WATERSHED MANAGEMENT – AN INTRODUCTION

Gerd Förch[1] and Brigitta Schütt[2]

[1] University of Siegen, Research Institute for Water and Environment, Paul-Bonatz-Str. 9-11, 57068 Siegen, Germany
[2] FU Berlin, Institute for Geographic Sciences, Malteserstr. 74-100, Haus H, 12249 Berlin, Germany

1. Introduction

The utilisation of natural resources, such as water and land, is today closely interlinked with the goals of sustainability and environmental appropriateness. The concept of watershed management has internationally gained significance following the United Nations Conference on Environment and Development in 1992 in Rio de Janeiro (also known as the Earth Summit). Watershed management as a measure of development implies that the resources within a defined watershed should be utilised for the benefit of the local population and in harmony with the environment. In this context, an integrated approach is applied: the watershed is understood as an ecological system which can only sustain as a unit. People are an integral part of the system, thus perceptions of resource utilisation have to be understood in the context of impacts on the environment. Planning and development are not carried out with the one-sided goal of satisfying any human need. Rather, the societal development goals are defined by the given environmental framework. Resources are only to be utilised as far as they are renewable, in order to preserve the basis of survival for future generations.

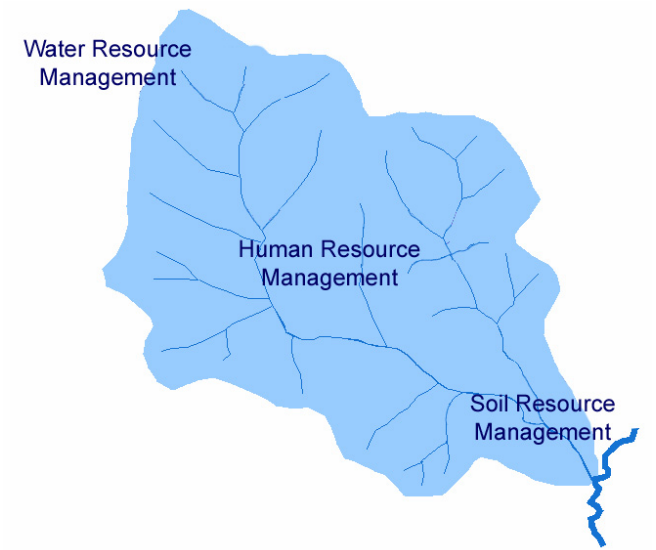

Figure 1 Components of Watershed Management

While priority is given to the use of land and water, it is also important that people can further develop their skills and knowledge in order to allow for an economically sustainable utilisation of resources. For instance, one should not employ bans on forest utilisation, but rather work with the local populations towards a

sustainable forest management concept.[1] The local population can benefit from the diverse range of forest products, including timber as well as non-timber products, such as honey, herbs and bush meat, by selling these on the market and thus improving their incomes in the long-run. In order for interventions and measures to be successful, it is critical that the local population can clearly define and implement its interests in the utilisation of the resources.

Watershed management relies on the participation of the population in planning, utilisation and monitoring and thus supports the building of democratic structures, especially in developing countries. Moreover, this concept is suitable for providing a framework for the utilisation of traditional social structures and traditional knowledge for development.

Watershed management currently does not get by without the support of external specialists, who have to convey modern knowledge and expertise (e.g. assessing natural processes and the impacts of men's activities). The population of a sustainably managed watershed is not isolated from the outside world. On the contrary, the watershed population forms the basis community for a regional community.

Definitions of Watershed Management:

SCSA Soil Conservation Society of America (1982): *Watershed Management* is the integrated utilisation, regulation and care of the water and land resources in a watershed with the aim of meeting predefined development goals.
FAO (1987): *Watershed Management* is the process of developing and implementing a series of actions for the management of natural, agricultural, and human resources within a watershed to provide required and appropriate goods and services to society under the precondition that land and water resources are not negatively affected. Watershed management needs to consider the prevailing socio-economic and institutional factors, within and beyond the watershed.
All India Soil and Land Use Survey (AISLUS, India 1988): *Watershed Management* is the coherent development and utilisation of the land and water resources within the natural boundaries of a watershed to deliver and produce in a sustainable manner from plant, animals and their products, while ensuring a controlled and clean inflow of water into downstream communities.
AFPRO Action for Food Production (India, 1988): *Watershed Management* is the attempt to utilise the available natural resources in a watershed through a process of technological and human development within one integrated programme in an optimal manner, in order to improve the living standards of the local communities.
Common Definition (e.g. of GTZ): *Watershed Management* is an integrated approach to the management of natural resources that aims at securing the living conditions of local communities in a sustainable manner.

Considering the currently common definitions of watershed management, two different approaches come to the fore. On one side, for regional developers in rural areas, the improvement of the quality of life for the local population is the centre of attention, while the regeneration of natural resources is viewed as secondary, as means to an end. On the other side, the basic approach which is preferred in the field of natural resources management views water as the basic element of all life. The aim thus is to develop an integrated package of

[1] Like social forestry and eco-tourism as the use of forests for future generations

measures to increase the availability of water for increased biomass production and to reduce its destructive force via erosion. The improvement of living standards is thus a consequence, but not primary aim of the intervention.

Watershed management measures are implemented by technical cooperation schemes at the level of projects or programmes, where the latter cater for the integration of local measures into regional or national development endevours. Herein, various steps are integrated, ranging from appraisal, monitoring, and assessment of current status, to the development and implementation of planning measures (environmental management) and the capacity building of regional actors in order to facilitate the successful and sustainable implementation of planning concepts.

In order to secure the sustainability of individual projects, technical cooperation schemes offer so-called post-watershed or watershed-plus measures to be implemented upon project completion. Post-watershed refers to any measures necessary to sustain the positive impacts of a watershed treatment programme. This is a multidisciplinary task, same as the actual project. In contrast, watershed-plus applies to activities that are intended to secure e.g. marketing possibilities of rural products, development of a rural micro-credit system, and the distribution of obtained advantages also amongst the socially disadvantages and landless.

2. Components of Watershed Management

- Human resource development (qualification of resource managers and users, design and development of local structures for cooperation, i.e. associations, cooperatives, etc.)
- Water management and utilization of water resources, rainwater harvesting,
- Soil and land management (land rights, land use planning, soil conversation, etc.),
- Crop yield management (post harvest, storage management, marketing),
- Reforestation, area closure, silviculture, agroforestry,
- Pasture management, fodder crop production,
- Livestock management (stable systems, grazing management, marketing, dairy production),
- Rural energy management (decentralised utilization of renewable energy resources, such as biogas, solar cookers, fuel saving stoves, cultivation of fast growing trees for fuel wood),
- Farm and off-farm activities to create and enhance value (creation of local and region infrastructure, such as roads, schools, drinking water, capacity building of the informal sector, etc.)

These components are interdependent and interrelated, therefore, any technical or organisational measure taken should be evaluated in terms of impacts on other components.

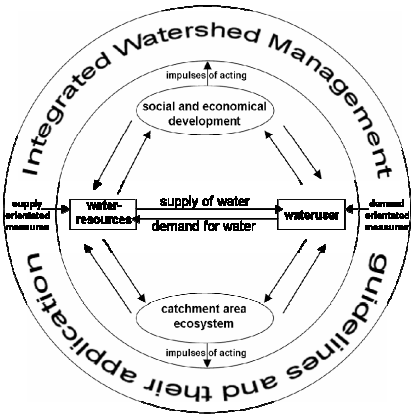

Figure 2 Processes influencing the process of watershed management (adopted from Heathcote 1998, 376)

A watershed or catchment is an open system, the watershed boundaries are predetermined by the water divides. The watershed forms the natural planning unit for the implementation of development projects and is accordingly defined internationally, e.g. by the EU Water Framework Directive.[2] Though, it has to be considered that the delineation of river watersheds is often difficult in cases where e.g. groundwater aquifers extend beyond the actual watershed boundaries into other watersheds. Nonetheless, a watershed forms a natural unit and thus a sensible geographical basis for the integrated management of water and land resources (European Commission 1998, 28).

A watershed can range in size from a few hundred square meters to several million square kilometres. Additionally, a watershed itself can be part of a larger watershed (sub-watershed) (Tidemann 1996, 346). Farrington et *al*. (1999, 5) subdivided watersheds in India into the following categories:

- *micro-watershed* (500 – 1,000 ha),
- *mini-watershed* (ca. 5,000 ha, includes several sub-watersheds),
- *macro-watershed* (a river basin that can extend beyond several 1,000 ha).

3. Basic Principles of Action and Objectives

In development cooperation as formerly defined by the North, the local people who live in a watershed for a long time have been often viewed as degrading land and water resources. Projects often aimed at educating the local people in new cultivation methods and land use concepts, requiring them to accept and adopt these methods and generally telling people what is appropriate and what is not. Such a top-down approach considered neither traditional land use nor the traditional knowledge or cultural systems local people have adapted and passed on over generations (FAO, 2003). Project experience though showed that the prescribed soil and water conservation measures were rarely successful and often resulted in deterioration of the situation, like in Ethiopia where vast measures were implemented in the 1980ies. As a consequence, the results of many years of development cooperation were disillusioning and did not bring the expected achievements, especially not when considering the large amounts of money that where invested. However, the reasons of failure were mainly underestimated local structures rather than wrong technical inputs from outside.

As local farmers did not participate in the planning, the result was a lack of acceptance of project measures and once the project was completed and the external "helpers" left the structures were not maintained and deteriorated. In order to create an incentive for local farmers to participate in project activities, they were often promised higher returns. This often meant that farmers agreed to measures they did not really believe in. Consequently, after completion of projects, the farmers were neither able nor willing to maintain the new structures. More often than not, the measures that were supposed to improve soil conditions, e.g. terraces, had negative impacts and accelerated soil erosion due to the lack of maintenance and the uncontrolled runoff.[3] An evaluation in Ethiopia showed that 40% of the terraces constructed by projects of the *World Food Programme* were destroyed in the following year.[4] In addition to the failure of soil conservation, this kind of development support also created recurring crop failures, thus, making farmers more and more dependent on external financial support, weakening self-confidence and self-reliance (*dependency syndrome)* (Pretty et al. 1995).

Although earlier projects have integrated the principle of participation into their projects, this – in the best case scenario – often only meant that the population was given information or asked for their opinion, while in the worst case scenario, they were only allocated work to (Farrington et al. 1999, 4). Only in rare instances was the benefit or advantage (i.e. income) that the population would receive from natural resources management

[2] Planning and development is foccussed on areas defined by natural boundaries like the water devide rather than political or administrative boundaries; upstream – downstream user conflicts are easier to tackle when the common resource can be understood as natural rather than political

[3] stone terraces often served as habitats for rats, which consequently destroyed substantial amounts of the crops, no wonder that farmers rejected them

[4] it was more profitable for he farmers to construct terraces again and again because they were paid for it through continuing food for work programmes than start tilling the fields and producing their own crops

clearly defined or how new or integrated concepts would help create sustained income in the future.[5] It is still to be discussed whether the external intervention was to be blamed for the failure or the prevailing underestimated political conditions the beneficiaries or target groups were living in.

Moreover, earlier programmes have often been implemented with disadvantages for the socially weakest. The programmes focused solely on technical and physical measures, while ignoring social aspects, such as equal opportunities for women, landless and young people (FAO 2003). Emergency measures, such as food-for-work programmes that were employed globally for the development of infrastructure, often resulted in the destruction of local markets when implemented on a regular basis. (Förch 2002) Food aid is still used as payment under food-for-work schemes and surplus is sold on the local market for far lower prices than local produce. Furthermore, such (permanent) programmes are misused for stabilising political power by directing funds to the wanted clientele.

Watershed management today not only aims to stabilize land, water and vegetation resources, but also to increase productivity of resource utilization in an environmentally, economically and also institutionally sustainable manner (Farrington et al. 1999). This principle has emerged from the understanding that *"... the sustainable utilisation of water [...] cannot be viewed by sector. Water is not only a basic need, but is also a centre-piece of sustainable development and a crucial part of poverty alleviation. Water is closely linked to considerations of health, agriculture, energy and biodiversity [...]. Achieving the targets of Johannesburg (Rio + 10 conference) will be difficult without advancements in the water sector"(BMU 2003)*.

The above mentioned experiences have led to the recognition that a sustainable utilization of resources will not be possible without consideration of the interests of the affected farmers or rural population. The local population has to be viewed as the key to solutions, rather than the cause of problems, as it has been the case in many projects and programmes. Moreover, the importance of traditional and local knowledge has been acknowledged and it has been suggested to include this knowledge into programmes in order to increase the probability of success (Pretty et al. 1995).

Securing the natural resources in a watershed for following generations should take place under consideration of the following principles (Heathcote 1998, 7):

- An adequate amount of water that is available in a sustainable manner for years to come has to be made available to the population;
- The natural resources within a watershed have to be protected and kept free from pollution;
- The (drinking) water quality has to be maintained at a standard that allows all inhabitants to live in physical and mental wellbeing;
- Economic development within the watershed has to take place in harmony with available natural resources;
- The local community has to participate in all development measures.

One of the most important goals of watershed management is the provision and security of safe drinking water for all people. Access to sanitation is closely connected with this goal and has particular importance for women and children. The goal to halve the number of people without access to safe drinking water and sanitation by 2015 (*Millennium Development Goals)* has been reconfirmed during the UN Conference for Environment and Development in Johannesburg (Reimold 1998, 5; Trittin 2003).

An additional goal that has been identified during the Earth Summit in Rio de Janeiro in 1992 is the reduction of the impacts of natural disasters, such as floods and drought (Reimold 1998, 5). This goal deserves special attention especially in the context of climate change, as the occurrence of natural disasters is expected to increase, heavy rainfall and longer dry periods may lead to more land slides, avalanches and mud avalanches, as well as drought catastrophes (International Year of Freshwater, 2003).

[5] German Development Cooperation has a record of succesful projects of this kind worldwide, like Watershed India and IFSP South Gondar/Ethiopia

The introduction of watershed management measures on an area-wide scale may counter some of these extreme events, as they work to strengthen the natural retention capacity and to balance the water budget in the long run. The greater retention, i.e. the delay of surface runoff results in increased infiltration of rainfall. Thus, a reduction of costs associated with damages caused by extreme events can be achieved. In general, a more effective management of the financial resources that are available for environmental protection and development cooperation is essential, as it is goal as well as result of wisely implemented watershed management projects (Reimold 1998, 5).

The importance of the resource land for food production is coming into the fore despite increasing yields, mainly due to the globally declining per capita area of agricultural land. Independently of these global trends, agricultural production has decreased from 1989 to 1996 by 12 – 40 % in at least six Sub-Saharan countries, while production rates are similarly changing negatively in several central and west Asian and Latin American countries (Lal 2000, 12). In the context of population growth, it remains unquestionable that the improvement and restoration of soil quality and thus the increase in production rates has to be a central component of development assistance. In Ethiopia, for instance, the annual increases in food production are regularly negated by the population growth of around 3 % per year.

An improvement of the economic situation of the population can be supported and sustained by the introduction of intensive and sustainable land management practices within the framework of watershed management, while at the same time regenerating natural resources (Pretty et al. 1995).

The increase of agricultural yields in the countries of the South could also influence a different development: unemployment in rural areas is an important push-factor for migration into cities, which in turn is one of the most underlying causes of urban poverty and population growth in the mega-cities of the third world. Watershed management in rural areas that may lead to a sustainable improvement of living conditions there may directly impact on urban areas as well.

4. Management of Water Resources

4.1 Historical Overview

Since prehistoric times, people have attempted to control runoff of rivers and water quality. Controversies over water in Mesopotamia are known from as early as 4,500 years ago (Bronze Age). The oldest passed down legal regulation, for instance, was the maintenance of irrigation canals in the Babylon of Nebuchadnezzar (around 1,500 BC). The Romans had decrees that prohibited the pollution of water and breaches of the rules were heavily punished. Humans to date have not been able to utilize water on a large scale in such a way that its quality is retained, despite the fact that water management measures are known since a long time. This decline in water quality has been especially drastic in recent times with the progressing industrialisation, which has taken place at the cost of water quality. Nonetheless, water pollution caused by industrialisation has been viewed over several decades as inescapable consequence of economic development (Heathcote 1998).

In 1962, public and political rethinking first took place with the publication of “Silent Spring” by Rachel Carson concerning environmental conservation and especially the protection of water. In 1977, a UN conference on water took place in Mar del Plata, Argentina. The outcome of this conference was an action plan with the goal to provide all people with access to safe drinking water and sanitation by 1990 (UN decade of Water Supply and Sanitation). The implementation of the plan was left to the responsibility of the national governments. Each country was supposed to establish basic principles of action for the protection of water and institutions for their implementation, to enforce existing laws, and to make successful participation of population and institutions an overall goal (Heathcote 1998). However, at the latest during the Earth Summit in Rio de Janeiro in 1992 one had to acknowledge that the action plan failed completely. It was recognised that the centralised management of water has not worked and that planning had to be transferred from the national to the local level, i.e. to the watershed

level. The high standard of water supply and sanitation systems in Germany today is not at least the result of decentralised water provision and sanitary facilities.
Watershed management itself is not a new concept, but has already existed in an earlier version in the 1950s (Lal 2000, 14). However, the earlier form of watershed management was not a concept of rural development, but was restricted to the management of resources in river basins, i.e. to the stabilisation of land, water and vegetation, rather than encompassing the concept of sustainable resources management (Farrington et al. 1999). The term integrated watershed management is often used in the literature and refers to the modern approach of ecosystem management, emphasizing the management of systems rather than that of individual components of a watershed, i.e. the classic management of sectors in governmental action.

4.2 Water Scarcity

Renewable freshwater resources of the world are limited. Water scarcity is a fundamental problem for millions of people, especially in semiarid and arid regions of the world. Around 1.2 billion people lack access to safe drinking water (Trittin, 2003). While per capita water consumption in developed countries is significantly higher than in developing countries, consumption continues to increase only slowly in recent years (Stiftung Entwicklung und Frieden, 1999, 302). In Germany, for instance, per capita consumption of drinking water was an average of 140 litres per day in the early 1990s and has dropped to an average of 125 litres per day in 2003, because of rising awareness for a valuable resource. In contrast, in the USA, Japan and Israel, drinking water consumption is still on a much higher level, near or even beyond 300 litres per day and capita although the availability of the resources is limited. In developing countries where populations continue to grow rapidly, the problem of water scarcity is expected to increase significantly in the coming years and decades, unless a sustainable awareness of resources management emerges.

A larger demand for water and increasing water consumption is not only a function of growing populations, but also of increasing standards of living and better health services. However, it should be taken into consideration that the largest water user on a global scale is agriculture. The provision of drinking water is easier to control technically than water consumption in irrigated agriculture, which makes a significant contribution to the securing of food production, especially in developing countries.

"Already today, more than one third of the global population lives in countries that experience small to high water stress, according to an UN survey of the global freshwater reserves.[6] As a consequence, these countries are exhausting more than 20 % of their available water reserves. In 2025, two thirds of the global population will be living in these water stressed countries." (Stiftung Entwicklung und Frieden 1999, 302).

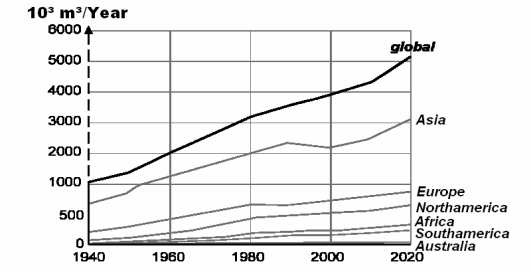

Figure 3 Global Water Consumption 1940-2020. (Source: Aktuelle Ergänzungen zum Medienpaket Umweltschutz in Wirtschaft und Gesellschaft 1995,15)

[6] Since this survey does not relate to technical standards of water or resource utilisation central Europe is wrongly considered to be under medium water stress

Some authors estimate that in 2050 around four billion people will be affected by some form of water scarcity (Lal 2000, 11). The problem of limited water reserves, especially in regions of Africa and Asia, is exacerbated by the fact that large amounts of the available water are polluted. However, every living being is dependant on clean water, as it determines health, living conditions and biodiversity (Heathcote, 1998, 1). Water-borne diseases caused by contaminated drinking water are widespread: WHO estimates that 3.3 million people die alone of diarrhoea annually FAO 2003).[7] The availability of water also determines in how far areas are suitable for agriculture, and it influences industry, transport and recreation (Tideman, 1996, 347).

5. Management of Land Resources

Land degradation is one of the largest threats to global food security. The future utilisation of land resources will significantly influence whether the problem of undernourishment can be resolved. The area of arable land available per capita will steadily decrease, due to global population growth. Lal (2000, 5) assumes that the arable area of 0.22 ha per capita in 1998 will be reduced to 0.16 ha in 2025 and to 0.10 ha in 2100.

Already today some 17 % of the total global land area covered by vegetation is degraded. Especially Africa is severely affected, as 65% of the agricultural area are characterised by soil degradation. On a global scale, 0.5 % of agricultural land is lost to soil erosion annually since 1990 (Stiftung Entwicklung und Frieden, 1999, 296). Desertification, i.e. the formation of deserts due to anthropogenic causes in sub-humid zones of the earth forms a special problem within land degradation. On a global scale, anthropogenic interventions into the landscape account for 20 % of the total wastelands, i.e. heavily degraded or vegetation free areas of arid and sub-humid regions (Lal 2000, 6). *"The most severely affected regions, besides the Sahel, include southern Africa, Western Arabia, parts of Southeast Asia, Mexico, Eastern Brazil, as well as parts of the Southwestern US, Australia and in the Mediterranean. Globally, more than one billion people live in these regions and are thus potentially affected by desertification." (Stiftung Entwicklung und Frieden 1999, 298).*

The main determinant of land degradation and desertification is soil erosion, i.e. anthropogenic interventions into the natural processes of a given area by economic activity, and thus, interference beyond the natural level of erosion by wind and water (Table 1, Figure 4). Lal (2000, 6) estimates that 82 % of all severely and very severely degraded soils are caused by soil erosion. Erosion is initially caused by inappropriate agriculture and the mismanagement of resources (Lal 2000, 6; Stiftung Entwicklung und Frieden 1999, 298). In particular, this means: overgrazing, deforestation and inappropriate cultivation techniques (Figure 4). During the process of soil erosion by water runoff at the surface causes the removal of soil that can not entirely be regenerated naturally (= on-site damage). At the same time, soil erosion leads to increased deposition of sediment at the lower parts of slopes in rivers and lakes and destroys habitat (= off-site damage)

Moreover, soil loss and degradation caused by mistakes in irrigation should not be underestimated; especially in drylands salinisation is a problem. For instance, in the Indus watershed and the Aral Sea region, salinisation has created soil loss with little opportunity of rehabilitation, because of mismanagement of drainage from irrigated soils.

[7] Water demand management as a tool of watershed management needs to consider the necessary quality of water for different purposes. I may not be possible anymore to keep the quality of water distributed through pipe networks to households on the high standard of potable water: It seems that more people can be reached with hygienically safe water through bottled water (the minimum 5 litres per day for drinking) instead of piped water at lower costs.

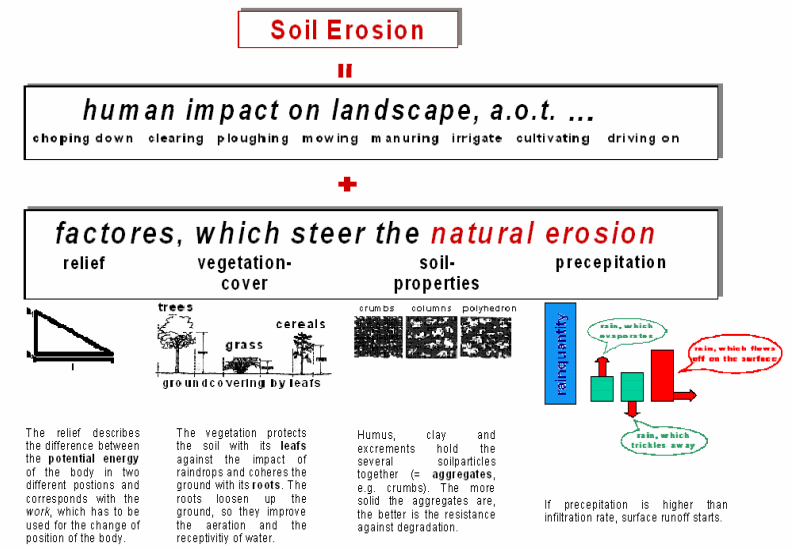

Figure 4 Factors that determine soil erosion by water

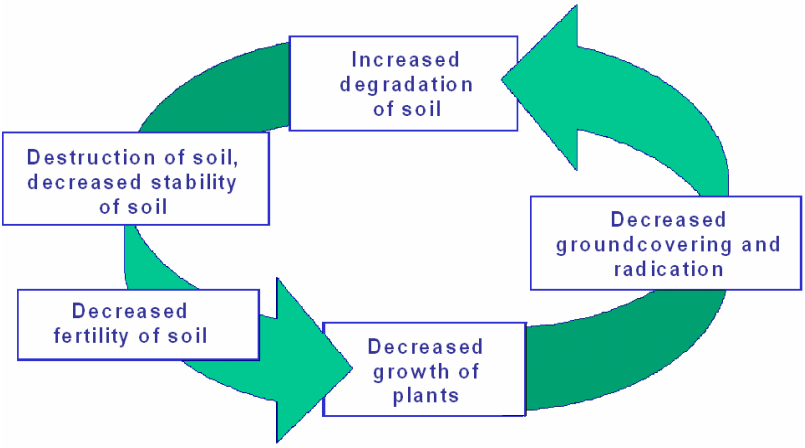

Figure 5 Vicious Cycle of Soil Degradation

6. Management of Human Capital

Participation

The lack of participation of beneficiaries in the majority of development projects, especially in the 1960s and 1970s, to some extent also in the 1980s, was one of the mean reasons for the failure of numerous development initiatives. As a result, this aspect has gained a lot of attention and is today one of the main principles of current watershed management projects.
"Participatory management has been defined as a process whereby `those with legitimate interests in a project both influence decisions which affect them and receive a proportion of any benefits which may accrue. " (Farrington et al. 1999)

The immediate integration of beneficiaries or the target groups during all phases of project planning and implementation creates interest in the process and increases the prospect of institutional and environmental sustainability of the project. Once the community participates in the decision making process they also take responsibility for the decisions that they have made (European Commission 1998, 73).

Table 1 Causes of land degradation (Source: Stiftung Entwicklung und Frieden 1999, 297)

Region	Total degraded area Mio. ha	Proportion degraded area of total vegetated area in %	Overgrazing in %	De-forestation in %	Inappropriate cultivation in %	Other in %
World	1.965	17	35	30	28	8
Europe	220	23	23	38	29	10
North- and Central America	158	8	24	11	57	8
South America	244	14	28	41	26	5
Africa	494	22	49	14	24	13
Asia	746	20	26	40	27	7
Oceania	103	13	80	12	8	0

The local population has to play a major role, however it should not be the only stakeholder involved in the allocation of rights or have the sole responsibility for natural resources (Farrington et al. 1999, 4). The creation of participatory structures includes the following steps (European Commission 1998, 73):

- The establishment of appropriate organisations and associations within the community of water users and farmers (e.g. the water users associations that are common in Germany);
- Bringing attention and awareness of the role of women to the personnel;
- Identifying the needs and entitlements of the poorest parts of the population; it has to be secured that they have the possibility of representing their interests and have same access to all services;
- Investigating local, indigenous watershed management techniques and initiatives; ways have to be found to expand on and legitimise appropriate methods.

Participation means the involvement of existing local organisations, interest groups, and political decision makers. The key to success is the interlude between local population, local organisations and the state (Farrington et al. 1999, 4). However, the approach may fall short of success unless the economic interests and opportunities of the water and land users are taken into consideration and improved (e.g. micro credit schemes, income generating activities).[8]

[8] In countries were family income is far below the poverty line, like in almost all African rural communities, the clear definition of the individual benefit from a measure that requires participation in labour , cash or kind must be done at the start of any intervention if somewhat sustainable impacts should be reached.

Women as Decision Makers

Women are the main actors in the household in terms of agricultural production, and in water and fuel wood supply in most parts of the world. They often spend several hours each day with the collection and transport of water and energy supplies. In Africa, around 90 % of the workload associated with the collection and transport of water and fuel wood is carried out by women. The provision of access to safe drinking water within the vicinity of settlements would consequently mean more time for women for other activities. Especially the daughters of a household would benefit, as they would be able to go to school instead of collecting water (International Year of Freshwater 2003).

Women produce the majority of food in the third world, and their role is becoming more important in the context of selective migration into cities (it is usually men who migrate to bigger cities, especially in Africa). Women maintain the knowledge about local biodiversity, soil and water conditions, as well as traditional cultivation techniques (FAO 2003).

However, more often than not, women are not involved into the decision making process and have in the past been underestimated in the implementation of development strategies. Women are the ones who are most affected by inadequate conditions, especially since they produce the largest proportion of food and in most cases are responsible for the water supply. Consequently, women have to receive special attention in watershed management projects. Emphasis should be placed on the involvement of women in decision making processes as well as on the creation of independent income generating activities (European Commission 1998, 73). A declaration was passed at the summit in Johannesburg in 2002 that stipulated that women should have an equal share in decision making processes, easier access to information, and participate in natural resource management and project implementation (International Year of Freshwater 2003).

Furthermore, the impact of the unlimited and uncontrolled spread of HIV infections on local communities must not be forgotten. Orphans and elderly people are not able to sustain family and community life.

Traditional Knowledg*e*

Traditional Knowledge is the knowledge that local societies have acquired and conserved over generations and is based on the experiences of managing nature for livelihood security (Harmon 2002, 1). Hence, traditional knowledge underlies an inherent dynamic that results from the adaptation of knowledge to the constantly changing social, ecological and economic conditions of society (Maffi 2002).

Traditional knowledge is deeply rooted in society. The broad knowledge that the local population possess is geared towards livelihood security within the specific local living conditions in an integrated manner (Schröder 1995). Based on these characteristics, traditional knowledge is contrasted with scientific knowledge, while parallels and overlapping may occur (Warren 1991, Scoones & Thompson 2000). The differences between traditional knowledge and scientific knowledge are mainly that the latter has a claim to globalisation. Furthermore, the methods of gaining new knowledge and the way and sources for the application of the respective knowledge differ (Antweiler 1995).

Local strategies of soil and water conservation have received increasing interest in research, especially due to the growing interest of development organisations in traditional knowledge (Critchley 1994). Studies that have been conducted within this context point towards a wide array of indigenous techniques in terms of biological, physical and agronomic measures that have traditionally enabled a more sustainable utilisation and protection of water and land resources. Also characteristic of the selection and application of specific indigenous techniques is the fact that the measure often fulfils several goals at the same time (Scoones & Thompson 1996).

Sustainable methods of resource use that exist in societies are recognised under traditional knowledge and have been developed and adopted across many generations. Hence, a gradual internalisation of traditional

knowledge has become possible. An example would be stone bunds that were possibly initially just made of stones that were collected off agricultural fields and piled up in lines at the field edge. Observations of farmers, such as the deposition of sediment uphill of these runoff barriers and the reduction of soil erosion downhill, has resulted in the directed construction of stone bunds e.g. in Kenya and later on of terraces after the **Tabia-System** (Figure 6).

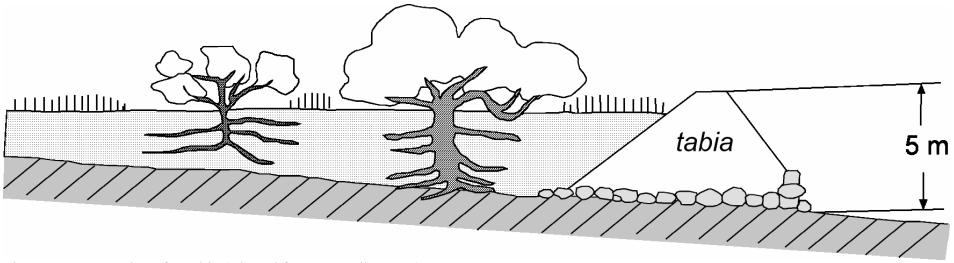

Fig. 6 Cross section of a Tabia (adapted from Bonvallot 1986)

Correspondingly, these traditional land management and soil conservation techniques are characterised by a high level of flexibility, as well as by adaptiveness to local conditions that are alternating within a small area (i.e. availability of building materials, such as wood or stones) and also the availability of labour.

Maintenance of vegetation is important over a, as long as possible, time period also during the dry season as an important soil conservation measure. Agricultural cropping systems not only improve the basis of cultivation, but also maintain soil fertility and protect against splash erosion. An example is mixed cropping, i.e. the cultivation of crops with different growing season and length, as well as use (e.g. grains, legumes, vegetables, fruit trees, etc).

The Konso people in southern Ethiopia are exemplary for their diverse cropping system (Förch 2003). The question remains whether technical and social systems based on traditional knowledge, which were successful for centuries, may sustain also in future under new conditions of socio-economic behaviour and pressing population growth.

7. Planning Cycle

The individual components of the watershed, as well as the relationships between the characteristic form (e.g. slope, bedrock) and process factors (e.g. distribution of annual precipitation, average precipitation intensity) have to be understood in a comprehensible manner in order for watershed management to be effective. The concept has to include all aspects of the watershed: water resources, water users, ecosystem relationships between water, soil, air and vegetation, and anthropogenic impacts. The latter is a combination of economic factors, such as fields, pastures, forests, livestock farming, and social factors (Heathcote 1998, 375). To that effect, the development of a watershed management concept is based on a comprehensive analysis of the underlying natural and socio-economic attributes of the watershed (Reimold 1998, 3). First of all this includes a compilation of existing, i.e. secondary, data. Soil analyses, geological and hydrological surveys, as well as precipitation data, and records of ownership structures, land use and infrastructure are often already available. In dependence on problem formulation and research question, these data can be used as a basis and can be reconfirmed accordingly in the field Tideman 1996, 356). The compilation of hydrological data, such as information about the availability of groundwater and surface water, water quality and water demand of different stakeholders in the watershed are of great importance (European Commission, 1998, 75).

In terms of problem identification and analysis the following aspects are to be considered (Tideman 1996, 356):
Problems within the natural environment: information about erosion risk of slopes, as well as the development of badlands, etc. can be gained from maps and aerial photographs. Precipitation amounts, intensity and frequency of eroding thunderstorms can be derived from meteorological data. An estimation of surface runoff and groundwater recharge can be made based on the analysis of discharge hydrographs.

Problems within resource management: information on inadequate land use techniques, such as shifting cultivation, uncontrolled deforestation, overgrazing, as well as unrestrained mining has to be collected and the causes for these unsustainable management practices need to be identified;

Impacts of degradation in the watershed: problems such as soil erosion, water contamination, risk of drought and flooding have to be identified based on existing and new data, as well as field observations. Additionally, information on development, frequency and extent of natural disaster are relevant for planning and successful implementation of measures for integrated watershed management;

Socio-economic problems: socio-economic surveys based on questionnaires and expert interviews are an important basis for information about ownership structures, social conditions and economic activities within the watershed.

The main planning responsibility should lie with an elected committee that represents the community. Participation of local and regional organisations and agencies facilitates cooperation and contacts with existing initiatives in the field of, for instance, land use planning would facilitate easier access to information. The areas of responsibility and the roles of the stakeholders have to be clearly defined. Moreover, a project budget and plan of implementation have to be compiled (Heathcote 1998, 381).

Planning goals are to be defined and a catalogue of measures to be developed on the basis of inventories of the physical, economic and social conditions in the watershed. The distinctive characteristics of individual sub-watersheds have to be considered and specific conservation strategies and measures developed accordingly (Reimold 1998, 7). Implementation, especially of technical measures commences at the water divide and continues down slope, as erosion processes caused by surface runoff take place with gravity down slope and as amounts of water increase in the same direction the force of erosion increase correspondingly. In upstream locations, forest cover has often been reduced by deforestation and overgrazing. Thus, the only solution to the resulting problems is reforestation. In middle and downstream locations and with decreasing slope and increasing water availability, cultivation is the preferred land use. Therefore, the construction of terraces serves the goals of water harvesting and soil conservation (Tideman 1996, 7).

Heathcote (1998, 375) suggests that changes in the social and economic forces in the watershed could push towards changes in practices. The same holds true for changing contexts within the ecosystem. The concept for the implementation of watershed management projects is therefore never static, as the anthropogenic and ecological components aren't either (Figure 2).

It is indispensable that regular monitoring and report writing takes places during project implementations. This is necessary in order to convince agencies and donors of progress made and to ensure participation of all stakeholders. Moreover, new ideas or technologies that have not been considered in the beginning may be integrated. It is also important that the condition and functioning of structures and equipment is evaluated regularly. Also, the continuous training of and information sharing with the population is an important factor, which would contribute towards community consensus about the planning process as well as participation of beneficiaries and institutional sustainability of watershed management after project completion (Heathcote 1998, 387).

8. Conclusions

Knowledge of the user interests concerning natural resources of all stakeholders presents an important key indicator for project success. This is demonstrated by this quote by an Indian forestry agent:
„*We have planted millions of young trees annually for over twenty years. These have been immediately illegally cut down by farmers for fuel wood, while the forest was used as pasture for their sheep with the result of increasing soil erosion. Within the project we have then learned to ask the farmers about their problems. They know the relationship between deforestation, overgrazing and erosion. They were not ignorant. They were just never asked for their needs. And the forest belonged to the state, not to the people. This is different today. The forest is stable and is used and conserved by the farmers, who have constant yields that create income for the farmers. The grass is cut in order to feed the water buffaloes that produce milk. Since we have built a small reservoir to retain rainwater and recharge groundwater, there is again water in the village well. The farmers can sell the produces on the nearest market. In the meantime, there is a school in the village and the first two-storey building."*

This example shows that development projects have to bring the local and regional actors together with representatives of the government. The farmers have to learn again to see their land as their future and to cultivate and to capitalize on it themselves (Honore 1999). On the other hand, governments have to create the framework conditions for local and responsible action that is geared towards the future in the context of a sound utilisation of natural resources. Continuing food aid like in many African countries does not form this essential framework.

9. References

Aktuelle Ergänzungen zum Medienpaket Umweltschutz in Wirtschaft und Gesellschaft, 1995. Wirtschaftswissen in der Schule fördern. http://www.wk.or.at/aws/pdf/umweltschutz-erg.pdf

Antweiler, C., 1995. Lokales Wissen. Grundlagen, Probleme, Bibliographie. In: S. Honerla & P. Schröder (Hrsg.): Local-Knowledge-Tagung 1994, Bonn – Lokales Wissen und Entwicklung: Zur Relevanz kulturspezifischen Wissens für Entwicklungsprozesse. Bonn. S. 19-49.

BMU, 2003. Das Internationale Jahr des Süsswassers. Herausforderung und Chance für einen bewussteren nachhaltigen Umgang mit Wasser. http://www.bmu.de/sachthemen/gewaesser/suesswasserjahr.php

Bonvallot, J. 1986. Tabias et Jessour du Sud Tunisien. Agriculture dans les zones marginales et parade àl'érosion. Cah. ORSTOM Pédol. 22, 163 - 172.

European Commission (Hrsg.), 1998. Towards sustainable water resources management. A strategic aproach. Brüssel, Luxemburg.

FAO (Hrsg.), 2003. Water and people: whose right is it? http://www.fao.org/sd/2003/pe0301a2_en.htm

Farrington, J. C. Turton & A.J. James (Hrsg.), 1999. Participatory Watershed Development: Challenges for the Twenty-First Century. Oxford.

Foerch, W. (2002), BA Thesis, University of Reading, UK

Foerch, W. 2003. The Agricultural System of the Konso in South - Western Ethiopia (www.geog.cam.ac.uk/people/watson)

Harmson, D., 2002. Traditional knowledge. http://www.terralingua.org/Definitions/DtradKnowl.html

Heathcote, I.W., 1998. Integrated watershed management. Principles and practice. New York.

Honore, G., 1999. Our land, our selves. A practical guide to watershed management in India. New Delhi.

International Year of Freshwater (Hrsg.), 2003. Water for our future: What are the trends? http://www.wateryear2003.org/ev.php?URL_ID=3697&URL_DO=DO_TOPIC&URL_SECTION=201

Lal, R., 2000. Integrated watershed management in the global ecosystem. Boca Raton.

Maffi, L. 2002. Traditional ecological knowledge. http://www.terralingua.org/Definitions/Dtek.html

Pretty, J., I. Guijt, P. Shah & F. Hinchcliffe, 1995. Joint watershed management: new evidence from the New Horizons project. http://www.nuffic.nl/ciran/ikdm/3-1/articles/pretty.html

Reimold, R.J., 1998. Watershed management. Practice, polices, and coordination. New York.

Scoones, I. & J. Thompson 2000. Bdeyond farmer first. Rural peoples knowledge, agricultural research and extension practice. London.

Stiftung Entwicklung und Frieden (Hrsg.), 1999. Globale Trends 2000. Fakten, Analysen, Prognosen. Frankfurt/M.

Tidemann, E., 1996. Watershed management. Guidelines for Indian conditions. New Delhi.

Trittin, J., 2003. Das Internationale Jahr des Süßwassers. -Editorial der BMU-Zeitschrift ‚Umwelt', 4/2003. http://www.bmu.de/sachthemen/gewaesser/suesswasserjahr_trittin.php

Warren, D.M., 1991. Using indigenous knowledge in agricultural development. –World Bank Discussion Paper, 127. Washington, D.C.