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## **Desertification and Theories of Desertification Control: A discussion of Chinese and European concepts.**

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### **Historical background**

Early 1900: The word “desertification” was introduced by the French scientist Aubreville (1949) in his report “Climats, forêts et désertification de l’Afrique tropicale”. The concept was discussed earlier by European and American scientists in terms of increased sand movements, desiccation, desert and Sahara encroachment and man made deserts (Boville 1921, Coching 1926, Renner 1926, Stebbing 1935, 1938, Lowdermilk 1935, Jones 1938).

At this time, desertification meant the spreading of deserts or desert-like conditions. The symptoms of the phenomena were often related to sand movement and encroachment into oasis and desert margins. Aubreville (1949) also stated that there are real deserts being born today, under our very eyes, in the 700-1500 mm annual rainfall areas.

One school favored the idea of a postglacial climate change (desiccation, gradually increasing aridity) as a major driving force causing desertification. Others stressed the importance of human impact. The human impact was expressed in terms of bad land management including over cutting, overgrazing, over cultivation and misuse of water leading to salinization.

The American “Desert Bowl” forced millions of people to leave their farms in the American Great Plains in the 1930’s. The drought and land degradation catastrophe had an important impact on the western scientific thinking for a long time initiating research and development efforts in soil erosion and soil conservation techniques (Thomas and Middleton 1994).

Since then, different concepts of desertification have developed and been discussed over and over again by scientists, politicians and the international aid and development society. Renewed international concern can usually be related to the outbreak of major periods of drought and famine in the Sahelian part of Africa.

Late 1900: Very important international events were the UN Conference on Desertification (UNCOD) in Nairobi 1977, the UN Conference on Environment and Development (UNCED) in Rio de Janeiro 1992 followed up by the UN Convention to Combat Desertification (UNCCD) adopted in 1994 and entering into force in 1996. In 2003 UNCCD designated the Global Environment Facility (GEF) as a financial mechanism to assist developing countries in implementing the Convention (GEF 2003). GEF expects to commit more than US\$500 million to help reduce land degradation in developing countries during the 2003-2006 period.

UNCOD in 1977 was called upon as a result of the severe drought and repeated crop failures that struck the Sahelian zone in Africa during the 1965-1973 period (the Sahelian Drought). It was concluded that desertification was not only an African problem but also a problem of global significance as stressed by Thomas and Middleton (1994). Several definitions were presented in the UNCOD documentation summarized by Mainguet (1991), Helldén (1991)

and Thomas and Middleton (1994). It was implicitly understood that desertification leads to “long lasting” and possibly “irreversible” desert-like conditions. “Decreasing productivity” is a key process included implicitly or explicitly in most definitions. Desertification was commonly considered to affect arid, semi-arid and sub-humid ecosystems by the combined impact of droughts and human activities. The relative role of climate, droughts and human impact was discussed. The key problem was identified as a chronic process of land degradation in which man’s occupation and use of the drylands was playing the major role. Drought was rather seen as a catalyst which exposed the effects of the long-term degradation caused by people (Thomas and Middleton 1994). The most important causes of desertification were the same as reported during the first decades of the century i.e. over cutting, overgrazing, over cultivation and misuse of water.

UNCOD formulated and adopted the Plan of Action to Combat Desertification (PACD), endorsed by the UN General Assembly in 1977. The responsibility for following up and coordinating the plan was given to the UN Environment Programme (UNEP). The desertification prone countries were urged to develop National Plans of Action to Combat Desertification. This was seen as a fundamental instrument for the implementation of the PACD recommendations. Many national plans have been written but few, if any, have ever been financed and implemented. The rhetoric, and sometimes unrealistic, content of many of the national plans was pointed out by Thomas and Middleton (1994).

UNEP’s concept of desertification was seriously challenged by groups of scientists during the 1980’s and at the beginning of the 1990’s (Helldén 1984, 1988, 1991, Mainguet 1991, Thomas and Middleton 1994). The mere existence of desertification, as the UN described it, was questioned. The word “myth” circulated in scientific publications and mass media. The criticism probably contributed to a UNEP initiative to modify the prevailing concept of desertification in 1990.

The new definition introduces the idea that desertification does not need to lead to the development of deserts or desert-like conditions. It simply refers to all types of land degradation in the drylands of the world. Human adverse impact on the environment is considered to be the only cause of desertification (Rozanov 1990, UNEP 1990):

-Desertification/land degradation, in the context of assessment, is land degradation in arid, semi-arid and dry sub-humid areas resulting from adverse human impact.

”Land” in this concept includes soil and local water resources, land surface and vegetation or crops. “Degradation” implies reduction of the resource potential by one or a combination of processes acting on the land, including water and wind erosion, sedimentation and siltation, long-term reduction in the level of diversity in natural vegetation, crop yields, soil salinization and sodication.

In mid-1991 UNEP changed the concept again (Helldén 1991):

-Desertification is land degradation in arid, semi-arid and dry sub-humid areas resulting *mainly* (author’s italics) from adverse human impact.

The UN at UNCED redefined the definition once more in 1992. The new definition is confirming that desertification is the same thing as land degradation. New is the recognition that not only human impact but also various factors including climatic variations are

important causes of land degradation in the drylands. The definition and concept reminds of the old discussions that took place during the first decades of the 20<sup>th</sup> century.

- Desertification is land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities (UNCED 1992).

The Earth Summit in Rio de Janeiro resulted in the action plan and recommendations documented in Agenda 21 (UNCED 1992). Beside general and global recommendations of conventional soil conservation and land rehabilitation measures many of the most important recommendations cover the sphere of socio-economy and are as valid for poverty fighting and general development measures as they are for desertification control. Socio-economic issues, mainly as indicators of desertification, were discussed already at UNCOD in 1977. However, socio-economic and political factors are now recognized as important driving forces behind bad land use contributing to land degradation and desertification.

UNCED was followed up by the UNCCD in 1994. National Action Programmes (NAP) is one of the key instruments in the implementation of the Convention similar to UNCOD's previous approach in the Plan of Action to Combat Desertification. More than 40 countries have provided copies of their NAP to the UNCCD Secretariat, most of them during the present millennium. China did so already in 1996.

Desertification mitigation approaches and control success or failure varies with concepts of causes and consequences. Nowadays, there is a rich flora of handbooks on all kinds of biophysical theories and practical techniques on how to fight land degradation and desertification assuming it is caused by human impact on the environment (e.g. Wenner 1977, Hurni 1985, Hudson 1985, Mainguet 1991, Lal 1994, Morgan 1995). The handbooks cover most aspects of soil conservation (wind & water erosion control e.g. shelterbelts, fencing, bunding, sand fixation, terracing, water harvesting, gully control, species recommendations, plowing techniques, nursery establishment), irrigation, rangeland management and grazing strategies, forestry, agro-forestry and agriculture.

The degradation control difficulties increase when it comes to considering the importance of climate variability in the desertification process. The difficulties grow when the social and economic causes and consequences of human and climate-induced desertification have to be addressed and controlled. The control problem grows even more when alternative survival strategies, i.e. leaving the land or stop using it for agriculture, is considered the only available solution to save the affected people and land. This might very well be the best response to climate change. It implies that biological-physical control measures must be replaced by or combined with, social, economic and political measures.

Some aspects of these problems are discussed below through a presentation of a few recent and relict desertification and mitigation cases. The discussion is based on listed references and my own field experience of land degradation and desertification in Africa, Europe and Asia since the mid 1970's.

### **Africa**

The symptoms of desertification in the Sahelian countries, bordering southern Sahara, has been described in terms of sand drift, dune movement and Sahara encroachment into desert oasis and infrastructure and into neighboring rangelands and cultivated lands. It has also been described as the development of new deserts or desert-like conditions inside the savanna

zone, growing out from villages, permanent cultivations and waterholes, causing declining biological productivity in all areas affected. Human impact is considered the major driving force by exhausting the soil nutrients, mining the soil minerals and clearing the vegetation cover through existing land use activities. It is thereby exposing the ground for accelerating soil erosion (mainly wind erosion) in a vicious circle. However, the debate about the relative importance of climate compared to human impact as driving forces of desertification is still going on. Eklundh and Olsson (2003) recently observed a strong increase in seasonal NDVI over large areas of the Sahel during the period 1982-1999 based on a NOAA AVHRR study. The increase was interpreted as a vegetation recovery from the drought periods of the 1980's. Preliminary analysis indicates increasing rainfall during the period.

The cure in most desertification control plans aims at reclaiming lost land through the control of erosion by reestablishing or improving the vegetation cover. Techniques recommended include sand dune fixation, wind shelter belts, reduction of grazing pressure, agroforestry and introduction of fodder plants, reforestation, establishment of new water bore holes and even establishment of "green belts" along the Sahara to stop its encroachment southwards.

More than 25 years after UNCOD it has still not been possible to demonstrate that these programs in the Sahel have had any overall measurable effect on desertification. No reliable cost-benefit analysis seems to exist to estimate any regional, national or local success.

The role of underlying socio-economic desertification related factors like land access, ownership and tenure regulations, level of education, poverty, attitude to land degradation, access to a free market, taxation, alternative livelihoods, migrations, urbanization, cultural traditions, and demography are seldom considered in the plans or project implementations. The existence of, or lack of, incentives for the farmer and his family to keep up a sustainable land use is of course essential but often overlooked. The same is true for the possible impact of a climate change causing desiccation and the creation of desert-like conditions. If the people in some of the desertification affected areas are facing such climate changes (short term variability or long term change, regional or global) planting trees and establishing "green barriers" is a likely waste of time and money. Alternative survival strategies have to be identified and implemented.

In East Africa, e.g. Ethiopia and Kenya, land degradation is often related to high mountain areas. Deforestation, cultivation of steep slopes and intensive rainfalls are causing severe water erosion. The recommended cure in most control plans includes terracing efforts, beside general efforts to reclaim vegetation, wood and fuelwood resources through agroforestry and afforestation programs. Huge international aid funded (e.g. Work for Food) terracing and agro-forestry programs have been implemented in Ethiopia over the years. They seem to have been successful in checking water erosion. When combined with land rehabilitation measures of socio-economic character they have some times been successful in increasing the well-being and standard of living of the people. A good example is Machakos in Kenya (World Bank 1992). On the other hand there are examples of huge terracing programs with a questionable environmental and economic effect. This is true in the driest parts of Ethiopia suffering from long severe drought periods and a possible desiccation trend. The terracing programs carried out in these areas are probably a waste of efforts based on the misleading assumption that what is good policy and works well in one part of the country (or the continent) should work as well in any other part overlooking differences in climate, ecology, economy, culture and human activities. Terracing, combined with protective fencing, is also used in very dry regions north of the Sahara, e.g. in Tunisia. As an example, huge low rainfall

(150-250 mm) rangeland areas in central Tunisia (Sidi Bouzid and Hicheria region) were terraced during the second half of the 20<sup>th</sup> century as a water harvesting technique to increase water infiltration and to decrease water erosion (SIDA 1983). The project was made possible through international development funding. When the funding vanished the result often became deserted terraces with dead vegetation.

## **Europe**

The UNCED (1992) and UNCCD definition of desertification has been fully adopted in Europe. Most of the research and the control activities are focusing on the Mediterranean part of the European union. There are however, large areas outside the arid, semi-arid and dry sub-humid parts of Europe where land degradation has lead to the creation of large true deserts and desert-like environments. These areas may exemplify recent and relict severe degradation caused both by climate change and/or human impact.

According to the Icelandic erosion assessment programme the degraded areas cover 40% of Iceland. The scientific and political societies in Iceland often relate the land degradation problems to human over use of the rangelands, starting with the introduction of cattle and sheep raising at the time of the settlement in 874 A.D. They consider overgrazing and overuse of the forests for fuelwood and charcoal production to be the most important processes opening and exposing the landscape for soil erosion with growing desert patches and deserts as a consequence.

Most farmers on the other hand, seem to believe that the desert patches and deserts are natural phenomena (Helldén and Ólafsdóttir 1999a, 1999b and Olafsdóttir 2001). The initiation and expansion of the phenomena are supposed to be related to infrequent climatic events (winter storms), possibly enhanced by the traditional winter grazing custom, no longer practiced. A majority of the Icelandic farmers interviewed seems to be of the opinion that the “desertification” problem does not have any economic or management significance.

The observations and results presented by Helldén and Ólafsdóttir indicate that the importance of climate may have been underestimated as a possible and important contributor to land degradation and desertification in Iceland. They assume that cold and dry periods have favored the development and expansion of desert patches and deserts. It is indicated that the Little Ice Age (1200-1900), especially during the second half of the 19<sup>th</sup> century, offered favorable conditions for frost initiated soil exposure followed by events of severe wind and water erosion. An outstanding high rural population pressure and a correspondingly high grazing pressure adding to the degradation risk in the study area also characterize the second half of the 19th century.

Quite different approaches are obviously needed to control land degradation on Iceland depending on which desertification theory and cause is accepted. The importance of climate impact versus human impact must be analyzed before any cure can be successfully applied.

The farmers in south Sweden suffered from severe desert encroachment characterized by sand creep and shifting dunes at the end of the 18<sup>th</sup> century. The reason was previous vegetation clearing of glacio-fluvial sand plains in central Scania (Vombsankan) and along some of the coastal dune areas to expand cultivations and grazing lands for a growing population (Glimberg 1964). The moving sands were fixed and afforested in the 19<sup>th</sup> century and at the beginning of the 20<sup>th</sup> century to stop the encroachment. It started through a local

farmer initiative. The pressure of human activities decreased considerably during the first decades of the 20<sup>th</sup> century thanks to the general economic development and the related urbanization processes. The sandy lands became forest and rangeland. Dune encroachment is no longer a severe problem.

The northern part of the Swedish west coast (Bohuslän) tells a different story. The coastal land was probably forested at the end of the Viking time (11<sup>th</sup> century). Since that time, periods of extremely rich abundance of herring along the coast attracted very large amounts of people from all over Europe to settle along the coast and in the archipelago from time to time. The first documented period took place 1083-1138 followed by an intense herring period every 100 years (Wibeck 1917). Intensive forest cutting for timber (housing and ships) and fuelwood (cooking, heating, herring oil cooking plants) took place all through medieval time. Vast land areas were also cleared for cultivations and grazing through deforestation and burning. Soil erosion accelerated to such a degree that both vegetation and soils had disappeared completely from vast areas at the end of the 17<sup>th</sup> century or even earlier. Thousands of km<sup>2</sup> turned into an almost irreversible bedrock desert or desert-like condition. No land reclamation programs were ever started. The last important herring period took place during the second half of the 18<sup>th</sup> century followed by a shorter period at the end of the 19<sup>th</sup> century. The population pressure decreased dramatically during the first half of the 20<sup>th</sup> century because of the decreasing fishing industry importance, the general industrial and economic development and the related urbanization process. Today, the combined fishing and agricultural economy has almost vanished, the grazing heath lands have turned into forests and the desert like bedrock coastland and archipelago has become a very popular summer vacations and recreation area. The once poor fishing villages have all turned into summer crowded resorts. Parts of the man made desert are protected as nature reserves. There are now signs of a slow natural revegetation process as a result of the decreased population pressure and a more favorable climate replacing the Little Ice Age.

## **China**

China has suffered from desertification for thousands of years. It is a serious problem affecting large parts of the rural population. It relates a lot to sand encroachment and moving dunes. Zhenda et al. (1986) states that “the desertification process denotes the dynamics of wind erosion which covers the wind erosion of the surface, surface roughening, the development of block drifting sand and the formation and evolution of intensive sand dunes”.

The human factor is considered to be the direct and major cause of desertification (Zhenda et al. 1988, Zhenda and Tao 1993, Zhenda and Shuhong 1995,). This was recently confirmed by local farmers in Inner Mongolia in an attitude study carried out by Lund university in cooperation with the Chinese Academy of Sciences (Brogaard and Xueyong 2002). The farmers also acknowledged the importance of the 30-year contract on cultivated land in 1997 for their investment in long-term management, but emphasized the importance of chemical fertilizers for short-term economic survival, according to the same study. Although human impact is considered the main cause of desertification voices have also been raised indicating the importance of climate variability in the process (Li and Lin 1993). Obviously the discussion of land degradation in China makes a difference between desertification (meaning sand movement and sandy desert encroachment mainly) and other types of land degradation (e.g. gullying in the loess badlands, dam siltation problems, salinization) (Zhenda and Tao 1993, Jinzhu 1990). This is in disagreement with the European and UN concepts.

There is no doubt Chinese scientists and government institutes have been successful in their fight against land degradation and desertification. Mainget (1991) pointed out that it is noteworthy that Chinese scientists are active at all stages in the battle against land degradation. Sand and dune stabilization including afforestation and the development of intensive irrigation systems are solutions often chosen in the desertification control work. There are even satellite monitoring based results indicating a general increase in biomass production during the 1980's and 90's as a result of active measures to halt desertification in the Mu Us Sandy Land (Runnström 2000, 2002). There are however also contradicting reports indicating ongoing desertification in the very same area (Wu and Ci 2000).

According to a recent GEF news release, land degradation, which includes desertification, can be described in terms of loss of biodiversity, reduced subterranean carbon sequestration, and pollution of international waters (GEF 2003). In China, a new 15 million US dollar GEF grant is supporting a government campaign to protect the dry environments of the country's impoverished western region threatened by land degradation according to the same news release. The money will be used to help coordinate the government's efforts to engage local residents in hands-on conservation.

### Conclusion

The causes and consequences of desertification cannot be generalized on a global, continental, regional or even national level. They are site specific. Every site and case needs its own diagnosis, based on an integrated and systemic research approach, before the right cure, often complex and integrated in nature, can be identified and implemented. A successful cure is likely to include action of both social, economic, political, biophysical and local participatory character. It also includes an integrated monitoring and evaluation program to measure indicators of desertification, carry out cost-benefit analysis, recognize success, avoid repeated mistakes and initiate positive feedback mechanisms.

To avoid expensive desertification control programs in the future there is a need for a globally valid prevention strategy: use international development funding to build more schools and universities, subsidize the rural students and raise the salaries of the teachers in the desertification affected countries.

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