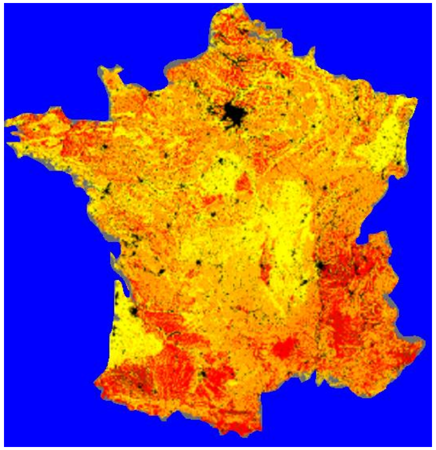
(Atlas of Population and Environment)

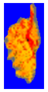


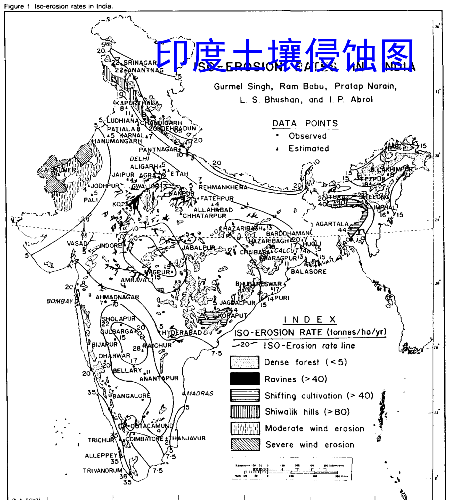


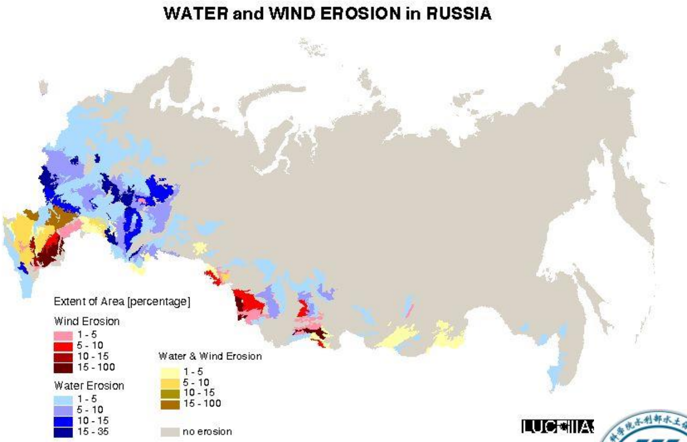
Soil Loss, Australia

Annually, Monthly









http://www.iswc.ac.cn/




Severe erosion area in USA

Severe erosion area in USA

Dust and sand storm
--Gansu province, China

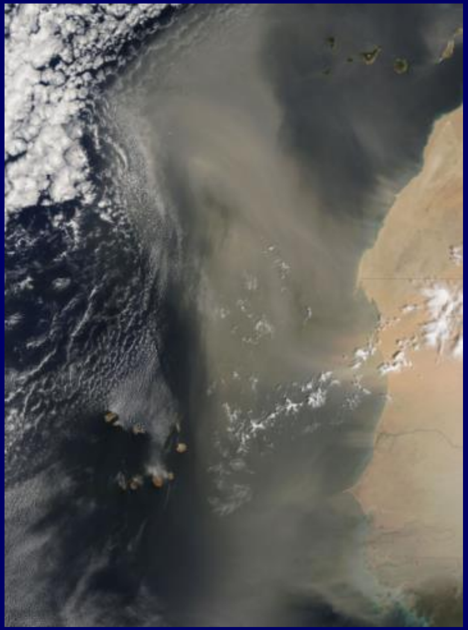
Severe erosion area in Europe

Introduction – Soils need protection

or contaminated by diffuse and local pollution

or, lost by water and wind erosion



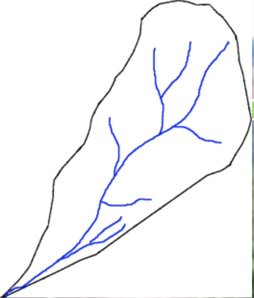
Introduction – Soils need protection

- Soils form slowly, on average in the range of a few mm/cm per 100 years under the combined effects of climate, parent material, flora, fauna and fire, but
- Soils degrade quickly, e.g. a single rainstorm can erode several cm (≈ centuries!) of soil, or an instantaneous pollution event can make the entire soil unusable

Soil erosion in the Južna Morava river watershed

Gully erosion on the arable land in the Južna Morava river watershed

Landslide in Uttaradit Province



27,154 ha Agriculture Area Damaged

How does it work? 恶性循环

Increasing demand for food, fiber, fodder by growing human and livestock populations

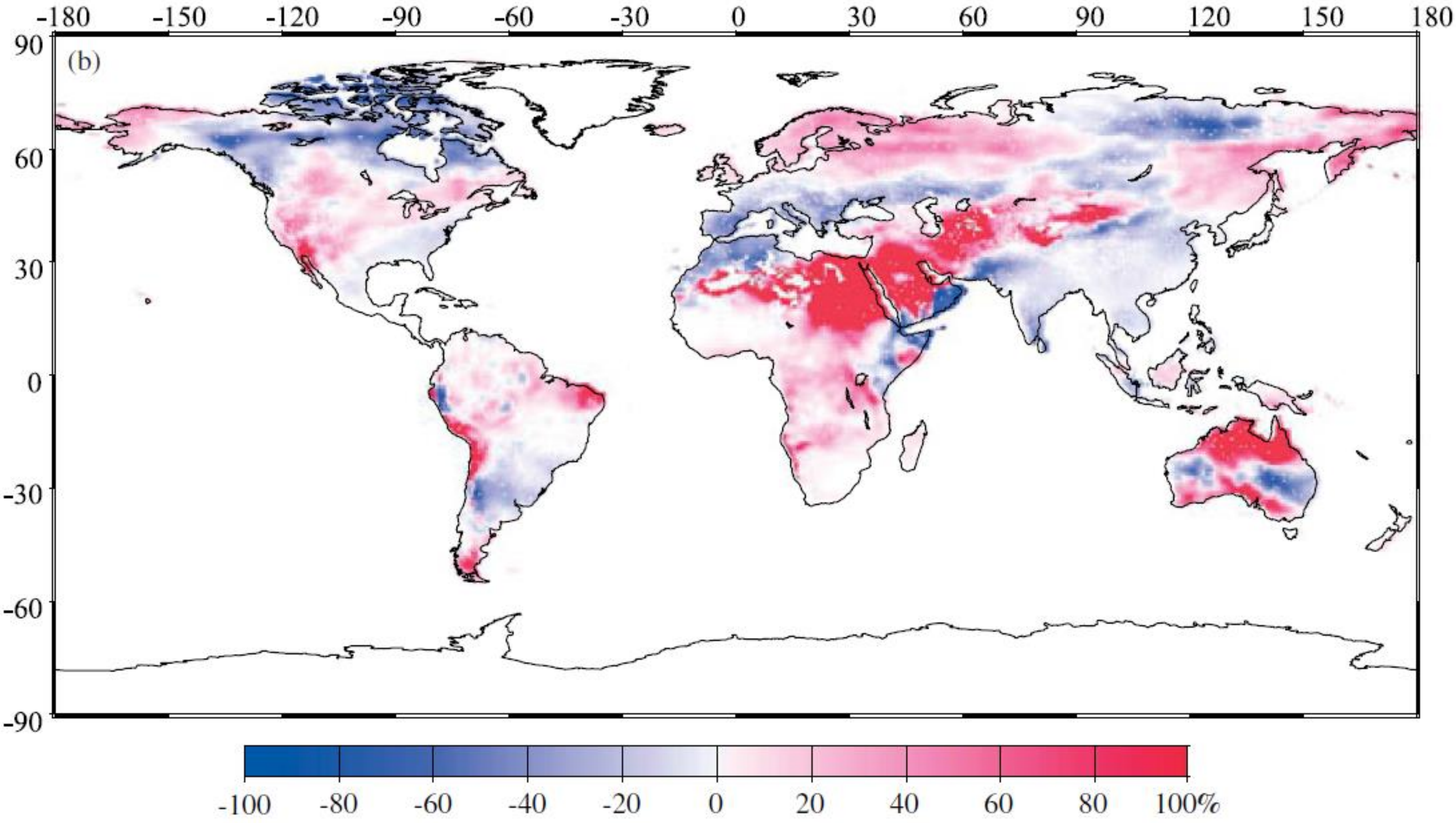
Over-exploitation of natural resources for cultivation, grazing, fuel wood and timber

Decrease of plant cover

Land degradation

High water and soil losses

Projection of soil erosion change in the 2090s due to global warming



Yang, 2013. Hydrological Processes

Potential soil erosion

Region	1900s	1910s	1920s	1930s	1940s	1950s	1960s	1970s	1980s	2090s
Whole world	8.7	8.9	8.9	9.3	9.3	9.7	9.9	10.1	10.2	11.6
Continents										
Africa	3.8	3.7	3.8	3.9	3.8	4.2	4.5	4.5	4.4	6.0
Asia	10.4	10.8	10.8	11.2	11.3	11.8	12.0	12.0	12.2	14.4
Australia	2.4	2.4	2.5	2.4	2.7	2.7	2.8	3.1	3.0	4.1
Europe	10.7	11.4	11.2	11.6	10.7	11.5	11.6	11.6	11.1	8.9
N. America	6.8	6.8	6.9	7.5	7.9	8.3	8.8	8.9	9.3	10.0
S. America	6.1	6.3	6.4	6.8	7.0	7.0	7.2	8.2	8.5	10.3
Selected countries										
China	14.9	15.6	14.9	15.1	15.0	15.0	15.0	14.9	14.7	14.2
India	14.3	15.1	15.3	16.2	16.6	17.1	16.6	16.8	16.8	15.5
Thailand	5.5	5.8	6.5	7.8	9.0	10.4	12.2	13.4	14.1	17.3
Selected basins										
Huanghe	7.7	7.8	7.2	7.8	7.6	7.7	8.2	7.4	7.5	6.2
Yangtze	29.1	31.0	28.8	29.5	29.3	30.0	29.9	29.5	29.1	26.5
Mekong	7.3	7.1	7.7	7.8	8.9	8.6	9.5	9.0	9.6	13.0
Ganges	38.3	40.7	40.0	40.8	40.9	39.7	40.1	41.0	42.2	40.7
Indus	20.6	19.8	20.9	19.5	19.6	22.3	21.1	21.0	21.5	20.4

(unit: ton ha^{-1} year^{-1})

Yang, 2013. Hydrological Processes

Change in soil erosion for the 21st century

Regions	Total change %	By land use %	By climate %
Whole world	13.9	5.3	9.0
Africa	36.2	18.8	15.7
Asia	11.9	3.6	8.2
Australia	51.1	8.0	42.4
Europe	-4.9	-7.7	3.9
North America	-6.9	-4.5	-2.2
South America	12.2	7.8	6.3

Yang, 2013. Hydrological Processes

How to do with the severe soil erosion?

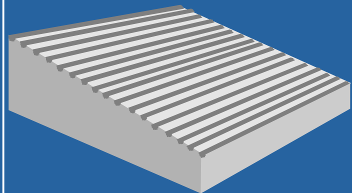
- ❖**Vegetation practices:** Plating tree, shrub and grass
- ❖**Engineering practices:** Terraced fields, Check dams, ditch, fish scals and others
- ❖**Tillage practices:** Contour farming, Nooe less till, stubble mulch and others
- ❖**Soil improving practices:** Using Chemical, physical and biological methods.

What is WOCAT?

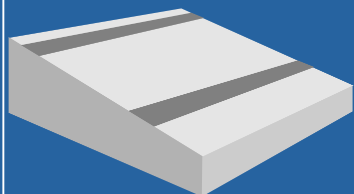
WORLD
OVERVIEW OF
CONSERVATION
APPROACHES AND
TECHNOLOGIES

Case Study Sites of SWC in the world

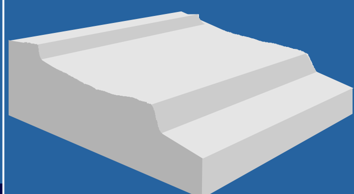
Potentials for prevention and restoration 全球防治水土流失措施



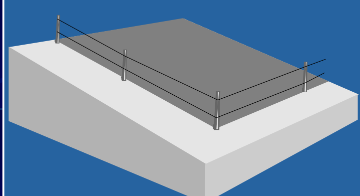
农耕 Agronomic measures such as mixed cropping, contour cultivation, mulching, etc.



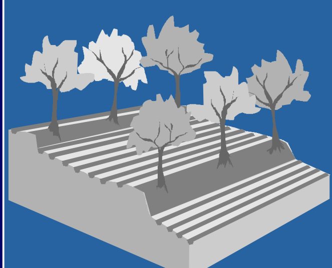
植被 Vegetative measures such as grass strips, hedge barriers, windbreaks, etc.



工程 Structural measures such as terraces, banks, bunds, constructions, palisades, etc



管理-Management measures such as land use change, area closure, rotational grazing, etc.

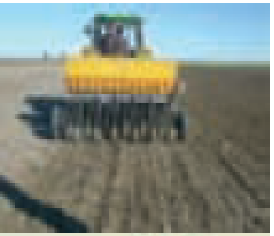


综 合 Combinations in conditions where they are complementary and thus enhancing each other.

In WOCAT prevention and restoration measures are categorized in agronomic, vegetative, structural, management, and combined options

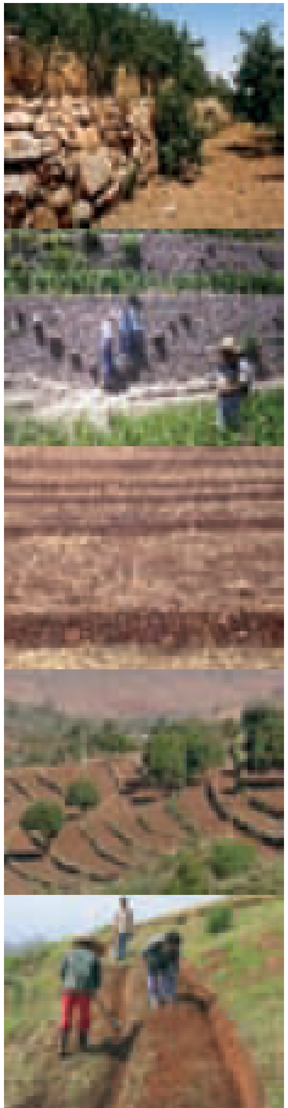
Case study Sites of measures

Conservation agriculture

	Morocco	**No-till technology** A no-till system with crop residue management for medium-scale wheat and barley farming. ➜ p 69	**Applied research and knowledge transfer** Innovative, cross-disciplinary community-based approach for development and transfer of no-till technology at the farm level. ➜ p 73
	UK	**Conservation agriculture** Improved soil management based on non-inversion tillage for cost-effective and timely crop establishment. ➜ p 77	**Soil management initiative** An independent organisation that promotes the adoption of appropriate soil management practices, especially conservation agriculture, within England. ➜ p 81
	Kenya	**Small-scale conservation tillage** Ripping of soil using oxen-drawn implements, to improve water storage capacity and cropland productivity on small-scale farms. ➜ p 85	**Self-help groups** Small-scale farmers forming self-help groups to provide mutual support for adopting and promoting conservation agriculture. ➜ p 89
	Australia	**No-till with controlled traffic** Large-scale no-till grain production with permanent wheel tracks common to all on-farm equipment. ➜ p 93	no approach described
	Australia	**Green cane trash blanket** Elimination of burning as a pre-harvest treatment of sugar cane, and managing the resultant trash as a protective blanket to give multiple on and off-site benefits. ➜ p 97	**The 'triple bottom line'** A new expression used by agriculturalists in Australia to explain why farmers change practices: the 'triple bottom line' implies economic, environmental and social concerns. ➜ p 101

Case study Sites of measures

Terraces



Syria

Peru

South Africa

Kenya

Thailand

Terraces (continued)

		Technology	Approach
	Nepal	**Traditional irrigated rice terraces** Level bench terraces with risers protected by fodder grasses, used for irrigated production of rice, potatoes and wheat. ➜ p 297	no approach described
	P. R. China	**Orchard terraces with bahia grass cover** Rehabilitation of degraded hillsides through the establishment of fruit trees on slope-separated orchard terraces, with bahia grass planted as protective groundcover. ➜ p 281	no approach described
	P. R. China	**Zhuanglang loess terraces** Level bench terraces on the Loess Plateau, converting erodible, sloping land into a series of steps suitable for cultivation. ➜ p 285	**Terrace approach** Highly organised campaign to assist land users in creating terraces: support and planning from national down to local level. ➜ p 289
	Philippines	**Rainfed paddy rice terraces** Terraces supporting rainfed paddy rice on steep mountain slopes: these have been in existence for more than a thousand years. ➜ p 293	no approach described

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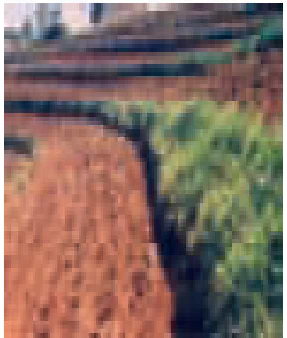
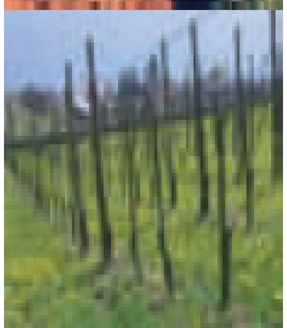
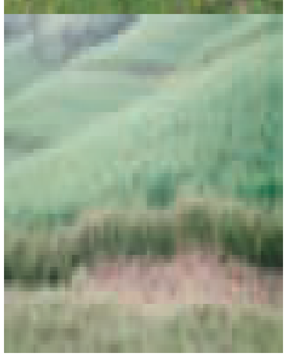
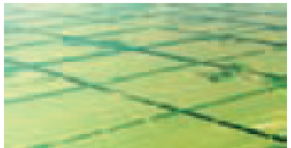
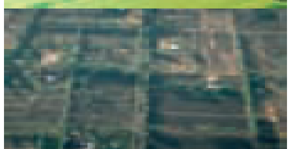
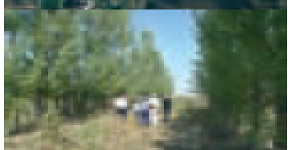
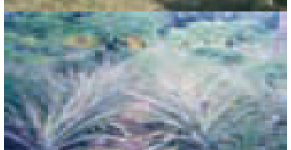
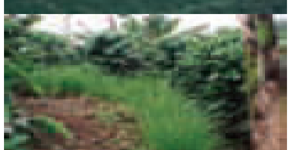
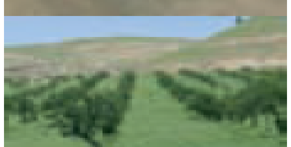
Case study Sites of measures

Vegetative strips/ cover

	Philippines	**Natural vegetative strips** Within individual cropland plots, strips of land marked out on the contour and left unploughed in order to form permanent, cross- slope barriers of naturally established grasses and herbs. ➜ p 129	**Landcare** Associations that help diffuse, at low cost, soil and water conservation technologies among upland farmers to generate income while conserving natural resources. ➜ p 133
	Switzerland	**Green cover in vineyards** Naturally growing or sown perennial grasses/herbs providing cover between rows in sloping vineyards, where the vines are usually oriented up and down slope. ➜ p 137	**Farmer initiative within enabling environment** Initiative and innovation of land users, stimulated by government's technical and financial support. ➜ p 141
	South Africa	**Vetiver grass lines** Contour lines of vetiver grass planted within fields of sugar cane, on stream banks and roadsides, to act as 'hedges against erosion'. ➜ p 145	**Self-teaching** Learning how to use vetiver grass as a vegetative conservation barrier through instructions from a booklet and hands-on, practical experience. ➜ p 149

Case study Sites of measures

Agroforestry

	Country	Technology	Approach
	P.R. China	**Shelterbelts for farmland in sandy areas** Belts of trees, planted in a rectangular grid pattern within areas of farmland, to act as windbreaks. ➔ p 153	no approach described
	Kenya	**Grevillea agroforestry system** Multipurpose *Grevillea robusta* trees planted along farm boundaries, on terrace risers and occasionally scattered in cropland. ➔ p 157	**Spontaneous spread** Spontaneous land users' initiative to meet household needs – especially firewood and timber – through planting *Grevillea robusta* trees as part of an agroforestry system. ➔ p 161
	Kyrgyzstan	**Poplar trees for bio-drainage** Poplars planted to lower the ground water table and reduce salinity where irrigation drainage systems have broken down; lucerne cultivated between the tree lines. ➔ p 165	no approach described
	Philippines	**Multi-storey cropping** Cultivating a mixture of crops with different heights (multi-storey) and growth characteristics which together optimise the use of soil, moisture and space. ➔ p 169	no approach described
	Colombia	**Intensive agroforestry system** A protective and productive high-input agroforestry system comprising multi-purpose ditches with bunds, grass barriers, contour ridges, annual crops and fruit trees. ➔ p 173	**Integrated rural community development** Development of an impoverished indigenous reserve – incorporating alternative land use systems – through intensive training provided by a small NGO. ➔ p 177
	Costa Rica	**Shade-grown coffee** An agroforestry system which combines coffee with shade trees – including fruit, timber and leguminous species – in a systematic fashion. ➔ p 181	**Agroforestry extension** Participatory extension of agroforestry systems, especially of shade-grown coffee, to promote sustainable and productive use of natural resources among small and medium scale farmers. ➔ p 185
	Tajikistan	**Conversion of grazing land to fruit and fodder plots** Fencing-off part of an overgrazed hillside, combined with terracing, manuring and supplementary irrigation for grape, fruit and grass production. ➔ p 189	**Farmer innovation and self-help group** Overcoming administrative and technical problems, an innovative land user, assisted by a self-help group, has established a fruit garden within degraded communal grazing land. ➔ p 193
	Tajikistan	**Orchard-based agroforestry** An agroforestry system where legumes and cereals are planted in fruit orchards, giving simultaneous production and conservation benefits. ➔ p 197	**Transition from centralised regime to local initiative** A land use system established during the authoritarian regime of the Soviet Union is being adapted to farmers' needs through their own initiative. ➔ p 201

Case study Sites of measures

Water harvesting

India

Sunken streambed structure

Excavations in streambeds to provide temporary storage of runoff, increasing water yields from shallow wells for supplementary irrigation.

→ p 205

Comprehensive watershed development

Participatory approach that includes a package of measures leading to empowerment of communities to implement and sustain watershed development.

→ p 209

Niger

Planting pits and stone lines

Rehabilitation of degraded land on gentle slopes through manured planting pits, in combination with contour stone lines.

→ p 213

Participatory land rehabilitation

Planning and management of individual and village land, based on land users' participation, with simultaneous promotion of women's activities.

→ p 217

Syria

Furrow-enhanced runoff harvesting for olives

Runoff harvesting through annually constructed V-shaped microcatchments, enhanced by downslope ploughing.

→ p 221

Participatory technology development

Participatory technology development, through close researcher-farmer interaction, for sustainable land management of olive orchards in dry marginal areas.

→ p 225

Continuous mulch

Agronomic measures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Structural measures

Structural Farmland

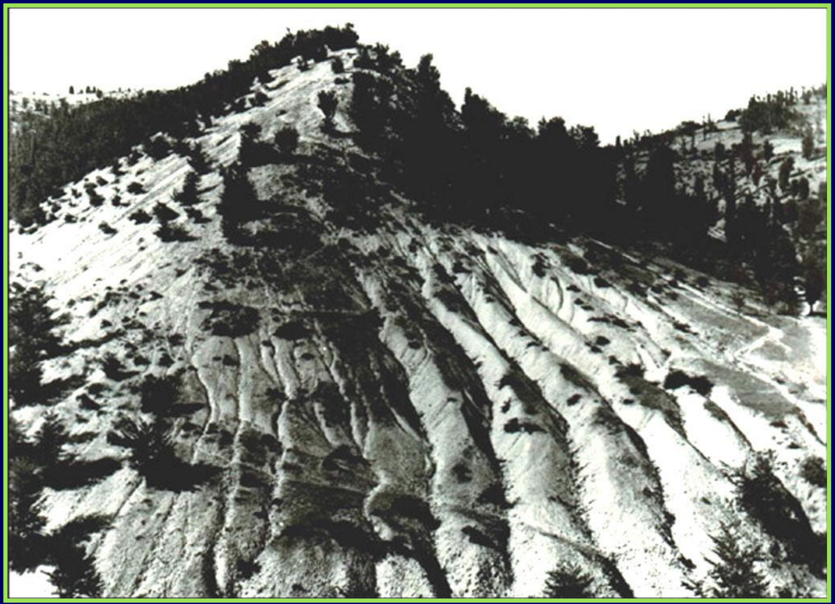
left: Aerial view over Zhuanlang county where 90% of the hillsides are covered with terraces. Reducing runoff and erosion, maintaining soil fertility and making farming operations easier are key for rainfed agriculture in this semi-arid environment. (He Yu)
right: A 4 m high terrace riser, where the lower part is vertical and bare – demonstrating the stability of the loess soil at this depth. The upper part is sloping, and stabilised with grasses, bushes and trees. (Hanspeter Liniger)

Zhuanglang loess terraces

China – 庄浪水平梯田

Level bench terraces on the Loess Plateau, converting eroded and degraded sloping land into a series of steps suitable for cultivation.

The Loess Plateau in north-central China is characterised by very deep loess parent material (up to 200 m), that is highly erodible and the source of most of the sedi






Conclusion

Soil erosion is a big problem in the world. The Climate change has become an indisputable fact and resulted in a variety of impacts on soil erosion environment

Many countries have made great efforts to create a lot of successful experiences and examples of SWC to adapt climate change and the changing world.

There is long way to go for SWC on mitigation and adaptation to changing world.

Suggestions

01

To monitor, assessment and predict the impacts on soil erosion caused by climate change and human activities

02

To integrate and extend the existing models of soil and water conservation to adapt to climate change and to meet the needs of natural and social development

03

To develop new knowledges including theories, models, and technologys of soil and water conservation to adapt to the changing world

Thank You for your attention