Rethinking Natural Resource Degradation In Semi-Arid Sub-Saharan Africa:

The Case of Semi-Arid Tanzania

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List of Acronyms

a.s.l.	above sea level
DoE	Department of Environment
DOVAP	Dodoma Village and Afforestation Project
FAO	Food and Agriculture Organisation
GTZ	German Society for Technical Cooperation
HADO	Hifadhi Ardhi Dodoma
HASHI	Hifadhi Ardhi Shinyanga
HIAP	Handeni Intergrated Agroforestry Project
HIMA	Hifadhi Mazingira Iringa
KEP	Kilosa Environment Project
LAMP	Land Management Programme for Environmental Conservation
LRDC	Land Resources Development Centre
MNRT	Ministry of Natural Resources and Tourism
MRALG	Ministry of Regional Administration and Local Government
NEMC	National Environment Management Council
NGO	Non-Governmental Organisation
PC	Planning Commission
PMO	Prime Minister's Office
RDC	Regional Development Committee
RDD	Regional Development Director
RIDEP	Regional Integrated Development Programme
RPLO	Regional Planning Officer
RUDEP	Rukwa Integrated Development Programme
SCAPA	Soil Erosion Control and Afforestation Project in Arusha
SECAP	Soil Erosion Control and Afforestation Project
SIDA	Swedish International Development Agency
SWC	Soil and Water Conservation
UNCED	United Nations conference on Environment and Development
UNEP	United Nations environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organisation
URT	United Republic of Tanzania
VPO	Vice President's Office
WMO	World Meteorological Organisation

1. Introduction

In order to understand the policies that are required to support sustainable soil fertility management, soil and water conservation in any region, it is worthwhile understanding the principles underlying the soil management first. According to de Haas and Friedrichsen (1995), soil management that conserves resources is closely linked to the hierarchy of goals to sustainable agriculture and hence sustainable development.

Sustainable development ensures the satisfaction of economic, social and cultural needs of the present generation without undermining the needs of future generations (Bruntland Report 1987; UNCED 1992). In this case, sustainable agriculture and rural development means using and conserving natural resources and directing technological and institutional change to meet the current and future needs of stakeholders. This kind of development conserves soil, water, and the genetic resources of flora and fauna, protects the environment, applies appropriate technology and is economically and socially viable (SARD FAO/Netherlands 1991).

Sustainable soil management means using the limited and partially renewable natural resources soil, water, and plant nutrients in cropping, pasture farming and forestry with the aim of conserving the soil productivity for future generations as well. As the basis for plant and animal production, soil plays a key role in food security, income generation and rural development (de Haas and Friedrichsen 1995).

As this review suggests, promoting sustainable soil management, particularly in semi-arid areas calls for interventions that go beyond the scope of the farm enterprise. This is due to the fact that experience in development co-operation shows that finding answers to purely technical production problems does not work when no action is taken to remedy the social and economic causes to land degradation problems. This includes offsetting the cost of measures to avoid or mitigate soil degradation through higher yields and/or income. It also needs stressing that sustainable soil management can only be achieved by reducing pressure on the resource soil via flanking programmes such as creation of off-farm employment or family planning. This section of the paper reviews various parameters related to sustainable soil fertility management and soil and water conservation in the semi-arid areas of Tanzania. Key aspects that are reviewed in this section include the common characteristics of the semi-arid areas of Tanzania, climate and topography, land use systems, natural resource use and users (demography and characteristics of the farming systems and trends) within the semi-arid areas of Tanzania.

This review of literature focuses on a range of issues that can explain natural resource degradation in semi-arid areas of Tanzania. The main focus is on soil and water conservation (SWC), and relating them to physical characteristics, social parameters, policy issues and programmes. In addition, the review looks at perceptions of natural resource degradation among various actors, an overview of research projects on SWC, and on the adoption of indigenous and introduced SWC techniques. The review will also highlight changes in administrative set-up and their implications on SWC measures and socio-economic constraints to investment in SWC.

2. Physical Characteristics

2.1 Characteristics of Semi-Arid Areas of Tanzania

The existing climatological, geographical and agroecological literature is surrounded by high degree of imprecision and ambiguities as to the definition of semi-aridity and the validity of various moisture and temperature indices used to characterise it (Oram 1977). According to Grove (1977), semi-arid lands are those parts of the world where the rain is insufficient or barely sufficient for satisfactory crop growth in most years. Such regions can be defined only in an arbitrary manner.

According to Hudson (1987) political, social and economic issues are as important as the technical problems in semi-arid areas. Drought is part of natural order in semi-arid areas, and that the recent disasters of degradation and famine in Africa result from misuse and mismanagement of the natural resources which reduced the region's ability to cope with the additional stress of drought. It is, further, urged that the extent of the erosion problem and the pressures on the semi-arid ecosystems result from increasing human and livestock populations.

There is inadequate information on semi-arid areas, compared to areas of higher agricultural potential. This is because the potential agricultural areas constituted an important source of revenue and livelihood for many people. In addition, most of the efforts concentrated on crop production rather than livestock keeping, which is the mainstay of many people in semi-arid areas. Also, geographers were attracted to the higher agricultural areas because of the population dynamics characterising these areas. Some of the constraints in the semi-arid areas, however, include the spatial and temporal[1] variability of rainfall, the wide diversity of soils and water shortage. The technological requirement in semi-arid areas is that it must facilitate improved farming and show short-term benefit to the farmers

In Tanzania, there has not been a rigorous attempt to delineate semi-arid regions as reported by Wallen (1967). One of the earliest attempts to delineate or describe semi-arid parts of Tanzania was made in 1977 in a Technical Paper prepared for the United Nations Conference on Desertification (United Republic of Tanzania 1977).

Because of the difficulties and uncertainties of defining semi-aridity, the paper suggests that it is safer to regard the areas of Tanzania falling below the 800 mm (31.5") rainfall isohyet as semi-arid. Thus, the whole of Dodoma, Singida and Shinyanga regions and much of Mbulu District and the lower areas of Arusha, Moshi and Pare District to the north, and of Iringa to the south are included in this area (UNEP/FAO/UNESCO/WMO 1977).

Rough estimates indicate that between 45 and 75 percent of Tanzania receiving a mean annual rainfall of 200-800 mm is susceptible to land degradation problems. According to Darkoh (1982), the principal areas affected are the arid central part of the country. These include the region surrounding the new capital of Dodoma, the Lake Victoria Basin (Sukumaland) and Maasai territory stretching northward to the Kenyan border. In the arid central belt, land degradation is revealed in "alluvial or residual surfaces subject to stripping of top soil and accelerated run-off, gully erosion on the slopes, and/or sheet erosion or deposition on flat lands" (UNEP/FAO/UNESCO/WMO 1977). Temple (1973) and Watson (1973) pointed out that the semi-arid plains of Tanzania are characterised by unreliable rainfall, repeated water shortages, periodic famine and high pressure of overgrazing and of dryland cultivation of marginal areas.

[1] Spatial–temporal variability means variation from one place to another as well as variation in frequency of occurrence

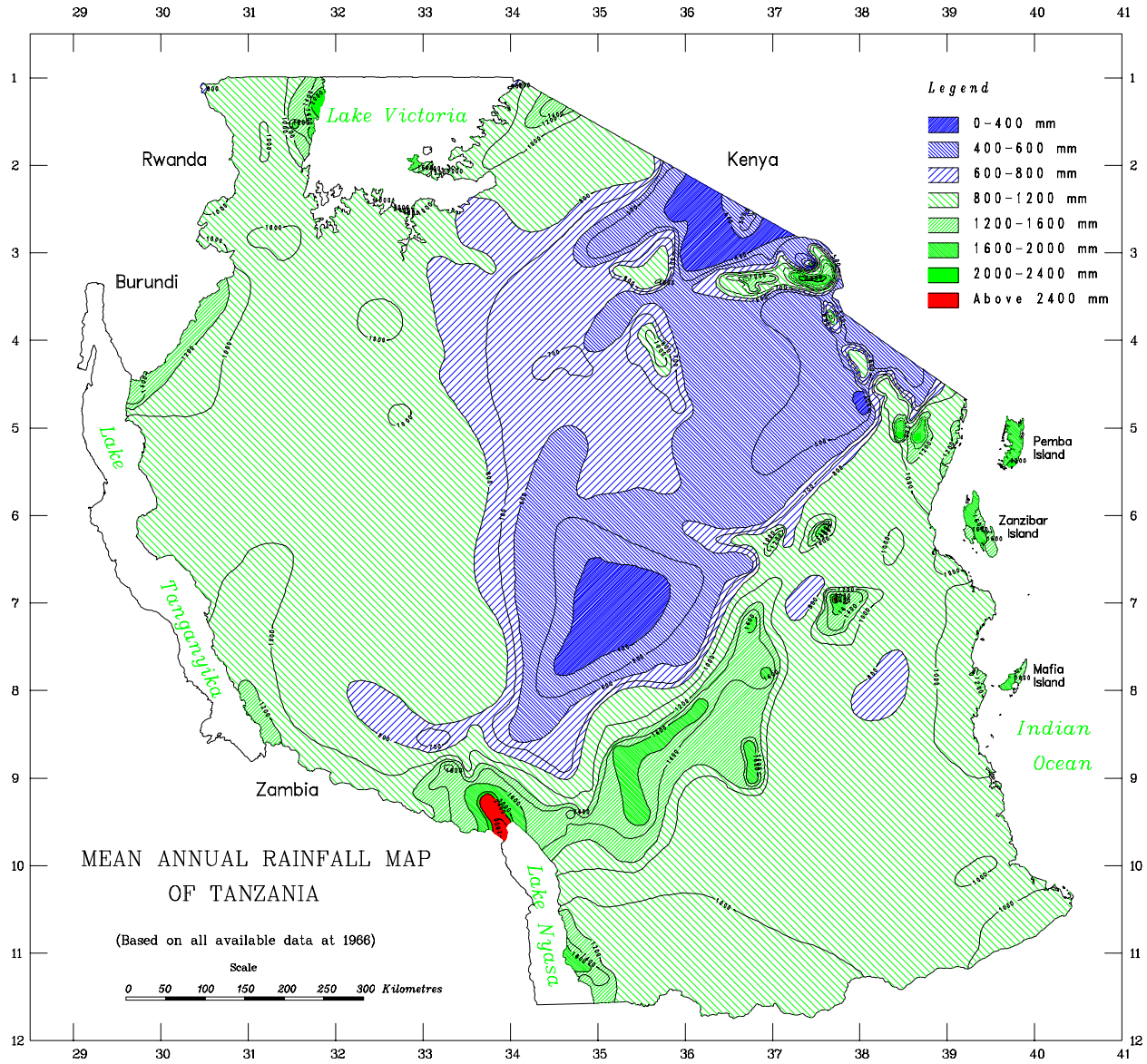

Figure 1: Mean Annual Rainfall Map of Tanzania

In the current review, the definition put forward by Darkoh (1982), Temple (1973) and Watson (1973) has been adopted. For that matter, Figure 1 indicates the semi-arid areas of Tanzania. In this case, the semi-arid areas of Tanzania area those receiving mean annual rainfall of 200 to 800 mm.

2.2 Climate

In order to understand the problems of the semi-arid regions of a given land, it is important to evaluate the actual natural and human conditions, or those resulting from the interplay of the two in the areas under consideration. The natural conditions refer to factors such as climate, hydrology, pedology and vegetation. The discussion of the climatic characteristics of an area often includes several aspects of air temperature, air pressure, winds, atmospheric moisture (humidity, clouds and fogs and precipitation) (Semait, 1980). Unfortunately, data on these climatic parameters in most semi-arid areas of Tanzania is extremely insufficient on some aspects.

One important characteristic of the semi-arid areas of Tanzania is that rainfall is unreliable, both between and within seasons (Kaduma, 1980). The probability of receiving 600–800 mm per year is very is both unreliable and unpredictable. Hence, semi-arid areas are characterised by repeated water shortages (Darkoh, 1982). Even during an average year, rains may start well and then disappear in a month at a critical point in plant growth, so that a promising harvest in the case of agriculture is reduced to meagre proportions. In Dodoma, for example, the onset of the rainy season can occur any time over a period of about 60 days, while the end may occur any time over a period of 30 days. Another very important aspect of the climate of semi-arid areas of Tanzania is the occurrence of dry spells within the growing season. In Dodoma, for example, the probability of obtaining a dry spell of 10 days within the growing season exceeds 50%. As a consequence of this spatio-temporal variation in rainfall, farmers practise staggered planting in order to overcome this situation (Berry *et al*., 1972).

Hence, the overwhelming factor that restricts rainfed crop production in semi-arid areas is not the duration of growing periods, but their variability in time (De Pauw, 1983). Variability affects both the onset date as well as the duration of crop growing periods. Statistical analysis of time series rainfall data has indicated that coefficients of variation of growing period and duration may vary from less than 10% to more than 40%. Also the onset dates are vulnerable to extreme variations: the percentage of growing periods that are likely to start in the most common onset month may be as high as 75% or as low as 20%. Alternatively the period required to contain at least 80% of all onset dates may vary from less than 6 weeks to more than 4 months.

The rainfall distribution in Tanzania, which has been used as a criterion for demarcating the arid, semi-arid and other zones, is presented in Figure 1. The semi-arid areas of Tanzania are mostly found in plain areas. Darkoh (1982) reported that the principal areas that constitute the semi-arid areas include the region surrounding the new capital of Dodoma, the Lake Victoria Basin (Sukumaland) and the Maasai territory stretching northwards to the Kenya border (see Figure 1). The northern arid lands and the Maasai steppe, have short and unreliable rainfall onset dates, covering less than 2 to 2.5 months. The rainfall suffices the growing period of less than 2 months. In the central semi-arid lands the rainfall onset dates are unreliable. The rainfall is low and covers the crop-growing period of 2 to 3.5 months. The rainfall onset dates in the south-eastern semi-arid lands is low, unreliable, but adequate for the 4 to 6 months growing period.

From Figure 1, it has been observed that semi-arid environments dominate in the area running from northeast through central to southwest of Tanzania. Central Dodoma is the driest region in Tanzania. The rainfall is low and highly variable in quantity, duration and onset and end dates. Studies reported by Ngana (1993) have evaluated the seasonal rainfall characteristics in semi-arid areas of central Tanzania. These studies have shown that in Dodoma rainfall fluctuates a great deal above and below the mean value of 550 mm. Dodoma has mono-modal rainfall which falls between October and May. The coefficient of variation of rainfall in this region that is standard deviation over the mean was found to vary between a high value 309% in October and 57% in December and March. The seasonal average coefficient of variation was 26%. Another example of the semi-arid areas of Tanzania is the Maasai steppe. This area covers approximately 8000 km^2 in the northeastern Tanzania. Moisture limitation has been reported as the most limiting factor to both rainfed crops and livestock husbandry in the area.

2.3 Topography

In mid-Tanzania, the landscape shows a typical semi-arid topography represented by pediment plains dotted with granite remnants and hills (Christiansson, 1981). Generally, the landscape patterns in the

East African semi-arid regions can be traced directly or indirectly from the differences in the availability of water for plant growth to the impact of animals on the vegetation (Belsky, 1989). According to Christiansson (1981) and Belsky (1989) the semi-arid areas of Tanzania are composed of a variety of landscapes that are typical of undisturbed regions of semi-arid East Africa. The northern arid lands constitutes level to undulating plains (steepest slopes between 2% and 8%) between 1300–1800 m. a.s.l. while the Maasai steppes constitute rolling plains (steepest slopes between 8% and 16%) of 500 to 1500 m. a.s.l. (FAO, 1977; De Pauw, 1994). The central semi-arid lands have gently undulating plains between 1000 and 1500 m. a.s.l. The southeastern semi-arid lands are flat (slopes not steeper than 2%) with some gently undulating plains between 200 and 600 m. a.s.l.

2.4 Land Use Systems

In East Africa the semi-arid regions are generally considered to be too dry for productive cultivation and there is little irrigation. In this case, these lands are used for pastoralism or are set aside as National Parks or Game Reserves (Belsky, 1989). Land use systems in semi-arid areas are dynamic, and due to a variety of land use pressures, the trends show that they are increasingly coming under cultivation. According to Mwalyosi (1992), the Maasai eco-complex and other Tanzanian drylands in general are experiencing dramatic environmental changes. The changes have been observed in areas of cultivation, wood cover and bare land. Mwalyosi (1992) reported that there was a 44% increase in area cleared for cultivation during the last 30 years, while 77.2% of the former woodland has been destroyed during the same period, contributing to a 15.6% increase in grassland. Furthermore, bare ground increased by 33.1%.

Major land use systems in the semi-arid areas of Tanzania have been narrated in the LRDC (1987). The present land uses in the northern arid lands of Tanzania, which covers about 4000 km^2, are extensive nomadic grazing and game reserves. These areas are less suitable for arable farming and for grazing. However, there is considerable tourism potential.

The Maasai steppe covers about 8000 km^2 of the country. The present land uses are similar to those of the northern arid lands of Tanzania. This area is also less suitable for arable farming. Already the potential for grazing is low due to overuse. There is limited potential for irrigation because of the existence of saline/alkaline soils.

In the central semi-arid lands the present land uses are extensive semi-nomadic grazing as well as small-scale cultivation of drought tolerant roots, cereals and cotton. There is a possibility for improved grazing of seasonal swamps. In addition, there is scope for better integration of livestock in cropping systems, improved livestock production and marketing. The soil fertility, however, is low in this area.

The southeastern semi-arid lands cover about 15000 km^2. The present land uses include extensive semi-nomadic grazing and small-scale cultivation of drought tolerant roots, cereals and cotton. The area has a possibility for improved grazing of seasonal swamps, and furthermore, there is scope for better integration of livestock in cropping systems, improved livestock production and marketing.

2.5 Major Farming Systems in Tanzania

Table 1 provides a summary of some major farming systems in Tanzania as outlined by Ruthenberg (1980) and Food Studies Group (1992). As far as semi-arid areas of Tanzania are concerned, only livestock/sorghum-millet, pastoral and agro-pastoral farming systems are discussed in the present review.

Table 1: Summary of the Farming Systems in Tanzania

Farming systems types (Ruthenberg, 1980)	Farming Systems No.	Farming Systems (Food Studies Group, 1992)
Fallow systems	1	Maize/legume system
	2	Livestock/Sorghum-millet system
	3	Cassava/cashew/coconut system
Pastoralist systems	4	Pastoralist system
Agropastoralist systems	5	Agropastoralist system
Perennial cropping systems	6	Coffee/banana/horticulture system
Wet-rice systems	7	Wetland paddy/sugarcane system
Irrigated agriculture systems	7	Wetland paddy/sugarcane system

Livestock/sorghum-millet system is prevalent in Sukumaland (Shinyanga and rural Mwanza), south of Lake Victoria. The common crops grown there include sorghum, millet, maize, cotton, oilseeds and rice. Livestock is regularly used in agricultural activities and fed on grazing land or crop residues after harvest. A high degree of complementarity is achieved both in the interactions between livestock and cropping and in the differentiated land use according to soil patterns and soil moisture regimes.

The main system problems are high rainfall variability, both in duration and onset date (De Pauw, 1983), intense population pressure, declining soil fertility (due to overgrazing, deforestation and reduced fallow), and shortage of wage labour during peak periods in more commercialised farms.

Pastoral and agro-pastoral systems occur mainly in the semi-arid parts of the country. The borderline with livestock-integrated cropping systems is that at least 50% of needs or income are derived from livestock. In the purely pastoralist systems stock keeping with little or no supplementary arable farming is based upon a highly mobile grazing and watering pattern and the sale of milk and ghee in exchange for food crops.

2.5.1 Pastoralism

Purely pastoral systems are the principal means of livelihood in arid and semi-arid areas where climatic and soil conditions do not favour sufficient food production. The Maasai tribe forms the core of this semi-nomadic system in Tanzania.

The main problems of pastoralist systems are undocumented and therefore unrecognised tenure or user rights and a lack of public understanding about this land use and the need to protect it. Extensive grazing by the pastoralists is not perceived as a land use to which secure user rights can be claimed. The land on which it is practised is therefore treated as unoccupied land that can be claimed by more permanent forms of land use. This problem has become acute, particularly in the last few years due to an increase in instances of outright grabbing of pastoral lands for private ranches as well as encroachment of farm areas into previously marginal grazing areas. Furthermore, opportunity cropping accompanied by soil mining in the most fertile pastoral areas and a significant reduction in the size of pastoral areas available for grazing and watering adds to the problems in this area.

2.5.2 Agro-Pastoralism

In agro-pastoral systems there is an intimate interaction between arable cropping and cattle keeping that keep the tsetse fly at bay. This system mainly occurs in the semi-arid areas of Dodoma, Singida and Mara regions.

The main problems of this system are low and unreliable rainfall, resulting in high risk of crop failure and population pressure, which leads to both over-cultivation and overgrazing, often with mutual encroachment on croplands and rangelands. Both phenomena in turn have led to exhaustion of an already low fertility status and vegetation degradation and severe soil erosion. Reaction by the government to counteract this environmental degradation has in some districts (e.g. Kondoa) resulted in forced partial or complete destocking and out-migration of many agro-pastoralists from these semi-arid areas into Tabora, Mbeya and Morogoro regions.

Lack of effective land use planning, uncontrolled population growth and introduction of Tanzanian village agricultural production system in semi-arid areas have contributed to the present state of affairs (Mwalyosi, 1992)

2.5.3 Characteristics of Farming Systems in Tanzania

As discussed earlier, high rainfall variability, intense population pressure, overgrazing, deforestation and reduced fallow, shortage of wage labour seriously affect the semi-arid areas south of Lake Victoria during peak periods in more commercialised farms. These system problems have resulted in considerable out-migration first into neighbouring regions and later into far-away places such as Mbeya and Rukwa regions.

The major occupation in semi-arid areas of Tanzania is pastoralism associated with small-scale peasant farming. According to Darkoh (1982), in the past, nomadic grazing was common in these areas. Nomadism, by its very nature, is transitory and does not necessarily result in overgrazing. However, as an indirect consequence of increases in human and livestock population, this previously satisfactory system of indigenous animal husbandry has broken down.

The traditional transhumanic bush farming, which ensured a sustained yield, has had to give way to a quasi-static agriculture for which sustained yield farming systems have not yet evolved (United Republic of Tanzania 1977).

In parts of Dodoma district, areas of bush which were previously uninhabited have disappeared and given way to human habitation and cultivation. Rigby (1969) reported that the cattle population explosion has brought with it problems of inadequate grazing (especially during the dry season), unmitigated browsing and trampling. Driven from the exhausted flat lands, the peasants are now cultivating the rocky hillsides and upper pediments.

Insufficient length of fallow between cultivation periods has led to the impoverishment of land whilst cattle grazing has removed the last vestiges of vegetation cover (United Republic of Tanzania, 1977). Kondoa-Irangi, which is in the northern part of Dodoma, has suffered the same problems as far back early 19th century. Gillman (1930) reported Kondoa-Irangi district lies in an area of deeply weathered friable gneissic soils unsuited to static agriculture and subject to periodic drought and intense rainstorms. These areas seemed untouched by accelerated erosion in the 1890s. According to Gillman (1930), Kondoa-Irangi was devastated over the next thirty years as increasing population, both human and animal and ill-suited cropping and animal husbandry practices served steadily to impoverish the land. Deep gullies and ravines developed, often along cattle tracks, rapidly extended in the weathered gneiss and affected even areas that retained dense deciduous thicket vegetation. By the 1930s, bad land usage and management had caused the country to “crumble” irreversibly (TNA4; TNA1; Van Rensburg, 1958).

To the north of Kondoa, lies a largely pastoral territory occupied by the Iraqwi or Mbulu people. Tradition has it that the Mbulus lived in a confined area of favourable rainfall up to a hundred years ago. However, as with the Gogo or the Irangi, rapid population growth led them to expand, firstly into reasonable agricultural land and subsequently into semi-arid territory to the west and south, previously under nomadic pastoralism. As in the neighbouring areas, systems of transhumanic pastoralism and seasonal grazing reserves have broken down in Mbulu district.

Conservation measures (e.g. controlled grazing, destocking and culling, and planned clearing of tsetse bush) were introduced after 1944 but were allowed to lapse when the development fund came to an end in 1953. The consequence was environmental deterioration which was accelerated, in turn as a consequence of chronic overstocking (Fuggles-Couchman, 1964; Berry and Townshend, 1973).

To the west, beyond Lake Eyasi, one enters the Sukuma country, which includes Shinyanga and Mwanza regions. Semi-aridity in Sukumaland has been attributed mainly to over-cultivation and poor land management. This land supports about 80% of the cotton grown in Tanzania. Agricultural production is based on rain-fed cultivation without proper soil and water management systems. Soil exhaustion and sheet erosion have seriously affected crop yields (Rounce, 1949; Collinson, 1972). In the 1920s, the colonial administration's anti-tsetse campaigns also led to the wholesale repetitive clearing of vegetation in the area. In Shinyanga and parts of Singida, wind erosion occurs on arable land where light sandy soils dry out quickly after rain. Wind erosion is also a problem where mechanised large-scale arable farming has been introduced without the protection of windbreaks or strip cropping.

In the west of Arusha (northern semi-arid lands), the natural vegetation in the area has been considerably destroyed by human activity, and pressure on grazing land has been increasing yearly, resulting in continued depletion of the vegetation. The area most critically affected lies in the rain shadow of Mr Meru where the soil is composed of very light volcanic ash blown westward by the prevailing wind. Wind erosion is a very serious problem here, while soil erosion and deposition is rapidly leading to the siltation of the reservoir dams constructed in the western area (United Republic of Tanzania 1977b).

The Chagga on the slopes of Mount Kilimanjaro and the Pare on the Pare Hills occupy the north-eastern periphery towards the Kenya border. Oral tradition reveals that these communities originally occupied nucleation on the mountain slopes surrounded by cultivated farms of bananas and coffee further down-slope. Forest and unoccupied land originally separated these homesteads and farms (Kihamba/shamba as the Chagga calls them) from each other. With population increase, these empty interstices fell to cultivation and habitation. As upward penetration was limited by altitude and government imposed forest reserves, the lower flanks were quickly settled and turned into arable fields supporting maize and other food crops (Kisanga, 1997).

Increased population pressure and utilisation of the best agricultural land in the highlands for coffee have caused the migration of agricultural groups from the densely populated highlands slopes into the adjacent drier marginal plains. As the rainfall tails off rapidly to the west of the mountains, these areas are better suited to millet and sorghum growing or grazing however they are presently being intensively cultivated for maize, and are rapidly losing their fertility. As a result of improper agronomic practices and over-cultivation without adequate conservation, run-off and sheet erosion are on the increase.

The southern and eastern portions of the semi-arid zone present narrow frontages of habitation between tsetse belts. The Hehe, the Bena, Nguru, Kaguru and other smaller communities inhabit the areas. Today the familiar phenomenon of flourishing highland people spreading into the lowlands repeats itself along with similar problems.

The farming systems, and the economics of agricultural production in the semi-arid areas of most developing countries, Tanzania included, have been studied less, partly as a result of the lower interest, partly because of the physical difficulties of large areas and fewer roads. The farming systems are complex because of:

- Combinations of settled agriculture and nomadic or semi-nomadic livestock, or seasonal transhumance;
- Cultural complexes of communal ownership or tribal grazing rights;
- Cultural and ethnic boundaries may be different from the political boundaries.

To help the adoption of improved farming methods Farming Systems Research (FSR) is required to provide a better understanding of the motivations of *subsistence farmers, semi-nomadic cultivators and pastoralists.*

Most farming systems in Tanzania still do not use adequate external inputs and soil fertility is mainly restored through fallow. However, population pressure and insecurity of tenure reduce the latter (De Pauw, 1994).

2.6 Land Resources

Most of the semi-arid areas of central and the western plateau of Tanzania are covered by sandy soils, developed on sediments and acid basement complex rocks with low natural fertility and poor moisture storing properties (De Pauw, 1994). According to De Pauw (1994) Seven percent of Tanzania is covered by old weathered soils occurring mostly in the Maasai steppe, unsuitable for agriculture due to low fertility, poor structural properties and lack of water. In some semi-arid areas the country is covered by extremely variable soils, including acid sulphate soils, salt-affected and soils of volcanic origin.

The main soil constraints relate to poor natural fertility, requiring considerable amounts of fertiliser or amendments and poor moisture storing properties, including poor retention on sandy soils and surface capping on medium-textured soils. Soils of good innate fertility occur only in young alluvial valleys which are subject to flooding, and on volcanic highlands, of which the wetter parts are already overexploited and the drier parts are subject to wind or water erosion.

The major occupation of the semi-arid areas of Tanzania is agro-pastoralism. The biggest disadvantage to this is that most areas (more than 50% of the country) are infested by tsetse. This concentrates the considerable livestock population on tsetse free areas, creating conflicts of interest with agricultural land users and contributing to overgrazing. Living examples of such conflicts can be found in west Kilimanjaro between the pastoralists (Maasai) and the agriculturists (Chagga) and in Monduli district in Arusha region between the Maasai and Meru.

According to LRDC (1987), the northern arid lands of Tanzania constitute soils derived from volcanic ash, fertile in places and vulnerable to wind and water erosion. In the Maasai steppe the soils are medium textured with low fertility and are susceptible to water erosion. This area includes Pangani floodplain with large proportion of saline and alkaline soils. The central semi-arid lands constitute

well-drained sands of low fertility on uplands and black cracking clays (smectites) around Shinyanga. The south-eastern semi-arid lands constitute moderately fertile loam and clays in the south and infertile sands in the centre.

2.7. Demography

As in other areas, the human population of semi-arid regions is increasing naturally. However, there are other demographic factors that impact on land use. In general, there is out-migration from more densely settled areas, in some cases encouraged by national policies of land allocation such as the move of Chagga and Meru from the Northern highlands to the vast land in Morogoro and Kilosa. Increased human population in these highlands and the *Kihamba*[2] land tenure system made some people, who miss the land to migrate voluntarily individually or in groups to areas with plenty of land such as the previously mentioned Morogoro region. The other types of migration include commuting, in which some farmers are engaged in other business like wage labour. In this case the farm activities are left to the wives and children. In such situations, the quality of farm management and conservation practices, which always require high labour input, is impaired. Living examples can be found in the Lower Moshi areas of north-eastern Tanzania.

Furthermore, it has also been suggested that the increase in settled agriculture in areas previously occupied by nomadic pastoralists such as the Maasai Steppes in Arusha, have been accompanied by a higher growth rate among the settled population than the nomadic Pastoralist population.

Increases in the livestock in the population has been attributed mainly to the success of veterinary sciences (Darkoh, 1983) and the demand for meat products which has risen dramatically in the urban areas. According to LRDC (1987), the population density in the northern semi-arid and Maasai steppes is relatively low while that of the central and south-eastern areas is medium.

3. Perceptions of Natural Resource Degradation

3.1 Methods and Theories in Understanding SWC Problems

Whilst it is well understood that there are differences between “insiders” (local people) and “outsiders” in the way in which each perceive SWC, this difference can be partially attributed to methods used in studying SWC problems.

If soil and water conservation issues are juxtaposed alongside development paradigms that have dominated development discussion, three dimensions emerge: The classic approach, the neo-liberal approach (much favoured by the World Bank in the 1990s) and thirdly, the neo-populist approach (Blaikie, 1996).

The classic approach to soil and water conservation – and to environmental management in general is top-down; state instigated and influenced by state or internationally sponsored scientific institutions. This approach sees local resource users’ knowledge in a dismissive and adversarial manner (Blaikie, 1996). Such analysts tend to assume that “local knowledge is part of the problem, leading to backward production techniques and environmental degradation” (Blaikie, 1996:10) Since local knowledge is

[2] Kihamba is the Chagga land tenure system in which the first and last–born male children in a family are entitled to a piece of their parents land.

seen as defective, irrational or traditional, the solution lies in the adoption of expert-led knowledge and innovations.

Most of the "outsiders" perceptions are influenced by "positivism" or classic approaches, namely approaches that attach greater importance to pure science as the ideal approach. Indeed, the term SWC is a product of particular state institutions in the USA at the start of this century, and was exported (with distinctive scientific research methods) via British colonial officers, who were trained in the USA, to the British Empire (Blaikie, 1996). After the independence of the colonies, "both USAID and ex-colonial officers now in senior positions in international institutions such as the Food and Agriculture Organisation (FAO), extended the scientific methodologies within a paternalistic colonial mode of implementation. Since the SWC has been the classic example of the classic approach to environment and development, and has established itself as a central theme in current colonial discourse" (ibid. 23).

In addressing SWC problems, the classic approach sought answers from outside the affected communities. Where externally driven solutions failed, as it was the case with most SWC programmes, excuses were sought not in the solutions themselves, but elsewhere. Hudson, who did a review of 35 SWC projects undertaken by FAO, made this conclusion in explaining their failure:

"Design errors were mainly the result of incorrect assumption made at the design stage overestimating the effect of new practices…the rate of adoption of new practices…the ability of host country to provide back-up facilities…the time required to mobilise staff and materials for the project… estimate of the economic benefits… capacity to provide counterpart staff and…the recurrent costs…strength of national research base and its ability to contribute to the project…underestimate the problem of co-ordination among different ministries or departments" (Hudson, 1991:vii–viii).

Apparently, diagnosing the causes of the failure in this way actually led to further top-down expert technological drives, and less participation of the resource users. This approach has been criticised and led to a "paradigm shift" to what is referred to as neo-populist stance which calls for bottom-up approaches (Chambers, 1983, 1993; Pimbert and Pretty, 1994). The neo-populist school recognises that protection of soil resources has been part and parcel of local people's production systems and understanding of the use of different qualities of natural resources (Blaikie, 1996). Thus neo-populist scholars have established that in the area of SWC there are close to one hundred practices, most of which are short-term water conservation rather than ways of keeping soil in place (IFAD, 1992). Some projects are now emulating good examples from traditional experiences and promote their wide use – e.g. in Burkina Faso (Dialla, 1994). Also credible evidence is abundant in East Africa that there are indigenous technologies that can maintain production whilst saving soil and water efficiently. Evidence that farmers in East Africa had developed and adopted techniques that effectively conserved soil and water over long periods and in the face of increasing population is also available (Tiffen et.al., 1994).
The neo-populist school advocates a process of learning from the farmers and using the so-called bottom-up approaches and techniques. Most of these techniques fall within the broader context of participatory approaches (Chambers, 1983, 1993; Scoones and Thompson, 1994).

Dealing with a related issue, Oudwater and Martin (undated) have combined systematic and participatory approaches to study indigenous knowledge on soil and soil and water management. Their conclusion is that farmers' knowledge is site-specific and relative rather than absolute and universal. In general they conclude that farmers tend to compare soil types in terms of colour (darker/lighter) or fertility (less/more) when describing a particular soil (ibid: 5). Increasing SWC problems, and the

spread and adoption of participatory approaches in these studies have stimulated studies on indigenous knowledge (IK) in SWC matters[3]. Without romanticising IK, it is crucial to note that it does not always provide the answers to all SWC problems, neither is it adequate on its own. Nevertheless, for researchers to be effective, they should not ignore IK and focus on endogenous knowledge alone. Also, for local people to participate in externally motivated developments, local knowledge must be understood so that issues that affect the people are adequately understood and addressed.

This suggests that local resource users know very well what they are doing and why they are doing those things. To them, SWC is an integral part of sustainable livelihood system (Blaikie, 1996). If this is true then on what technical, social and methodological grounds do outside institutions intervene in SWC problems? Indeed even some of the neo-populist approaches still address matters up side down, by paying too much attention to developmentalists, rather than to the needs of the local people. However, some of the neo-populist scholars are now including issues of land tenure, property regimes, local institutions, gender and equity in the discussions of SWC issues. Nevertheless, external agenda of soil conservation are still prevalent in the donor driven development programmes of sub-Saharan Africa. It is therefore clear that proper methodologies, which genuinely serve local resource users, are yet to be developed and used.

3.2 Understanding the Problem and Its Essence

There are many approaches of looking at soil and water conservation problems, this section looks at two common approaches. The first approach is to look at SWC problems through the "eyes" of the scientists. This is called the "*etic*" approach (Kaplan and Manners, 1972 in Kikula, 1997). Scientists determine what the problem is and suggest solutions. In this approach, it may be assumed that local people are not aware of the problem, hence they may require some form of awareness raising, by the scientists. The second approach is called "*emic"* or the local indigenous view of environmental problems (Kikula, 1997). This view assumes that local people are aware of the problems and are taking some measures to address the problems.

These approaches express different perceptions of SWC issues. It is important to understand these differences in order to find out how gaps between scientists and local resource users or amongst either of these groups, can be bridged to bring about sustainable use of natural resources. Perceptions may mean many things to different people, but in this section perception as defined by Kikula (ibid.) means awareness, concern and attitude of scientists or local people on SWC problems.

Studies on perceptions of environmental matters have become important as they shed more insights into areas of conflict between scientists and local communities, and how these differences in perception help or hinder efforts in environmental management. Differences in perception can also occur among people living in the same location, sharing the same resources. It is equally important to understand the basis for these differences and how they influence the use of natural resources. Environmental perception studies in Tanzania are scant. However some concerted efforts have been made in this direction (Kikula, 1997; Rutatora, *et al.,* 1995; Dejene, *et al*., 1997).

Soil fertility, soil erosion and water management problems are closely associated with what is often called land degradation. Land degradation can mean many things to different actors. In grappling with

[3] There are several attempts to learn from local people and use their experiences. The SADC Office of Environment and Land Management Sector Co–ordination Unit in Lesotho, initiated a regional study on Innovative Rural Action Learning Areas (IRALAS), which addressed the issue of SWC from the perspective of IK. Tanzania, Malawi, Lesotho and Mozambique have done such studies.

this issue, Kikula (1997) highlights some contrasting perceptions. For example, a rangeland manager would consider land degradation to include tree and shrub loss. According to Kikula, the loss of productivity and vigour, loss in cover, shift in botanical composition, are but some of the indicators of land degradation along a continuum of change. Furthermore, soil degradation is defined as a process, which reduces the capacity of land to produce crops (Kikula, 1997). The fall in soil fertility could be one of the observable features of soil degradation.[4] How these problems are understood is important because they shape and influence decisions about the measures to be taken.

Soil degradation manifests itself through soil erosion and decline in soil fertility. Tanzania is one of the countries in sub-Saharan Africa that is increasingly affected by these forms of soil degradation. Semi-arid areas such as Shinyanga, Singida, Dodoma regions and parts of Arusha region are particularly vulnerable to these problems because of the inherent low soil fertility, low productivity, unreliable rainfall, and improper land and livestock practices (Berry and Townshend, 1973; Dejene, *et al*., 1997). Semi-arid parts of Tanzania have experienced soil degradation problems since at least 1900 (Berry and Townshend, 1973). However, every time this problem is discussed, the tendency has been to look at it as if it was completely new. This has been so partly due to poor institutional memories (Kikula, 1997). This has implications on strategies that are being propagated to redress the problem. Instead of learning from previous approaches, there is a tendency to try new approaches, which have not been fully tested. Often mistakes committed in previous attempts are repeated.

Although semi-arid areas have experienced land degradation just like other areas in Tanzania, perhaps due to the attractiveness of the landscape, much attention has been given to the problem of soil erosion in the mountains. Lowland areas have received scant attention. According to Berry and Townshend (1973), semi-arid areas have serious problems and solutions to the physical problems in these areas are more difficult because the use of land and the subsequent erosion and deposition are bound up with the cultural and social systems.

3.3 Perceptions of SWC Issues During the Colonial Time in Tanzania

Perceptions are not static, they change with time as new insights are found and new technologies are put to use. Over a long period of time however, certain trends have influenced thinking in this area.

Generally, the outsiders' view – the etic, approach has dominated our understanding of SWC problems for quite sometime. Both German and British colonial authorities in Tanganyika grappled with the SWC problem and treated it as a technical problem that required technical solutions. Numerous studies that were done in this field focused on technical aspects. For example, quantitative data on run-off and soil loss were collected in order to measure the extent of the problem (Staples 1933; van Rensburg, 1955). Similarly, studies that focused on soil erosion collected data on reservoir sedimentation and sediment yields in selected catchments in Tanzania (Rapp *et al.*, 1973). These studies were influential in suggesting technical solutions to the problems.

Technical solutions to these problems often took the form of contour farming and bench terracing. Beside these measures, livestock reduction was also propagated. These suggestions came from the so-called experts who, inevitably came from outside the problem areas. These experts (local or international, but always working together), defined the problems, suggested the solutions and

[4] Further definitions of soil degradation are provided in FAO (1977) "Assessing Soil Degradation" Soils Bulletin, No. 34.Rome; FAO (1978) Methodology for Assessing Soil Degradation. Report on the FAO/UNEP Expert Consultation and FAO (1979) Provisional Methodology for Soil Degradation Assessment. FAO, Rome.

supervised their implementation. In Tanzania, laws were also set to ensure that technical solutions were adhered to by the local communities (Rapp *et al.*, 1973). Very little attempt was made to learn from the affected communities, and to use their experience to inform the solutions and approaches to soil and water conservation problems. The people were secondary, and often, they were blamed for causing these problems. It is not surprising therefore, that most of the technical solutions applied in past conservation efforts yielded few positive results.

Inadequate attention was paid to the understanding of the intricate relationship between perceived causes and the social processes of change. Various scholars blamed the farmers for some of the land use practices, which were attributed to these problems. For example Berry and Townshend (ibid.) blame cattle and more cattle, which is part of the culture of the people in semi-arid areas of Tanzania, for being responsible for land degradation in these areas. Expert gatherings such as the soil erosion conferences of the 1930s identified the cause of the problem as overcrowding in mountain areas and overstocking in the semi-arid areas. Wrong methods of cultivation were also seen as a problem in both areas (Berry and Townshend, 1973).

It is interesting to note that even scientific gatherings such as the one organised in the early 1930s to discuss the issue of soil erosion, also perceived the problem of SWC in technical and legal context. Following recommendations from this gathering, an advisory committee on terrain was formed. Also legislation such as the 1952 Native Authority Ordinance, National Park Ordinance, Forestry Ordinance, Grass Fire Ordinance and several others were enacted. Considerations of social issues within the context of SWC were limited to the Malthusian perspective, when SWC problems were blamed on simple arguments of population growth. Indeed, some regions in Tanzania (or even within the region) can be regarded as mostly populated, but fertility rates have been declining and population growth has remained relatively stable for sometime. Other population characteristics are usually not considered, thus the Malthusian thesis fails to explain the problem of land degradation in a holistic manner. The Malthusian thesis tempts one to reach one conclusion, namely population control as *the* solution to SWC problems. But experience shows that population control measures alone are not sufficient. This perception (Malthusian argument) however, has gained strong support even today, and is still being regarded as one of the causes of land degradation by scientists and some decision makers.

Whilst numerous scholars and officials laid the blame squarely on improper cultivation practices, deforestation and overgrazing as the major causes of soil degradation in the semi-arid parts of central Tanzania (Rapp *et al.*, 1973), they ignored the search for the real root causes of the problem. More importantly, detailed study and analysis has rarely backed up these causes (Berry and Townshend, op.cit.).

Efforts to deal with the problem of soil and water conservation after the second world war followed almost similar approaches except that, during this time, more concerted efforts were made. Several land use schemes were started in many parts of the country to address SWC problems. These included for example, the Uluguru Land Use Scheme of 1945 to 1955 and the Sukumaland Development Scheme, which started in 1946. Most of the activities in these and other schemes included tree-planting, terracing and contours, and were enforced through a combination of legislation and open coercion. The manner in which they were enforced and the amount of force that was used, raised more questions as to the real motive of the colonial officers. Indeed others saw it differently. Heusler noted that “the practical effect of this colonial soil conservation discourse was legitimisation for colonial powers to extract maximum agricultural and forest produce from the colonies for their own benefit” (Heusler, 1995:182)

Although several measures to address SWC problems were put in place by the colonial government, they were not effective because of the narrow understanding of the problem. The failure of the measures is also attributed to other factors. For example, most of the measures were unpopular with the people, because they interfered with the accepted agricultural practices (Berry and Townshend, ibid.). The people rejected some of the techniques because they used too much land or demanded too much labour. Destocking was rejected because it conflicted with the peoples' wealth and security, and it was seen as a ploy to benefit urban meat industries (Cliffe, 1964).

Not only was there lack of proper understanding of the essence of the problem on the part of the administration, "but they also failed to appreciate the culture and social organisation of the various tribes of the country" (Berry and Townshend, 1973:251). It is claimed that past conservation initiatives produced no demonstrable improvements on crop output (ibid.).

Also, administrators had not appreciated that many local people had adapted agricultural and pastoral systems to their environment and could control soil erosion, instead, they continued to pursue depopulation of mountainous areas and destocking in pastoral areas, and the enforcement of contours and terraces.

These approaches produced a strong disenchantment among the local population, against the administration for soil conservation. This was complicated even further when soil conservation rules or orders were enforced upon the indigenous people, living outside white settler farms. Small farmers felt they were being discriminated against. Summing up the failure of past conservation measures, Temple noted that "past conservation policies were often unsoundly based and unwisely implemented" (1973:121).

Much has been written about the failure of the pre-independent conservation programmes (cf. Cliffe, 1964; Maguire 1969; Fuggles-Couchman, 1964; Temple, 1971; Young and Fosbrooke, 1960, Kikula, 1998). African leaders who were struggling for independence capitalised on these weaknesses and turned the issue of contours and terraces into a platform for political campaigns against colonial domination (Iliffe, 1971). This has had far reaching implications as will be discussed below.

3.4 SWC Perceptions After Independence

At independence in 1961, the new administrators did not only inherit a whole range of colonial legislation and state apparatus but also an outsider's perception of SWC problems. The first ten years after independence were characterised by policy formulation, consolidation of the new rulers and the search for an appropriate path of development. Little attention was paid to SWC problems. Since, measures to address these problems were faulty during the colonial period, and since there was neither a proper land use policy, nor an environmental policy, SWC problems increased to an alarming level. The main thrust in development initiatives was on economic growth, in fact, environmental variables were not considered in economic development policies until very late in the 1980s.

By the early 1970s, the government, with donor assistance, continued to implement programmes to address SWC problems, as they were initiated during colonial period. Several programmes were initiated in various parts of the country, some aiming directly to SWC issues while others, covering broad aspects of the environment. Box 1 below presents a summary of some of these activities[5]. Most

[5] A full list of such programmes can be obtained from DANIDA (1998) DANIDA Identification Mission on Environmental Sector Programme. Overview of Donor Supported Environmental Activities in Tanzania. Ministry of Foreign Affairs,

of these programmes are top-down, reflecting the centrality of the experts in identifying SWC problems, designing mitigation measures and managing the processes, with some participation from the farmers.

1. Dodoma Region Soil Conservation Project (Hifadhi Ardhi Dodoma-HADO), 1973.
2. Rukwa Integrated Development Programme 1985.
3. Shinyanga Soil Conservation and Afforestation Project (Hifadhi Ardhi Shinyanga –HASHI), 1986.
4. East Usambara Conservation and Agricultural Development Project, 1987.
5. Kigoma Rural Integrated Development Programme, 1989.
6. East Usambara Catchment Forestry Project, 1989.
7. Soil Erosion Control and Agroforestry Project (SECAP), 1989.
8. Environmental Conservation in Iringa (Hifadhi Mazingira Iringa – HIMA), 1990.
9. Land Management Programme for Environmental Conservation (LAMP) in Babati District, 1991.
10. Dodoma Village Afforestation Project (DOVAP), 1991.
11. Dodoma Land Use Management Project, 1991.
12. Handeni Integrated Agroforestry Project (HIAP), 1992.
13. Tanga Coastal Zone Conservation and Development Programme, 1993.
14. Kilosa Environment Project, 1994.

Figure 2: Soil and Water Conservation Programmes in Tanzania

3.5 Local Perception of SWC Problems

Unlike the *etic* view, which presupposes that local people are not well versed with SWC issues, it has been established that there exists indigenous knowledge in SWC issues, and that relevant communities have been using this body of knowledge to overcome SWC problems. Dejene *et al.*, (1997) for example have reported that farmers are aware of various types of soil degradation that takes place in their local areas. Dejene and others have shown that farmers use a variety of indicators to interpret and explain SWC problems. These indicators include: rill gully erosion, water absorption capacity (level of run-off), exposure of roots, crop yield, change in colour or crop leaves, stunted crops, emergence of weeds and unpalatable species, appearance of termite mounds, and disappearance of grass (Dejene *et al.*,1997: iii). Likewise, Schmied (1989), doing her studies in Ruvuma Region documented how the Matengo people identified land degradation and how they dealt with it by introducing Matengo pits (or *ngoro* system).

Similarly, most pastoral communities practised traditional systems that were adapted to their conditions. For example, in Ngorongoro and Hanang, these systems were effective in range

Denmark. The years indicated in box 1 after each project, shows the start of the project. Some of them continue up to the year 2001.

management. The Barabaig pastoralists in Hanang classified pasture on the basis of variety of soil types, topography and availability of ground water. This enabled them to recognise specific forage regimes that were associated with several geographical features (Lane, 1996). In order to utilise pasture when it was most productive, and rest areas to allow regeneration, the Barabaig devised an efficient common resource management system. This practice was based on an eight-part seasonal grazing rotation system that exploited forage and watering points in different times of the year (Lane, 1996; Bradburry *et al.*, 1995; Lane and Pretty, 1991). Since their system depends so much on vegetation and availability of water, the Barabaig developed strict regulations and rules to prevent destruction of these resources. Barabaig were also capable of recognising environmental changes, by studying vegetation changes, and taking appropriate measures before land degradation became insurmountable. Also, details about the Maasai in Serengeti and Ngorongoro and how they lived in harmony with wildlife and managed to control land degradation have been well-documented (Potkanski, 1994; Shivji and Kapinga, 1998).

Other works that have documented the various forms and practices of traditional natural resources conservation methods in Tanzania include Busse (1902), Steinhouse (1944), Iliffe (1969, 1977, 1979), Kikula (1997) and Maddox *et al.* (1996) – to name a few. A common view across these and similar literatures is that indigenous communities identified SWC problems in accordance with the condition of their land. Using the example of Wahehe, an ethnic group, which is found in the Southern Highlands of Tanzania, Kikula (1997) shows how the Hehe people perceived land degradation. Some words in Kihehe language express various forms of land degradation and their causes. The existence of these concepts in local languages is an indication of the traditional awareness of the quality of the environment (Kikula, 1997).

Such concepts can be found in most of the ethnic groups in Tanzania and covered various aspects of land degradation (see Deneje *et al.*, 1997). In discussing this aspect, Kikula shows that local people explained a decline in crop output in relation to soil exhaustion, and that such explanations were generally, not very different from the scientists' view (ibid.). Similarly, Birch-Thomsen (1996) noted that local people were able to identify soil fertility problems by associating it with productivity per area. For example, he argues that, farmers in Mazombe Division, Iringa Region were able to point out that one acre was enough to fill a storage before villagization in 1970s, but today, one needs five acres to fill the same size of a storage. These perceptions are common among farmers, and indicate how they understand SWC problems.

Also taking shortage of trees as a land degradation issue, Kikula shows that many local people perceive this as a problem, but this may differ in terms of age, family size, education background and position in the village (ibid.). Furthermore, according to Kikula's findings it is not only interesting to note that the majority of local people know the causes and solutions to such problems, but also that a substantial number of local people do not know the causes nor the solutions. This is not only in Tanzania, but also in developed countries such as Australia. Local people there believed that strange things such lightning was a causal factor in tree decline.

Local people addressed SWC in many ways. Some of the well-documented cases for Tanzania are indicated in Box 2. These systems evolved after many years of adaptation to the local conditions, and helped to enhance efficient resource management. It is interesting to note that some of these approaches are still being applied today in some parts of the country with varying levels of success.[6]

[6] Some of the approaches that address soil erosion and soil fertility which are still being used today are presented in Dejene, Alemneh. Elieho K.Shishira, Pius Z. Yanda and Fred H. Johnsen (1997) Land Degradation in Tanzania. Perception from the Village. World Bank Technical Paper No.370. Washington.D.C.

The *etic* view is indeed indigenous knowledge (or local knowledge) (IK) on SWC issues. There has been growing awareness of the value of IK systems in SWC issues. Globally, this has been recognised in several International conventions and reports. Within the UNCED process, Agenda 21 and the

Figure 3: Examples of Indigenous SWC Approaches

- Mounds and ridges in Rukwa region
- Organic farming in Ukara Island, Mwanza region
- ***Ngitiri*** pasture conservation in Shinyanga and Mwanza regions
- Terracing and contouring in Arusha, Kilimanjaro, Tanga and Morogoro regions
- Stone barriers on slopes in Korogwe district, Tanga region
- Intercropping with trees in Arusha and Kilimajaro regions
- Shifting cultivation in many regions in Tanzania
- Rotational grazing in Arusha region
- Matengo Pits or ***ngoro*** system in Ruvuma region

Convention on Biological diversity recognised the importance of IK for sustainable knowledge. Also Chapter 26 of Agenda 21 requires UN bodies, other international development and finance organisations, and governments to "incorporate indigenous knowledge and programmes that may affect them" (para 26.5). More crucially, Chapter 26 recognises the need for holistic traditional scientific knowledge about land, natural resources, and environment held by many indigenous people. Similarly, article 8.j of the Convention on Biological diversity calls for the respect, preservation, and maintenance of indigenous and local knowledge, innovation, and practices in biological diversity conservation and sustainable use, as well as its wider applications and practices. Several other UN declarations are in support of IK e.g., the United Nations Commission on Science and technology for Development – Gender Working Group (UNCSTD GWG 1995) and the Report of the Fourth World Conference on Women in Beijing.

Although the value of IK has been widely recognised, scientific and development practitioners have not been successful in recognising the potential for enriching both IK and scientific system by looking for ways of linking those systems. Inadequate appreciation of IK has led to the dominance of external perceptions on SWC issues. It has also led to the obliteration of gender (mainly women) related perceptions on SWC by ignoring women's knowledge and perceptions on SWC. This has led to the marginalization of women and women's knowledge on SWC and other development issues, which contribute positively to sustainable development.

3.6 Conclusion

It is apparent from the foregoing observation that there is a gap in perceptions on SWC between scientists and local population, especially in terms of understanding the causes of these problems.
It is also apparent that most of the previous approaches that dealt with SWC problems were influenced by how those who initiated conservation problems understood/perceived the problems. The failure of most of these programmes is attributed to inadequate involvement of the local population, insensitivity to local needs, too much reliance on technical options and ignorance of local knowledge. More importantly, inadequate attention is paid to social problems such that SWC issues are assumed to be technical problems. Approaches to SWC have not been holistic.

4. Natural Resource Degradation and its Causes

Increased pressure on natural resources leads to loss of flexibility of livelihood strategies. This applies at the scale of the individual farmer whose meagre reserves of food and grazing are soon used up. It applies equally at the level of the village or tribe who in the past have traditionally held emergency grazing in the reserve. It further applies at a national level as grain stocks are depleted, and at the regional level when it is no longer possible to use the safety valve of major movement of livestock (Hudson 1987).

4.1 Estimates of Resource Degradation

In Tanzania, just like many developing countries, the previous emphasis on agricultural research and development has been on the best use of good soils and good climates. Little attention was given to marginal environments (Hudson, 1987). One result of this uneven spread of effort is a lack of information about the less favoured semi-arid areas. In the semi-arid regions there are few soil surveys to show what chemicals are available, and less research on the physical and chemical properties of soils to show their capabilities and problems. The arid central belt, for instance, is threatened by desertification which is revealed in "alluvial" or residual surface subject to stripping of topsoil and accelerated run-off, gully erosion on slopes, and/or sheet erosion or deposition on flat lands (UNEP/FAO/UNESCO/WMO, 1977). Studies on soil erosion on Kondoa provide estimates of the extent of soil loss. Mbegu (1994, p.1) reports loss of 1–2 mm of productive soil loss per annum, while erosion rates of the order of 55 tons hectare per year are reported for the most severely eroded parts of Kondoa. An estimate of the size of gullies is reported by Yanda (1996) to be 150 metres high, 100–150 metres of length and 20 metres deep. Also extent and consequences of siltation of the Mwisanga water reservoir in Kondoa is documented, highlighting the limitation of surface water dams in such an environment and the high costs of repairing such dams. The problems of agriculture in semi-arid areas of Tanzania are dealt with by Boesen *et al.,* (1998).

Farmers are aware that soil degradation, in various forms, is taking place on their farms as well as in the surrounding areas. This is based on their perception and interpretation of indicators that reveal certain conditions regarding crop and pastureland. The major indicators cited by farmers included rill and gully erosion, water absorption capacity (level of run-off), exposure of roots, crop yield, change in colour of crop leaves, stunted crops, emergence of weeds and unpalatable species, appearance of termite mounds and the disappearance of grass. Most physical and plant species indicators are local and site specific (Dejene *et al*., 1997).

4.2 Causes of Soil Degradation

The causes of resource degradation are viewed differently by different stakeholders. According to de Haas and Friedrichsen (1995) most donors perceive soil degradation as largely caused by:

- Inappropriate land use systems and methods;
- Heavier demands on land due to population growth;
- Inappropriate land use systems and methods;
- Inadequate agricultural legislation and ill-defined property relation;
- Adverse macro-economic conditions; and
- Collapse of social fabric in many rural areas.

The authors reported that overgrazing, deforestation, agricultural mismanagement, and overuse of natural vegetation and agro-industrial activity bring about human-induced soil degradation processes.

The effects are topsoil loss by wind and water erosion, depletion of soil organic matter and nutrient impoverishment.

According to GLASOD (1990), agricultural mismanagement, overgrazing and deforestation are the major causes of soil erosion and chemical soil degradation. Apart from improper use of technological advances (ploughs, fertilisers, and irrigation), extensive farming and the attendant high land requirements can also destroy soils (e.g. slash and burn). The latter is not as destructive for the soil as has been previously thought. In fact, the burning can replace nutrients to soils of low soil organic matter content and this is essential in areas such as semi-arid regions where available nutrients are low. This is true because plant available moisture is a constraint and biomass is low). A particular problem here is the farming of marginal land such as steep slopes or dry pastures. Such problems include accelerated soil erosion by water and wind during the rain and dry seasons respectively and loss of meagre biodiversity in such areas.

Soil degradation in most cases is considered as a creeping, unobtrusive process and is not usually noticed until it has reached an advanced stage, which is when preventive and curative measures are often, too late and as a result, are not taken at all. The results of soil degradation are the decline of soil fertility and productivity and hence an ultimate loss of yield.

Generally, soil fertility mining is the most common and insidious form of soil degradation. It is invisible but nearly everywhere. Soil fertility mining is caused by the negative balance between nutrient exports through crops and fertility inputs, mainly inorganic fertiliser inputs and minor organic amendments. According to De Pauw (1994) pressure on soil fertility sources has increased by constraints on the use of external inputs like fertilisers and incomplete agricultural extension packages e.g. improved high-yielding crop varieties.

Soil erosion, once a fairly isolated phenomenon, confined to areas with highly erodible soils or high rainfall and poor vegetative cover, is now spreading through all parts of Tanzania, but predominantly in mountain and semi-arid areas. In the semi-arid interior plains severe soil erosion has resulted from lack of protective vegetation cover, often prompted by overgrazing, itself forced by pressure applied on (agro) pastoral lands by other land uses. Overgrazing, combined with more frequent fires, is also the main agent in vegetation degradation.

De Haas and Friedrichsen (1995) suggested that the kind of land use and thus the magnitude of soil degradation is largely determined by general social, economic and policy/institutional settings. Depending on the national or regional conditions, soil degradation is subject to four factors of influence:

- social-demographic causal chains;
- services and infrastructure;
- situation on the different markets; and
- underlying policy measures.

Policy action can also have both beneficial and harmful effects. Policies with conflicting (development) goals combined with inadequate agricultural structures reinforce soil degradation, whereas a policy of incentives can promote soil management – these have been covered in Appendix 1 ‘Policies: Incentives and Disincentives to SWC in Tanzania and Socio-Economic Constraints: An Annotated Bibliography’.

5. Soil and Water Conservation Strategies in Tanzania

5.1 The practice of soil and water conservation

Measures for the conservation of soil and water are largely interdependent. Soil erosion by water results from the surface run-off of rainfall in excess of the amount the soil can absorb. Obviously, where run-off occurs, part of the rainfall fails to infiltrate into the soil, where it can be stored in the profile for use by the plants, or may gradually drain away to maintain the perennial flow of streams or to accumulate in subsurface aquifers. Methods of land use, or agronomic and mechanical measures suitable for the control of water erosion, aim principally at reducing run-off by increasing the proportion of the rainfall percolating into the soil and are consequently beneficial in conserving water. Wind erosion only occurs when the soil is dry, hence one of the chief measures for its control is the conservation of water in order to raise the moisture content of the soil.

Effective control of water erosion demands the proper use and treatment of various types of land over the whole of a catchment area, in accordance with the conservation requirements of each different portion of any size. Three measures that can be used to control soil erosion include good land use, good husbandry and appropriate mechanical measures (Webster and Wilson, 1980).

Despite efficient land use management in catchment areas there will naturally be big differences between rainy season and dry season stream flow in many places. This necessitates the provision of dams and reservoirs for storage in order to achieve a better distribution of available water throughout the year in semi-arid areas.

From the farming point of view, a more important factor is that over vast semi-arid areas of the tropics insufficient rainfall is the major limiting factor to crop production. In such areas it is vital to ensure maximum conservation of rainfall as soil moisture available to crops and grass by measures to improve infiltration and reduce run-off. Most of the mechanical measures and tillage operations already mentioned for the control of soil erosion have these objectives and will therefore, also aid water conservation (Mushala, 1985).

On one hand, the work of soil conservation usually involves three phases that succeed each other in the following order. First, some kind of physical survey is needed to enable different types of land to be mapped and classified as suitable for different purposes and methods of cultivation. Secondly, mechanical measures, such as the construction of earthworks, may have to be put in, and thirdly, appropriate agronomic practices must be employed (Webster and Wilson, 1980).

On the other hand, water conservation, in common with the control of erosion due to water, depends primarily on obtaining good infiltration of rainfall into the soil and minimising run-off, but it is also affected by the water consumption of vegetation. Pereira (1973) has provided a detailed account of the ways in which land use and farming practices can affect land management and conservation.

In the Tanzania, legislation now provides for the maintenance of protective forest reserves over extensive, highland catchment areas. Where the landscape is steep and broken it should clearly be kept permanently under forest, but there are large forested catchment areas which, by reason of their gentler topography, fertile soils and good rainfall, are of high agricultural potential. Until recently, decisions on land use for such catchment areas had to be largely based on mere opinion, since little factual information exists on the effect on water resources of a change from natural forest to other forms of land use (Kisanga, 1998).

5.2 Adoption of Soil and Water Conservation by Smallholder Farmers in Tanzania

The practices of soil and water conservation strategies in Tanzania have undergone changes in terms of their delivery and adoption. From the colonial era to the present, attempts have been made to introduce SWC measures in a wide range of settings in Tanzania. However, many introduced technologies have failed to be sustained in the long term once a specific project has been withdrawn (Kauzeni, *et al.*, 1987). The collapse of Kongwa Groundnut Project in Dodoma Region after Tanzanian independence can be used as a living example.

Soil and water conservation technologies are not simply structures involved in managing soil and water in agricultural settings and they also include agroforestry, agronomic and tillage practices. Any analysis of technology must therefore be situated within a social and economic understanding of the role of the technology, the rationale and purpose of its design. Technologies arise out of particular sets of historical and social circumstances. Different people have different attitudes and commitments to them and, because of the dynamic influences over their origin and maintenance, they continuously evolve and change.

5.3 Standard Solutions to Standard Problems: The Conventional Approach to SWC

The Adoption of soil and water conservation by smallholder farmers in Tanzania could build on the work of Reij *et al*. (1991, 1997). In this regard, the following sections are discussed and linked with the Tanzanian case studies.

Alarm about the potentially damaging consequences of soil erosion has prompted a long history of external intervention in SWC measures in Africa, Tanzania included (Hudson, 1987; Hudson, 1991; Hurni and Tato, 1992). The experience of the Dust Bowl in the United States proved highly influential in policy thinking from the 1930s onwards. This was compounded in southern Africa by the experience of drought. The prospect of such disasters afflicting the newly established colonies worried colonial administrators and politicians. Major programmes of soil conservation were initiated in many parts of Africa, where the colonial state was strong and there was a need to ensure that demand for land by the African farmers did not undermine the expansion of large-scale European-owned commercial farming enterprises. The result was an emergence of a set of interventions focused on the mechanical conservation of soil: soil bunds, ridging, contour ploughing and so on (Stocking, 1985).

By the 1940s, a wider set of environmental concerns had come to influence colonial development thinking: soil fertility decline, overgrazing and deforestation had been added to the list of ills inflicted on the land by African farming and livestock husbandry. This more comprehensive view of the environmental problem suggested a wider approach to land management that went beyond individual SWC techniques. By the 1950s an era of land use planning emerged based on a set of land husbandry principles.

In many areas local people rejected the land husbandry package. Farmers felt that the imposition of a particular model of land use practice undermined their existing agricultural management practices. During the 1960s and 1970s, development attention focussed on the need to modernise and transform supposedly backward agriculture to raise yields and productivity.

5.4 Putting People First: Participatory Approaches to SWC

The one important difference between the advocacy of SWC and land husbandry today and colonial precursors is the current emphasis on people's participation. The lessons from 1960s onwards taught project planners and policy-makers alike that imposed projects just do not work, certainly in the longer term. Advocates of a more participatory approach to development argued forcefully for 'putting people first' (Chambers, 1983).

Wider trends of democratisation, decentralisation and the retreat of the state have meant that participation has become both politically appropriate and practically necessary.

This constellation of factors has prompted the emergence of a new style of natural resource management intervention based on holistic, village-based resource management involving a participatory process in planning and implementation. This type of approach is now widely endorsed and representative of a broad consensus about development intervention in the 1990s.

The shift to local-level planning, appreciation of indigenous techniques and acceptance that there are limits to technological solutions to complex land management problems are undoubtedly a step in the right direction (Scoones *et al.*, 1996). One important concern is how far the scientists appreciate and know the indigenous knowledge? What are the characteristics of indigenous knowledge and its applicability in a wider context? This calls for another review on the characteristics of indigenous SWC techniques.

5.5 Characteristics of Indigenous SWC Techniques

For our purposes, indigenous refers to local practices, as distinct from interventions imposed from outside. However, many practices that maybe regarded as indigenous today are derived from elsewhere in the past. Indeed many 'indigenous' techniques have been derived from migrants living or passing through the area, learned during the journeys to other places or adapted from interventions imposed during the colonial era. However, an important issue pertaining the indigenous technology is the dynamics of technical change; how innovations are adapted and transformed; how technologies evolve through incremental adaptation; and how current practices are the result of cumulative responses to a range of influences over time.

Most local SWC practices have designs that reflect their multiple functions (Warren 1991; and Reij, 1991). Soil conservation and water harvesting may have different priorities depending on the average rainfall in the area, the soil types and the position of the site within the landscape. For instance in wetter areas, leaching of soil nutrients and sheet erosion may be a serious problem for agricultural production, and soil conservation measures may be of paramount importance (Tchawa, 1996). By contrast, in drier areas, water is a major constraint to agricultural production and the technologies are designed to capture and spread water to key agricultural sites. This trade-off between soil nutrient management and soil water management is central to current understandings of the production dynamics of African savanna environments (Frost *et al.*, 1986).

Types of SWC techniques also vary within landscapes. Generally, at the lower point in the slope, sink sites form where soil and water collect. Such areas include a variety of wetland patches within dry areas (Scoones, 1991) with examples of *mbuga* of Tanzania. Within dry areas, such sites are highly

valuable, constituting key resources in otherwise fairly low value landscapes. Some of the major characteristics of indigenous SWC have been outlined by Oudwater and Martin 1998.

5.6 Research Projects Looking at SWC in Tanzania

Major international research for dry areas in recent years, with the establishment of International Crops Research Institute for Semi-arid Tropics (ICRISAT) in 1992 and International Centre for Agricultural Research in the Dry Areas (ICARDA) in 1977. In this case, selecting or breeding cultivars for particular semi-arid climates shows promise, but has a long way to go (Hall *et al*., 1979). Other research projects looking at SWC include HADO, HASHI, SECAP and SCAPA (see Box 1 for more details).

5.6.1 Tree-planting

This is dealt with by Ahlback (1994), emphasising techniques of motivating and mobilising the people of Tanzania for tree-planting at village level. Specific case studies involving tree-planting include collaborative work between a Swedish NGO (Byskosinamligen) and a local NGO (Tanzania Association of Foresters) in Karatu, Arusha Region (Axelson and Hagborg, 1994). The role of fruit trees in the farming system is exemplified by the case of Upper Mgeta in Morogoro District, based on interviews with farmers and direct field observations. Although fruit trees were found in almost every farm, fruit production is generally neglected. Deciduous fruit trees have diverse functions e.g. trees close to the house mainly serve to produce fruits for home consumption and for sale whilst the major function of those planted in remote fields is to secure land tenure. Other important functions include: soil erosion control, capital saving after retirement and as heritage asset. Generally trees receive very little care and so the quality of fruits is usually poor. On the other hand, the market is unreliable and prices are low.

The value of integrating agro-forestry with SWC is shown by the case of four-year experimentation in Machakos, Kenya as reported by Kiepe (1992). The technique involves adding trees to conventional soil conservation works to control runoff and erosion. After four years success was recorded and thus plots were extended and quantitative observations made to record changes that have taken place. Further insights into the role of agro-forestry in SWC are found in the proceedings of a workshop on agro-forestry and environmental problems in the Tanzanian southern highlands. Kiango (p. 417–419) summarises the experiences from the HIMA (Iringa Environmental Conservation Project) in a paper.

5.6.2 Role of Livestock in SWC

The importance of integrating livestock in soil conservation measures is examined using a number of case studies, particularly HADO in Kondoa where the effects of eviction of free grazing cattle and introduction of zero-grazing (Fosberg, 1996) are documented. It is noted for example that, as a consequence, farmers have tended to concentrate on cash crop production only rather than with livestock production. The effects of total eviction of livestock in the HADO areas e.g. increasing malnutrition due to shortage of milk and meat is highlighted by Shayo *et al*., 1992; Liwenga, 1998). Thus the need for integration of livestock in SWC serves important food provisioning roles which should not be ignored. In a study concluded by the International Rural Development Centre of the Swedish Agricultural University (1987), it is argued that when stocking rates exceed carrying capacity, destruction of field layer vegetation is initiated and soil erosion is accelerated. Thus what is important to watch is the carrying capacity.

The possibility of combining production of fodder with soil erosion control and agro-forestry is examined in the case of the SECAP project in West Usambara (Kotschi, 1990). The work also documents experiences from Benin, Burkina Faso, Colombia, Rwanda and Zimbabwe. Opportunities for co-operation between scientists and farmers in eco-farming research are emphasised.

A study by Otsyina *et al.* (1996) on rotational woodlots for soil conservation, wood and fodder emphasises the introduction of trees into existing crop- and shrubland in a way that will restore the benefits of long fallow, while solving problems of land degradation and shortages of fuelwood and fodder. The application of economics to conservation was dealt with in a SADCC forum in 1988.

5.6.3 Case Studies of SWC and Rehabilitation

Within the literature, there are specific cases describing implementation of actual programmes from which area-based experiences can be gained. These include: HADO in **Kondoa** (Christiansson *et al.*, 1993; Forsberg, 1996; Mbegu *et al.*, 1993; Mndeme, 1987; Mugasha and Nshubemuki, 1988), **Bahi in Dodoma** (Rugumamu, 1992); Iringa (DANIDA, 1989: Lulandala *et al.*, 1992; Lema *et al.*, 1996)); **West Usambara** (Woytek, 1988; Kotschi, 1990; Massaro *et al.*, 1993); Kigoma (Davis, 1988); **Uluguru in Morogoro** (Temple, 1973; Delobel *et al., 1989;* Jones, 1996); **Mazimbu in Morogoro** (Hanken, and Sosaka, 1988); **Maswa in Shinyanga**, Shaka, *et al.*, (1996*);* **Sukumaland** (Kikula *et al.*, 1991); **Machakos**, Kenya (Kiepe, and Young, 1992) and **Eastern Zambia** (Egnell, 1990).

6. Factors Influencing the Adoption of SWC

6.1 Participation: Condition for Successful SWC Strategies

For the introduced SWC techniques to succeed, they should build on local practices and support farmer-to-farmer spread. A participatory approach to rural development is at, one level, much more modest than the grand scale campaign approach typified by food-for-work schemes. But at another level it is much more ambitious. Participatory approaches in the development of SWC provide a bridge between indigenous and external expertise, with the resulting interventions often being interesting hybrids, drawing inspiration from a number of sources.

The conditions for success are multiple, combining: a conducive policy environment; an effective institutional setting; access to a range of participatory methods and approaches; and personal changes among researchers and development workers (Pretty and Chambers, 1994).

The researcher and development worker must acquire new skills, new attitudes and new behaviours (Chambers *et al*., 1989; Chambers, 1993). Rather than planning, directing and enforcing, s/he must facilitate, convene, catalyse and negotiate. Rather than technological outputs, the focus is on the process by which the technologies arise, become adapted and spread. Rather than dividing responsibilities between researchers, extentionist and farmer, roles combine and joint activities are central. These are big changes to the conventional, linear model of technology development. But they are proving successful. With the shift made from a high level of external intervention in design, planning and intervention, to a more facilitative role, costs also drop, especially after an initial emphasis on training and local capacity building (Shah, 1994).

Successful participation therefore involves major reversals, certainly in professional behaviour and attitudes, but more fundamentally in power relations between different actors in the development process (Scoones and Thompson, 1994). This provides some very basic challenges for development organisations wishing to develop a participatory approach to SWC and natural resource management more generally.

However, it is a difficult task to dissect the interaction of influences that condition success or failure of particular SWC techniques in particular places at particular times. So many factors interact often in conjunction during periods of crisis, that much simple explanation for technological development is always lacking without historical insights. However, there are a number of important themes, and these are as follows:

6.2 Population Densities

As Boserup (1965) and many others have noted, population density has a major impact on the processes of agricultural intensification. With higher population densities, agricultural plot sizes shrink and land, rather than labour, becomes a key constraint to production. This in turn provides incentives for investing in new technologies, conserving the resource base and through this, increasing production (Phillips-Howard, 1996). Of course, a range of other factors must interact to encourage the process of intensification, but the evidence certainly suggests that rising population density is one of a number of important pre-conditions for investment in SWC measures. The argument runs counter to the oft-repeated Malthusian view that population growth will inevitably outstrip food supplies, resulting in environmental degradation, collapse in food production and ultimately starvation or forced migration.

6.3 Investment and Access to Capital

The lack of capital, markets and in particular, lack of formal credit opportunities is often highlighted as a serious constraint to investment in new technology. However, it is not clear that credit is, in fact, a major constraint. The uncertain returns from investment in dryland agriculture, and conservation measures in particular, mean that formal credit arrangements are unlikely to work effectively. In any case, small-scale SWC does not require major capital investment and therefore there is limited need to mobilise cash, except for the payment of labour in some cases.

6.4 Returns to SWC Investment

It is notoriously difficult to assess the returns to SWC investment. Studies on the returns to SWC in Africa are few and far between. Too often it is assumed that SWC is automatically beneficial, without looking in detail at the costs and benefits.

Some proponents of SWC programmes argue that calculation of immediate returns should not be a concern since such measures are aimed at long-term conservation which must attract external subsidy in order to assure intergenerational equity and to offset wider costs of erosion. But given the constraints on government budgets and the contraction of aid flows to Africa, cost-effectiveness, even in the short term, remain an important priority for project planners, as it always has for farmers.

6.5 Markets and Infrastructure

The incentive to invest in intensification will increase as the value of the output rises. But, without good infrastructure and access to markets, the growth in economic incentives may not parallel demographic pressures and the spontaneous innovation and spread of SWC may not take place.

However, if a good road system and competitively priced transport provide access to urban markets with high demand then crop values increase, resulting in higher incentives to invest for long-term gain. A good living example is the introduction of the Lower Moshi Irrigation Project which is co-funded by the Japanese Aid Agency (JICA) and the Tanzanian Government. In this project, the socio-economic conditions of the farmers, the infrastructure and the market have been considered, and this project can be regarded as a 'successful project' in this century.

6.6 Security and Tenure Rights

Investment in SWC will depend on the willingness of farmers to expend labour now for increased benefits which may be obtained in the first year (in particular in semi-arid regions) or some time in the future, for instance, in the case of agroforestry practices. This means that people must feel confident of secure benefits from this investment.

The example of the Lower Moshi Irrigation Project can still be referred in this case. This is because insecurity may arise through heavy-handed development interventions. For example, people expecting, or fearing, displacement may be unwilling to initiate SWC measures of their own. The history of SWC Africa has unfortunately been characterised by forms of external intervention that have undermined local initiatives.

6.7 Access to Information and Technology

Options for SWC evolve with changing access to information and technology. In some cases, the new forms of technology that emerge are combinations of previous practice and introduced innovation. The flexible combination of the old with the new draws on outside sources as well as on generations of local knowledge and practice, and offers an important route to success. However, some traditional practices may not be relevant in today's settings. Just as farmers reject externally imposed interventions that are inappropriate, so too will they abandon indigenous techniques. More important than the technique or technology itself is the process by which it arises; how different information sources and technological choices are derived from a little scientific experimentation than either replace it or re-impose it, is key to success.

6.8 Building on Tradition: Supporting Indigenous SWC

Farmers across Africa have always understood changes in their local environment and assessed the problems they face. They have needed to design, select and adapt technologies in order to survive and prosper. The ability to do so successfully is moderated by social networks and local institutions. External intervention adds another dimension to this process.

6.9 Some Attempts to Practice Afforestation in Tanzania

Most of the tree growing campaigns, which could reverse the desertification threat in the semi-arid areas of Tanzania, were initiated in late 1960s with a local slogan "*kata mti, panda mti*" meaning 'grow another tree once you cut one'. Such trees were grown along the riverbanks, around water sources and in the cultivated lands. Further, in some areas of Tanzania, bylaws were imposed to stop cultivating about 30 m from the river courses. However, campaigners (mostly politicians) did not do adequate research concerning the most appropriate tree species. From the farmers' point of view (Kisanga, 1998) some of the trees grown like the *Eucalyptus sp.* had adverse drying effects on their land. For that reason, most of the grown trees have been uprooted and cultivation has carried on.

In contrast to this idea, claims regarding the adverse effects of *Eucalyptus sp*. strands on water supply are reported to be exaggerations (Nshubemuki and Somi, 1979). Such contradictions have not been resolved among the farmers. Further, tree clearing in Shinyanga to remove tsetse is not uncommon. However, despite the contradictions that exist between the researchers and farmers in some places concerning the acceptability of some *Eucalyptus sp*., there are some areas in Tanzania, which enjoy the trees on their land. For instance in the East Usambara Mountains, some Tea Plantations, like the Ambangulu have grown the *Eucalyptus sp*. and this has been accepted and commended by both researchers and farmers in the surrounding areas. This has been attributed to the fact that the trees are well adapted in these rock mountains such that no other tree species could perform better in terms of the biomass yield : growth rate ratio. In addition, farmers in the semi-arid areas of Kigwa, Dodoma district enjoy the same *Eucalyptus sp*. trees. Hall and Asghedom (1979) assessed the planting and the uses of *Eucalyptus camaldulensis* that are basically planted for creating fuelwood in the areas with relatively low rainfall and high fuel demands. Planting of such tree species offered a good chance of achieving afforestation in Dodoma, Mombo and Same Districts where re-establishment of tree cover was a priority in land quality improvement.

Mnzava (1980; 1983) identified the unresolved constraints to tree-planting among the farmers in Tanzania. According to Mnzava (1980), lack of villagers' involvement in the planning of the tree growing campaigns was a major unresolved constraint for their success. Mnzava (1980) has done a detailed review of the experiences gained since commencement of the Village Afforestation Programme of 1967/68. Experiences showed that given favourable environmental conditions and the right tree species, the best tool is mobilisation of the rural people as well as institutional organisations which provide favourable conditions for tree-planting and the management of the indigenous forests.

Kaale (1984) attempted to elaborate on the practice of growing trees on individual and village levels. The author focussed on the role of trees in the socio-economic development of the society. Furthermore, species with multiple end uses such as production of fruits, fodder, fuelwood, timber, shade, medicine, soil and environmental improvement covering the semi-arid areas of Tanzania are discussed. Planting of scattered trees in farmland, around houses has been identified as one possible practice warranting adoption. Practical aspects and the knowledge of tree species suited to specific climatic and edaphic conditions should be given special consideration when choosing tree species.

7. Role of Institutions

7.1 Change of Institutions Responsible for SWC[7]

Management of SWC issues depends on the availability and effectiveness of institutions that are put in place to ensure that SWC problems are properly dealt with. Tanzania has established more than 100 government departments, institutions and NGOs, which deal with environmental matters (Dorm-Adzobu and Gilbert, 1995). Also many legal systems, which address SWC, have been established (Koziell and Sosovele, *forthcoming*). There are now institutions concerned with SWC and other environmental matters at the central government, whilst others are under local and district levels. Several institutional changes have been made as regards the management of SWC problems. This section looks at the institutional set-up, the changes that have occurred and their implications on the management of SWC issues in Tanzania.

[7] This section draws heavily from the forthcoming publication by Koziell and Sosovele, Environmnetal Governance in Tanzania. Draft Report. IIED and IRA

Tanzania has a rather unclear institutional arrangement for environmental management, apparently due to the presence of a plethora of institutions, policies, plans and laws (Koziell and Sosovele, ibid.). For quite some time, Tanzania pursued a socialist path of development which resulted in heavy investment at the central government level, whilst undermining local level institutions and participation of the local people.

At the central level, the government established institutions such as National Environmental Management Council (NEMC), Division of Environment (DOE), Ministry of Natural Resources and Tourism, and the National Land Use Planning Commission. NEMC and DOE have recently been put under the Vice President's Office (VPO), following concern over the lack of co-ordination, and with the aim of ensuring an even greater oversight capability to integrate environmental matters into all sectors. NEMC is mainly an advisory body to the government on matters pertaining to the environment while DOE is concerned with policy issues and co-ordination of programmes. Both NEMC and DOE are not represented at the local level, except perhaps through some loose linkages with Departments of Natural Resources that are within the District Council's set-up.

The Ministry of Natural Resources and Tourism (MNRT), which is responsible for sectors such as tourism, bee-keeping and wildlife, is represented at regional and district levels through the Department of Natural Resources. MNRT has an extensive network of divisional, ward and village level extension staff who are accountable to the District Executive Director.[8] However, certain ministries have a decentralised organisational structure, that others do not have. At the district level, this creates considerable confusion, for example, the catchment forestry programme is directly under the Ministry of Natural Resources and Tourism, but staff are physically based at the district level. Differences in salaries, services, working equipment and other incentive packages between these workers and staff under District Council creates some rivalries and other social problems (Koziell and Sosovele, ibid.).

Several other ministries and sectors have different environmental related programmes, but key issues in the institutional set-up are the inherent lack of co-ordination and clarity in what each of the institutions is expected to perform, and conflict of interest between departments and institutions.

7.2 SWC Issues and the Planning Process

The decision to decentralise the planning process in Tanzania was passed in 1972. Under this arrangement, local and regional governments with the support of the National Planning Commission were required to administer the planning process. Prior to that decision planning and decision-making was centralised. After 1972, the regional administration became responsible for planning and implementing projects at regional and district levels.

In theory, project proposals were supposed to emanate from the Village Council following discussion within the Village Finance and Planning Committees and the Village Assembly. Plans are then submitted to the Ward Development Committee, the District Management Team, and the District Development Council. After scrutiny, proposals from various districts are compiled and submitted to the Zonal Team comprising members of the Ministry of Regional Administration and Local Government (MRALG). The Zonal Team scrutinises budget ceilings as provided by the National Planning commission. After the scrutiny, the Regional Management Team prepares districts and regional budget estimates for the Regional Development Committee (RDC). In a meeting in Dar es

[8] Many of the lower level posts within the districts are vacant due to the Civil Service Reform Programme of the Government of Tanzania.

Salaam, the Regional Development Directors (RDD), Regional Planning Officers (RPLO) and Planning Commission (PC) meets to discuss and revise the district budget estimates. Often PC members impose cuts to meet budget ceilings. After this process the budget is consolidated and submitted to the Cabinet and finally to the parliament[9].

This process is meant to ensure that local communities are fully participating in decision making on matters concerning their development. However, this process is not always functioning as stipulated because village assemblies rarely meet to discuss projects. Also, decisions about budget ceilings are predetermined by the Planning Commission, therefore, projects at the district level must conform to the ceilings otherwise they are not passed. In practice therefore, planning is still top-down, particularly because many district councils do not have sufficient funds to manage projects initiated by the districts. Projects are supposed to receive funds both from central government and district generated funds. Due to an inability to generate sufficient funds, many district projects have failed to progress. Central government grants account for the highest proportion of district revenue. Also, lack of funds has influenced the choice of projects to be initiated by the districts. SWC projects have not been the most favoured projects; except in a few isolated cases such as tree-planting.

Due to lack of government funding, donors began to support planning that resulted in the Rural Integrated Development Plans (RIDEPS). Every region had one donor supporting these RIDEPs. However, there is inadequate research on the effectiveness of RIDEPS as a development strategy, as well as their implications on SWC programmes.

Although the decentralisation planning process aimed to support a bottom-up planning process, lack of democratic institutions and weak financial positions of the districts, limited the realisation of this objective. Instead, regional administration (which was part of the central government) continued to control decision-making.
The decentralisation process has gone through numerous changes. In 1972, the Ministry of Regional Administration and Local Government (MRALG) was formed until 1978 when it was abolished. It was re-introduced again in 1982. Between 1982 and 1995, the MRALG was under the Prime Minister's Office (PMO). After the multi-party elections in 1995, the MRALG was scrapped, but only to be reinstated again in 1998. These changes have had profound implications on the planning process and particularly on how SWC projects have been administered in Tanzania.

Despite the much talked about decentralisation process in Tanzania, there is as yet a decentralised environmental management structure (Koziell and Sosovele, ibid.). Koziell and Sosovele mention ten factors constraining decentralisation of environmental activities in Tanzania. These include aspects such as government priority to allocate resources to central government; poor revenue generation capacity in local governments; limited public awareness, and lack of clarity on which tasks should be performed at which level (ibid.). Numerous studies conducted in local government (Naustdalslid, 1995) have concluded that successful local government reform require strong commitment to devolution of financial control, including revenue generation and management responsibility; and, people's empowerment in democratic political process. Tanzania would need to translate political rhetoric about decentralisation into reality.

The lack of decentralised environmental institutions however, has not prevented international donors and NGOs from funding and managing a plethora of environmental activities. Donors have been

[9] For details of the planning process and issues see Joseph Semboja and Ole Therkildsen. *Handbook on District level Administration in Tanzania*. Educational Publishers and Distributors Ltd, 1991.

particularly active in supporting environmental activities in Tanzania, including a series of SWC projects. In the absence of clear guidelines for environment management, and particularly SWC programmes, donors have charted out management mechanism according to their own administrative culture and political agendas. This has led to a wide range of differences in project management (Koziell and Sosovele, ibid.).

In recent times, there has been a growing interest in supporting projects at the district level. Indeed the government has already issued directives to reduce the size and the role of the regional administration, by transferring some of the regional staff to the districts to provide further technical support. The regions will remain with advisory and co-ordination roles. Although this decision may strengthen the position of the local governments, more needs to be done particularly in giving the district a wider tax base so that they collect more funds for their development needs. Most of the important sources of revenue are still under the central government. Even the proposed retention scheme is not working properly because, often, the central government does not send back the proposed 25% of the taxes collected from specified sources e.g. natural resources.

A range of donor supported programmes have therefore been established. Some projects are *partly integrated* with the District Council. This set-up includes examples of Kilosa Environment Project funded by Irish Aid and the Handeni Integrated Agroforestry Project, funded by GTZ. In these projects, donors set up a parallel institution that enables them to by-pass government financial and administrative procedures, but at the same time to work with the District Government (Koziell and Sosovele, ibid). This set-up has the advantage of ensuring faster flow of revenue to the district for the projects and other requirements. In addition, donors set up their own monitoring and evaluation systems, and their own financial accounting system. Some form of local participation is also encouraged, but in practice, donors control everything. Such projects also employ additional technical staff (expatriate or national) in addition to the existing local government staff.

Another set-up is projects that are *fully integrated within District Council*. Examples of such projects are the Dutch-funded Rural Development Projects. However, an expatriate co-ordinator provides the main link between the districts and the Royal Netherland's Embassy. Another example is the Land Management Project (LAMP) in Babati funded by SIDA, which strives to achieve complete integration. However, in the LAMP, finances and logistics are controlled by an international NGO, but Babati District is required to contribute to the project, before SIDA releases funds. This means that for Babati District to get SIDA money, they must first show how much they have collected. This may appear reasonable, but its has some implications on the way in which taxes will be collected in order to meet SIDA conditions.

A third set-up is projects, which are *partly integrated with the regional administration*, and have similar intentions to the district-based projects. For example, the Rukwa Development Project (RUDEP), which established a separate department within the office of the RDD. Also the East Usambara Conservation and Agricultural Development Project funded by European Union and the Tanga Coastal Zone Conservation and Development also funded by Irish Aid have similar arrangement. Also the *Hifadhi Mazingira* Iringa (HIMA) project funded by DANIDA was under the regional administration through a project management unit set-up at the regional office to co-ordinate activities in Njombe, Makete and Iringa Rural Districts.

A fourth set-up is projects that are *directly under the central government but operate in districts.* Such projects may cover more than one district. Usually there is a management team, and project co-ordinator, which could be an expatriate or a national, based at the project site. Such projects include,

Dodoma Soil and Water Conservation Project – *Hifadhi Ardhi* Dodoma (HADO) and Shinyanga Soil and Water Conservation Project –*Hifadhi Ardhi* Shinyanga (HASHI). Others are the Soil Conservation and Agroforestry Project in Arusha (SCAPA) funded by SIDA and the Soil Erosion Control and Agroforestry Project (SECAP) funded GTZ. In such projects, the central government together with the donor are setting the priorities and implementing the programme. Local governments are not adequately involved, except perhaps in ensuring that project objectives as set by the central government are realised.

These four different arrangements, are inevitably based on different approaches and delivering methods. All of these approaches share one common feature, namely their focus on SWC problems from a technical point of view. A more classic case is that of *HADO* in Dodoma, which resulted in shifting livestock keepers and farmers to other areas in order to allow degraded areas to recover. Indeed gullies began to heal and vegetation returned in the control areas, but an alarming rate of degradation was developing in the areas where farmers and livestock keepers were moved. Also, these approaches to SWC problems did not address the issue of land tenure and land use disputes, which have characterised many areas with SWC problems. This is a serious omission because there is no way SWC can be resolved without addressing land tenure issues properly. Other issues, which have not been adequately addressed in these approaches, include the sustainability of the SWC programmes initiated by the donors, capacity building within the local institutions responsible for SWC programmes. Although, many programmes had a component of training local staff who would take over when expert staff leave, this component has not been adequately implemented. Expert staff have maintained their hold on the projects and left when projects were closed or about to collapse.

Decentralisation as such has not provided the basis for wider public participation because of the inherent constraints facing decentralisation process. Also, local governments are facing serious financial and manpower problems such that they cannot embark on SWC programmes on their own. Part of this problem however, can be attributed to lack of creativity on the part of the local authorities because there is abundant wealth of traditional knowledge amongst the local users that needs only to be tapped properly. Since such innovative approaches are lacking, there has been greater dependence on the central government and donors to initiate matters. Even in projects which are integrated with district council, donors have an upper hand and often tend to direct the delivery of SWC programmes. Sustainability of such programmes is questionable especially when donors withdraw from funding.

The main issue here therefore, is to find out how Tanzania can achieve effective decentralisation, how can local governments mobilise their own funds, involve many stakeholders in managing the environment and address SWC problems effectively. SWC problems are very much related to social problems, therefore it will be important to look as social problems in the districts, in order to suggest useful solutions.

7.3 Conclusion

Tanzania has created numerous institutions that deal with SWC issues but lack of co-ordination and funds have affected the performance of these institutions. Instead donors have directed the implementation of various SWC projects often through their own approaches. Some of these approaches stress local participation whilst others do not. But in practice, in the entire donor funded SWC projects, the participation of District Councils has been problematic due to poor institutional capacities. In addition, most donor funded SWC projects have not addressed socio-economic, land tenure and cultural issues adequately. Furthermore, there has been little attempt to draw experiences

from the traditional knowledge and institutions available in Tanzania on SWC problems. Often it is assumed that there is no knowledge on SWC problems when such projects are started.

8. Policies and their Socio-Economic Opportunities and Constraints: Incentives and Disincentives for Soil and Water Conservation in Tanzania

8.1 Approaches and Policies on SWC

The work of Annersten (1989) reviews approaches to soil and water conservation being undertaken in the Southern African Region (SADCC) in which he isolates different policies in play in each country and calls for the need to coordinate and harmonise the various approaches among member states. Kayombo and Mrema (1994) provide a more extended review that covers past and current soil conservation policies and strategies for the whole Sub-Saharan Africa region. In their study it is shown that many of the policies and strategies pursued for the peasant sub-sector tend to focus mainly on controlling/regulating the areas which these farmers cultivate, e.g. excluding them from those areas which are susceptible to erosion on the one hand and and/or enforcing/encouraging certain tillage and agricultural practices which, in the opinion of experts, reduce erosion.

The experience documented by Kayombo and Mrema is that, these measures have not been successful due to a number of reasons e.g. increasing the labour demand, concentrating more on on-farm structures and ignoring off-farm conservation measures. Instead, it is argued that, success in SWC measures is likely to succeed in areas with integrated land use planning which incorporates soil conditions, crops grown and markets for both inputs and outputs. Examples of such integrated land use planning, either induced by population pressure, e.g. Kilimanjaro and Mbinga in Tanzania and Central Province and Machakos in Kenya, or they have been undertaken from the outset, e.g. European enclave farming in Kenya and Zimbabwe in the 1940s and 1950s.

It is further argued that with most governments in Sub-Saharan Africa implementing structural adjustment programmes, which entail reduced government expenditures, it is unlikely that integrated land use planning can be undertaken unless agriculture becomes more productive. One way of making agriculture more productive is to increase the number of medium scale farmers, who can play a leading role in the construction and maintenance of the rural infrastructure and soil conservation measures.

A document relevant for the Eastern Africa region is the review of soil conservation in Eastern Africa by Lundgren (1993). It makes use of examples from Kenya and Tanzania to contrast soil conservation measures, attitudes of the colonial regime and the rather non-conservation attitudes of most post-independence regimes of Eastern Africa. One issue to reckon with is that conservation during the colonial times was linked to evacuation of people from fertile land and thus perceived as discriminative and hence something to be done away with after independence. However, from the 1970s, it was felt that efforts had to be made to conserve land. In Tanzania, the HADO project in Dodoma Region was born during this time.

Another useful review of conservation measures covering the colonial period up to recent post-colonial initiatives in Tanzania is provided by Kikula, Shishira and Maganga (1991). It covers types of land degradation in different parts of Sukumaland in Tanzania, discussing its extent and intensity. The role played by both physical and human factors and lessons drawn from the conservation measures are presented.

The technical, institutional and social aspects behind the acceptance and non-acceptance of soil and water conservation strategies and technologies is dealt with in the work of Stahl, *et al.*, 1993. It outlines and discusses the factors causing land degradation in East Africa and the patterns of land degradation in the highlands and semi-arid lands. Measures such as terracing, contour bunding, agroforestry, zero grazing and small-scale irrigation are discussed in terms of the land user's capacity to undertake investment and the motivations behind such investments.

Dejene, *et al.*, (1997), tackle the issue of incorporating farmers' perceptions and knowledge in SWC strategies and programmes. This study examines farmers' perceptions, particularly their understanding and interpretation of factors and indicators which they link to soil erosion and fertility decline, the level of degradation of crop and pasture land. It also looks at the institutional capacity to implement soil conservation and fertility measures with particular regard to land tenure policies, local organisations and extension The study also reports on technologies, best practices and indigenous knowledge used by households to control soil erosion, enhance soil fertility and increase crop and livestock productivity. The findings underscore that sustainable land use and successful policies and programmes require appropriate enabling policies and institutional arrangements to encourage intensification of smallholder farming systems.

8.2 Need for Harmonisation of Policies with Conflicting Objectives

Further to the review provided above, the role of indigenous knowledge in SWC is documented in the work of Lema (1996) and Fahrenhorst *et al.* (1992). Lema describes an indigenous soil and water conservation (SWC) technique in Iringa, Tanzania, known as "vinyungu" or valley-bottom cultivation. In the face of growing population pressures and land degradation, "vinyungu" cultivation, which is largely conducted by women, has come to play an increasingly crucial role in local food security. As an essentially dry-season activity, it is contrasted with upland dry and wet season cultivation with which it is closely linked. However, "vinyungu" cultivation still does not receive the attention it merits owing to the dominant perception among outsiders that it is a side-line, informal agricultural activity (Lema, *et al.*, 1996). The linkage between SWC and food security is emphasised in this study. A more recent linkage of SWC and food security is provided by Liwenga (in Bosen, *et al.*, 1998) in the case of Kondoa eroded area. It is argued that the removal of cattle from the project area has exacerbated problems of malnutrition.

On the other hand, Fahrenhorst examines the importance of traditional and forestry laws for the conservation and rehabilitation of natural resources. It is noted that under traditional systems, periods of fallow were adequate for resource renewal. Under current ecological, social and economic pressures more active conservation measures such as planting are needed. Traditional property rights prevent planting on communal land or on rented land. Where forests are state owned there might be conflicts between official state laws and traditional rights of use. Where land is state owned or where ownership is not clearly defined, the user has no incentive to conserve.

An important policy issue is that of how to incorporate indigenous knowledge systems in SWC into broader policy issues. A study on emerging discourses on land degradation in the Uluguru Mountains (Jones, 1996) reveals the importance of recognising differences in the conceptualisation of degradation and its extent, as reported by three groups of actors (colonial administrators, post-colonial scientists and local people). The contradiction between the different discourses on degradation is a factor that should not be ignored during the search for solutions that involve local people. This is very much a policy issue of how to reconcile the various positions to come up with an acceptable policy.

The empowerment of local people is also a critical policy issue dealt with in the literature (Massaro, *et al.,* 1993). A case study of the SECAP project in W. Usambara is documented from which lessons can be drawn. It is noted that for much of the 20th century the West Usambara Mountains of north east Tanzania's Tanga Region have been known for environmental crises and failed conservation programmes. This paper considers that the Soil Erosion Control/Agroforestry Project (SECAP), begun in 1981 as part of Germany's aid to the Tanga Integrated Rural Development Programme, may change the reputation of a failed project. The project is a community-based, integrated, ecologically sustainable, economically viable effort to increase people's capacities to meet their livelihood and development needs as well as an effort to control and reverse the processes of soil erosion and environmental degradation in the region. This paper traces the evolution of previous crises, describes SECAP's efforts to root effective technical assistance in Shambaa history and socio-economic conditions and presents a critical summary of lessons from that experience and their implications for the prospects of sustainable development.

Temu, *et al.,* (1996) describe a pitting technique of cultivation known as *ngoro,* common among the Matengo people of Mbinga District in the southern highlands of Tanzania. The technique is probably 200 years old. It is a system used to control soil erosion and to improve fertility still used today and it serves as a good example of successful indigenous technology for controlling soil erosion on steep hills. This is an example to demonstrate the value of indigenous knowledge systems and need to incorporate it within SWC policies and programmes. This goes together with the need for peasant input into the planning and implementation of government and donor-initiated strategies and programmes is emphasised in a study on Kondoa by Mushala *et al.* (1992). The role of women is given specific emphasis in Tibaijuka (1987) and Lema (1996).

Appendix 1

Policies, and their socio-economic opportunities and constraints: incentives and disincentives to invest in SWC in Tanzania: An Annotated Bibliography.

Ahlback, A.J. (1994)
Tree-planting: mobilising the people of Tanzania.
Summary: Discusses the techniques of motivating and mobilising the people of Tanzania for village afforestation programme, that is, the planting of trees as a soil conservation measure. (UDSM, Geography Departmental Library).

Annersten, L. (1989)
Soil conservation in the SADCC region; an analysis of approaches to soil conservation (Rural Development Studies paper No. 26) 42 pp.
Summary: Examines approaches being undertaken in the conservation of soil in the SADCC countries. The book discusses policies in play and purposes a co-ordinated approach among member states for soil conservation. (Sokoine University of Agriculture).

Antapa, P.L. (1989)
Development of Soil and Water Conservation Measures at Hanang Wheat Farms Arusha, Tanzania.
Summary: Describes the courses of soil erosion in the Hanang wheat farms and measures which were originally taken only to give other problems and the way they are being solved. (UDSM Library).

Axelsson A.L.; Hagborg, L.
Karatu yarir a Karatu gantsar. Great Karatu is green Karatu: a follow-up study of a tree-planting Development Centre, Swedish University of Agricultural Sciences. 1994, No. 268, 63 pp.; 3 app., 19 fig., 4 tab.; 41 ref. Uppsala; Sweden.
Summary: Since 1983 a small Swedish NGO, Byskosinamligen (BSI), has supported tree-planting in Karatu, Tanzania. The local counterpart is another NGO, Tanzanian Association of Foresters (TAF). In 1986 a baseline study was conducted in the villages of Bashay, Gongali and Gyekrum Arusha. A follow–up study was conducted in these three villages and a fourth programme village, Tloma, in 1993. Earlier, the Karatu area was used as grazing area by the pastoral Maasai. The Iraqw, a tribe consisting of agropastoralists, expanded into the Karatu area from the south. The Iraqws are mainly farmers but livestock has an important role in most aspects of daily life. When the practical part of the programme started in 1986, two of the goals were to improve the fuel situation and the situation for women. Today, it is probably more time-consuming to collect firewood in Karatu than in 1986. The paper provides information on the background, methodology, natural conditions and history of the Iraqw people, before discussing the villages and households, the project, including nurseries and tree-planting, and a conclusion covering popular participation, education and information, nurseries and soil conservation.

Biamah, E.K.; Gichuki, F.N.; Kambutha, P.G. (1993)
Tillage methods and Soils and Water conservation in Eastern African.
Summary: Reviews some research on tillage methods influencing soil and moisture conservation in the Eastern African countries of Kenya, Tanzania, Malawi, Ethiopia in the past four decades. It emphasises the importance of appropriate tillage and residual management methods in providing soil conditions favourable for soil moisture conservation and subsequent crop performance and yield on smallholder farms. (UDSM Library).

Carim, E. (ed.); Barnard, G. (ed.); Foley, G. (ed.); De Silva, D. (ed.); Tinker, J. (ed.); Walgate, R.
Towards sustainable development: fourteen case studies prepared by African and Asian journalists for the Nordic conference on environment and development, Saltsjobaden, Stockholm, 8–10 May 1987. 1987, xvi + many parts; pl., fig., OQEH. Panos Institute; London; UK.
Summary: These 14 reports of Nordic sponsored developed projects in rural areas were commissioned by the 1987 Nordic conference from independent African and Asian journalists. The case studies cover: the Mutomo Soil and Water Conservation Programme, Kenya; a programme for stabilising duties in Mauritania; a nation-wide soil conservation programme from Kenya; soil conservation in Wollo Province, Ethiopia; agricultural research and training at the Uyole Agricultural Centre, Tanzania; an afforestation project in Orissa, India; A forest inventory and management plan in north-eastern Tanzania; a rural development project in Turkana District, Kenya; integrated rural development in Hambantota District, Sri Lanka; monitoring water quality of the Mekong in Thailand, Laos and Vietnam; rural piped-water supply in south-eastern Malawi; a pulp and paper mill in Mufindi District, Tanzania; hydropower development and Mtera dam, central Tanzania; and rice pest control in Bangladesh. Three short introductory chapters are by I. Carlsson, G.H. Brundtland and S.S. Ramphal.
(ISBN: 1 870670 01 9).

Christiansson, C.; *et al.* (1993)
The hand of man: soil conservation in Kondoa Eroded Area Tanzania.
Summary: This publication describes the problems in general terms and provides ample illustration related to the efforts of rehabilitating the semi-desert areas of Kondoa. The book can be used as study materials at technical colleges and universities as well as for general information. It is highly illustrated with colour photographs. The report is a result of the on-going studies undertaken in Kondoa eroded area under (HADO).
(Ira Documentation Unit; FAO Library).

DANIDA/Tanzania, Mission Visiting Tanzania (1989)
Iringa Soil and Water Conservation Project: Plan of Operation
Summary: The paper highlights natural environmental problems and environmental assessment results in Iringa, showing the declining woodland resources in parts of the region. Also it tries to assess the performance of the environmental sector in Tanzania which means policies and administration is examined. An evaluation of the environmental sector in Njombe District in Iringa is given. Proposals for soil and water conservation projects are also provided.
(NEMC Library).

Davis, C.W. (1988)
Soil and water conservation and forest management in Rural Kigoma
Summary: This is an assessment which was made on the soil and water conservation in Kigoma Rural District. A discussion is also extended on the management of the forests in the area. Aspects dealt with include: assessment of the present situation; causes of the degradation and recommendation for improvement.
(DSM – FAO Library)

Dejene, A.; Shishira, E.K.; Yanda, P.Z.; Johnsen, F.H.
Land degradation in Tanzania: perception from the village.
World Bank Technical Paper. 1997, No. 370, x + 79 pp.; 12 pp. of ref.
Washington, D.C.; USA

Summary: This study examines farmers' perceptions, particularly their understanding and interpretation of factors and indicators which they link to soil erosion and fertility decline, the level of degradation of crop and pasture land, and the institutional capacity to implement soil conservation and fertility measures with particular regard to land tenure policies, local organisations and extension. It also reports on the technologies, best practices and indigenous knowledge used by households to control erosion, enhance soil fertility and increase crop and livestock productivity. The study was conducted in Kondoa District in Dodoma Region, Tanzania. Data were collected by means of a questionnaire in four villages (Goima, Haubi, Bereko and Mrijo Chini) during February–April 1996. Fifty households were interviewed in each village. The findings underscore that sustainable land use and successful policies and programmes require appropriate enabling policies and institutional arrangements to encourage intensification of smallholder farming systems. At the same time, there is also a need for policies that discourage environmentally damaging land use practices such as uncontrolled extensification in communally held land.
(IRA Documentation Unit)

Delobel, T.C.; Evers, G.R.; Maerere, A.P.; Jager, A. de (ed.); Verhaegh, A.P.
Position and functions of deciduous fruit trees in the farming systems at Upper Mgeta, Uluguru mountains, Tanzania. First international symposium on horticultural economics in developing countries, Alemaya, Ethiopia, 16–23 July 1989. Acta-Horticulturae. 1991, No. 270, 91–102; 3 tab., 1 fig., BLDSC; 9 ref.
Summary: A field study on deciduous fruit trees was carried out at Upper Mgeta, Morogoro district, Tanzania. The objective was to assess the position and functions of deciduous fruit trees in the farming systems. The methodology included interviews with farmers and direct field observations. Although fruit trees may be found on almost every farm, fruit production appears to be neglected. Deciduous fruit trees have diversified functions. Close to the house, they mainly serve to produce fruits for home consumption and for sale. Planted in remote fields, their major function is to secure land tenure. Other important functions include soil erosion control, capital saving for retirement, and as a heritage asset. Trees receive very little care and the quality of fruits is usually mediocre. On the other hand, the market is unreliable and farmers are offered low prices. Research and development programmes will focus on quality standards while simultaneously seeking better outlets.
(ISBN: 90 6605 404 2).

Egnell, G.; Sylwander, L.
Soil conservation for all! An anthropological and technical study of the soil conservation and agroforestry programme in Eastern Province, Zambia: a minor field study.
Working-Paper –International Rural Development Centre, Swedish University of Agricultural Sciences. 1990, No. 156, vi + 67 pp.; 11 ref. Uppsala; Sweden.

Fahrenhorst, B.; Altan, T.; Ehlers, K.; Scheumann, W.
[Die Bedeutung traditioneller Boden und Baumrechte fur den Schutz und die Rehabilitierung naturlicher Ressourcen]. The importance of traditional land and forestry laws for the conservation and rehabilitation of natural resources. Forschungsberichte des Bundesministeriums fur Wirtschaftliche Zusammenarbeit. 1992, No. 105, 277 pp.; 8 fig., 2 tab.; 42 pp. of ref.
Summary: The study examines how traditional property rights, tenure and forestry laws in developing countries affect the possibilities of conserving tropical forests, land and other natural resources. A detailed literature survey was supplemented by three case studies in Ecuador, India and Tanzania and by discussions with experts. Under traditional systems, periods of fallow were adequate for resource renewal. Under current ecological, social and economic pressures more active conservation measures

such as planting are needed. Traditional property rights prevent planting on communal land or on rented land. Where forests are state owned there may be conflicts between official state laws and traditional rights of use. Where land is state owned or where ownership is not clearly defined, the user has no incentive to conserve. Measures which could be taken to encourage the conservation and rehabilitation of land and forestry resources are proposed and the role of development aid in promoting such measures is discussed.
(ISBN: 3 8039 0407 2).

Forsberg, J. K.
Agricultural production activities and soil conservation strategies in a changing farming system, Kondoa Eroded Area, Tanzania. Working-Paper –International Rural Development Centre, Swedish University of Agricultural Sciences. 1996, No. 322, 63 pp.; 41 ref. International Rural Development Centre, Swedish University of Agricultural Sciences; Uppsala; Sweden.
Summary: This study focuses on the socio-economic and environmental factors that affect farmers of the Kondoa Eroded Area of central Tanzania in their agricultural production activities and land management strategies. The eviction of free-grazing livestock and the introduction of zero-grazing cattle, in combination with an increased market economy, have led farmers to concentrate more on cash-crop production only rather than on cash-crop cultivation in combination with livestock production. After the eviction land has become rehabilitated and the greener environment has resulted in some changes in crop production due to increased wildlife.

Hanken, M., Sosaka, S. (1988)
Soil Erosion by water – causes and cures with special reference to Mazimbu ANC – Farm , Morogoro Tanzania.
Summary: Studies soil erosion by water and soil conservation. Emphasis is placed on literature on tropical climates and mechanised farming. Data of importance for soil erosion are collected for Mazimbu ANC Farm. The collected data are used to assess present soil erosion at the farm and to prepare a soil conservation plan for the farm.
(UDSM Library)
International Rural Development Centre, Sweden University of Agriculture Science (1987).
Livestock integration in soil conservation programmes: Report from a mission to Dodoma Region Tanzania (being) a Review of the Range and Forage situation in areas affected by Dodoma soil conservation Project (HADO) and an assessment of the role of livestock production in the Jan– 9 Feb. 1987.
Summary: Report summarises findings of a mission which reviewed the range and forage situation in areas affected by land degradation in Dodoma region, where the Dodoma region soil conservation project (HADO) has been affected. It is argued that when stocking rates exceed the carrying capacity, destruction of the field layer vegetation initiates, among other things, accelerated erosion. The review has thus assessed the situation, concerning pasture conditions, the role of livestock and possible future improvements of livestock in relation to SIDA supported soil conservation programmes in some African countries.
(UDSM Library).

Jones, S.
"*Discourses on land degradation in the Uluguru mountains, Tanzania: Evolution and influences*". *Journal of Rural Studies.* 1996, 12: 2, 187–199; 73 ref.
Summary: The various discourses that have emerged with regard to land degradation (soil erosion, soil fertility decline) in the Uluguru Mountains, Tanzania are explored. The conceptualisation of degradation and its extent, as understood or reported by three groups of actors in the debate (colonial

administrators, post–colonial scientists and local people) are presented. The contradictions between the different discourses on degradation and the way in which power is used to legitimise different knowledge claims is also explored.

Kayombo, B.; Mrema, G.C.
Soil conservation, mechanisation and sustainability of agricultural systems in Africa: a critical review: NAMA–Newsletter. 1994, 2: 1–2, 30–42. (Network for Agricultural Mechanisation in Africa; Gaborone; Botswana).
Summary: A review is provided of past and current soil conservation policies and strategies in sub-Saharan Africa with reference to mechanisation and sustainability of the agricultural system. It is shown that many of the policies and strategies pursued for the peasant subsistence sector have focused on controlling/regulating the areas which these farmers can cultivate (i.e. excluding them from those which are susceptible to erosion) and/or enforcing/encouraging certain tillage and agricultural practices which reduce erosion (e.g. construction of terraces, planting trees). These measures have largely not been successful for a variety of reasons, such as increasing labour demand, which is in short supply as the peasant sector relies on hand tool technology for all field operations. Further, the conservation practices encouraged/enforced have concentrated on on-farm structures and have not usually incorporated off-farm conservation measures. Soil conservation programmes are likely to succeed in areas where integrated land use planning which incorporates the physical and chemical conditions of the soil, crops grown and markets (for both inputs and outputs) is implemented. Examples of such integrated land use planning, either induced by population pressure (e.g. in Kilimanjaro and Mbinga, Tanzania, and Central Province and Machakos district, Kenya) or undertaken from the outset (European large scale farming enclaves in Kenya and Zimbabwe in 1940s and 1950s) are presented. With most governments in sub-Saharan Africa implementing economic structural adjustment programmes with reduced government expenditures, it is unlikely that integrated land use planning can be undertaken unless agriculture becomes more productive. One way of increasing productivity and overall production is by increasing the number of medium scale farmers. Medium scale farmers can also play a leading role in the construction and maintenance of the rural infrastructure as well as soil conservation structures. This will require a major transformation of the institutions serving the agricultural sector. More physical scientists including agricultural engineers will also be required.

Kiepe, P.; Young, A. (1992)
Soil conservation through agroforestry: Experience from (four) 4 years of demonstration at Machakos, Kenya.
Summary: The objective of this paper is to demonstrate the potential for integrating agroforestry with soil conservation. Three techniques involved the addition of trees to conventional soil conservation works, whilst in the fourth control of runoff and erosion way by the trees themselves. By 1988, it was clear that in many cases the techniques used were successful and on this basis, the plots were extended and converted into a set of trials with quantitative observations. This paper reports 4 years experience of the demonstrations in particular showing the changes that have taken place in the slope profiles, as established by successive levelling.
(UDSM Library, Biodiversity collection).

Kikula, I.S.; Shishira, E.K.; Maganga, F.P. (1991)
Development in land degradation in Sukumaland. (IRA Research Paper No. 30, 1991).
Summary: This research paper provides an introductory background, describes the physical and human environment as well as trying to establish the role played by the physical and human factors in land degradation processes in Sukumaland. The report also touches on physiography, geology and soils as well as climate and vegetation of the area. It also deals with different types of degradation in the areas,

discussing their intensity and extent. Different land conservation measures from pre-colonial to the most recent initiatives are discussed.
(IRA Documentation Unit)

Kotschi, J
Eco-farming practices for tropical smallholdings. Verlag Josef Margraf; Weikersheim; Germany; 1990, 185 pp.; ref. at ends of chapters. (Tropical Agroecology No. 5).
Summary: This book has chapters on: agroforestry for soil maintenance in the semi-arid areas of Zimbabwe; conservation of soil fertility by peasant farmers in Atlantic Province, Benin; green manuring with fast-growing shrub fallow in the tropical highland of Rwanda; investigating possibilities of combining fodder production with erosion control and agroforestry in the West Usambara Mountains of Tanzania; multiple cropping with deciduous trees in the cold tropical highland of Colombia; low-cost soil and water conservation measures for smallholders in the Sudano-Sahelian zone of Burkina Faso; and opportunities for co-operation between scientists and farmers in ecofarming research.
(ISBN: 3 8236 1184 4).

Lema, A.J; Riej, C. (ed.); Scoones, I. (ed.); Toulmin, C.
"Cultivating the valleys: "vinyungu" farming in Tanzania". In: Sustaining the soil: indigenous soil and water conservation in Africa. 1996, 139–144. Earthscan Publications Ltd; London; UK
Summary: An indigenous soil and water conservation (SWC) technique in south-western Tanzania known as "vinyungu" valley-bottom cultivation is examined. In the face of growing population pressures and land degradation, "vinyungu" cultivation, which is largely conducted by women, has come to play an increasingly crucial role in local food security. As an essentially dry-season activity, it is contrasted with upland dry and wet season cultivation with which it is closely linked. However, "vinyungu" cultivation still does not receive the attention it merits owing to the dominant perception among outsiders that it is a side-line, informal agricultural activity.
Book-chapter (ISBN: 1 85383 372 X).

Lulandala, L.L.L.; Maliondo, S.M.; Munishi, P.K.T.; Temu, R.P.C.; Mbilinyi, F.; Kiango, W.; Ekpere, J.A. (ed.); Rees, D.J. (ed.); Mbwile, R.P. (ed.); Lyimo, N.G.
Agro–forestry and problems of the environment: Proceedings of the conference on agricultural research training and technology transfer in the southern highlands of Tanzania: past achievements and future prospects, 5–9 October 1992, Uyole Agriculture Centre, Mbeya, Tanzania. 1992, 393–428; 48 ref. (Session 6).
Summary: Five papers, with comments and questions appended: (1) Agro-forestry in the southern highlands of Tanzania (Lulandala; Maliondo; 395–404; 30 ref.); (2) The natural forests and environmental conservation in the southern highlands of Tanzania (Munishi; Temu; 405–411; 15 ref.); (3) Songea agroforestry and soil conservation project: an over-view (Mbilinyi; 413–416); (4) Transfer of technology considerations in an environmental programme: the case of HIMA (Kiango; 417–419) – the Hifadhi Mazingira programme; and (5) The role of farmyard manure in sustainable agriculture (Kiango; 421–425; 3 ref.). (ISBN: 9976–914–95–4).

Lundgren, L. (1993)
Twenty years of soil conservation in Eastern Africa.
Summary: Author draws examples from Kenya and Tanzania, hence its relevance in this database. The book tackles the history of soil erosion/land degradation and mentions the non-soil conservation attitudes of post independence regimes of Eastern Africa. Since conservation during colonialism was related to evacuation of people from fertile land, it was as seen as colonial and discriminative tendency

of colonialism and hence to be done away with at independence. However, from the 1970s it was felt that efforts have to be made to conserve land. So many projects were instituted. In Tanzania HADO was born during the time. Finally is concerned with lessons that can be drawn from both success as well as factors of failure with recommendations for improvement.
(UDSM, IRA Library; FAO Library Dar es Salaam).

Massaro, R.J.; Friedmann, J.; Friedmann, J. (ed.); Rangan, H.
Beyond participation: empowerment for environmental action in Tanzania's West Usambara Mountains. In: In defense of livelihood: comparative studies in environmental action. 1993, 25–51; 1 tab., 1 fig.; 41 ref. Kumarian Press Inc.; West Hartford, Connecticut; USA
Summary: For much of the 20th century the West Usambara Mountains of north east Tanzania's Tanga Region have been known for environmental crises and failed conservation programmes. This paper considers that the Soil Erosion Control/Agroforestry Project (SECAP), begun in 1981 as part of Germany's aid to the Tanga Integrated Rural Development Programme, may change that reputation. The project is a community-based, integrated, ecologically sustainable, economically viable effort to increase people's capacities to meet their livelihood and development needs as well as an effort to control and reverse the processes of soil erosion and environmental degradation in the region. This paper traces the evolution of previous crises, describes SECAP's efforts to root effective technical assistance in Shambaa history and socio-economic conditions and presents a critical summary of lessons from that experience and their implications for the prospects of sustainable development. Despite a favourable analysis it concludes that the project may yet fail not only through not tackling population pressure and land distribution but also in the aftermath of German domestic concerns. The project may also have intensified gender and class differentiation.
(ISBN: 1–56549–020–7).

Mbegu, A.; Christianson, C.; Ygard, A.
The hand of man; soil conservation in Kondoa Eroded Area, Tanzania. Nairobi: RSCU
Summary: Basically this publication is about Kondoa Irangi Hills as an area badly affected by erosion. The report answers concern – what is soil erosion, how is it started and how are people affected? Can soil erosion be halted – who rules? nature or man. The report concludes that there is a need for long-term strategies which would bring about changes in the economy and politics at the national level.
(DSM Forest Division – Ivory Room Library).

Mndeme, K.C.H. (1987)
Soil Conservation in Tanzania – the HADO Project, Dodoma District.
Summary: The Dodoma regions oil conservation project (HADO) in Tanzania operates in the three districts of Kondoa, Dodoma and Mpwapwa with H/quarters at Kondoa Township. It started in 1973 and since then most of its activities have been concentrated to the Kondoa Eroded Area which is one of the most eroded areas within Dodoma Region.
(UDSM Library).

Mugasha, A.G.; Nshubemuki, L.
Soil conservation in Kondoa, Tanzania: the case of the Rangi people in the HADO area.
Forest Ecology and Management. 1988, 25: 3–4, 159–180; 30 ref.
Summary: An evaluation of some of the effects of a soil conservation project (Hifadhi Ardhi Dodoma – HADO) inaugurated in 1974 in a semi-arid area of Tanzania which had been repeatedly cleared of vegetation (especially the Brachystegia woodland communities) for the control of tsetse flies and the provision of land for agriculture. The project covers 125 600 ha, of which 10 000 had been reclaimed by March 1983. Aims of the project were: to ensure self-sufficiency in wood requirements; to

encourage communal tree growing schemes, beekeeping, and the establishment of shelterbelts, shade avenues and fruit trees; and to conserve soil and water and reclaim depleted land – partly by modifications of traditional agricultural systems. The organisation and planning of the project is described. On a macroscopic scale, the project seems to have regulated water flow as shown by both increase in discharge at Ntomoko and by the absence of floods in low-lying villages. Increases in both plant and animal biomass have also been recorded. On a microscopic scale, there are contradictions emanating from the Rangi people, such as the practice of terracing, tree-planting (including the use of multipurpose trees and agro-silvicultural practices) and selective cutting of trees alongside shifting cultivation (which has too short a fallow period), and use of fire. This suggests that, where popular participation forms the basis of the conservation process, rapid changes in attitudes and conservation practices should not be expected. The need for intersectoral co-operation is implied. Short-interval periodic evaluations are advocated as a means of project monitoring. Evaluation criteria should be standardised so as to secure comparability.

Mushala, HM; Forster, P.G; Forster, P.G (ed.); Maghimbi, S
Environmental crisis and the peasantry in Tanzania.
The Tanzanian peasantry: economy in crisis. 1992, 236–249; 1 tab., OQEH; 12 ref.
Avebury; Aldershot, Hampshire; UK.
Summary: The environmental crisis in Tanzania is manifest in land degradation as a result of overgrazing, deforestation, over-cultivation, and poor land and water management. This paper describes the environmental crisis with reference to soil erosion in Kondoa district. An historical perspective is taken to examine the influence of land clearance, overgrazing, the introduction of agriculture, and the impact of early conservation techniques. The problem of erosion has existed since the German colonial period, and soil erosion has been achieved by destroying the natural ground cover. The absence of peasant input in the planning and implementation of government strategies is likely to lead to undesirable effects.
(ISBN: 1 85628 155 8).

Otsyina, R.; Minae, S.; Cooper, P.
"A never-ending story: rotational woodlots for soil conservation, wood and fodder". *Agroforestry Today*. 1996, 8: 2, 8–10; 3 ref.
Summary: Miombo (savannah) woodlands used to cover a vast part of the highland plateau that stretches from Tanzania southwards to Zimbabwe. However, this century has brought great changes to the region, with the woodlands receding as populations grow. In addition, particularly in Tanzania, the 1920s brought massive deforestation campaigns that were intended to eliminate tsetse flies and sleeping sickness in livestock, and people there now find themselves chronically short of fuelwood and fodder. This article describes the work of the Tanzania-ICRAF agroforestry project in Shinyanga and the Southern Africa Development Community (SADC) agroforestry project in Tumbi, Tabora, in looking at ways of reintroducing trees into existing crop- and shrubland, in a way that will restore the benefits of long fallow, while solving problems of land degradation and shortages of fuelwood and fodder. The rotational woodlot is proposed as a suitable system. This has 3 phases: (1) the establishment phase with integrated intercropping of multipurpose tree seedlings among crops for 2–3 yr. (c.f. the taungya system); (2) the fallow phase (2–4 yr.) in which cropping is discontinued, the established trees are left to grow and can be managed for fodder, and understorey growth is encouraged; and (3) clear (or partial) felling for wood production, with cropping established between stumps – the trees are coppiced and managed by pruning. The opened area can be cropped for 3–4 yr. before allowing tree regeneration and fallow development, at which stage livestock can graze. Brief details are given of maize yields from the establishment phase of such a system at Shinyanga, which used *Leucaena leucocephala*, *Acacia nilotica* and *Acacia polyacantha* as tree species.

Ruyumamu, W.; Tato, K. (ed.); Hurni, H.
Planning soil conservation in Bahi village, Dodoma District, Tanzania.
Soil Conservation for survival. 1992, 384–390; 8 ref. Soil and Water Conservation Society (SWSC); Ankeny; USA.
Summary: The development of an interdisciplinary approach to planning a soil conservation programme for the Bahi village area in Tanzania is described.
(ISBN: 0 935734 27 9).

Shaka, J.M.; Ngailo, J.A.; Wickama, J.M.; Riej, C.(ed.); Scoones, I. (ed.); Toulmin, C.
"How rice cultivation became an 'indigenous' farming practice in Maswa District, Tanzania". In: Sustaining the soil: indigenous soil and water conservation in Africa. 1996, 126–133.
Earthscan Publications Ltd; London; UK
Summary: Water conservation techniques have played a critical role in the development of smallholder rice cultivation in the Maswa district of Tanzania. Rice cultivation cannot be said to be an 'indigenous' practice, yet it now has the status of a 'traditional' crop despite the fact that it district which brought about corresponding significant changes in land use. Farmers began to experiment with water harvesting techniques and to adapt them to local conditions, largely replacing cotton as the main cash crop. The remaining high-market value of rice induces farmers to continue to invest in extensive soil- and water-conservation (SWC) measures within whole catchment areas to make sure that all water is utilised efficiently by all farmers living in the area.
(ISBN: 1 85383 372 X)

Shayo, C.M.; Kategile, J.A. (ed.); Mubi, S.
Introduction of dairy cattle production systems in soil conservation areas: Future of livestock industries in east and southern Africa: Proceedings of the Workshop held at Kadoma Ranch Hotel, Zimbabwe, 20–23 July 1992. 1993, 201–210; 22 ref. (International Livestock Centre for Africa; Addis Ababa; Ethiopia).
Summary: Dodoma is a region situated in the semi-arid zone of central Tanzania. The pressure of cultivation and grazing, among other factors, resulted in severe land degradation in some areas, to such an extent that there was a danger of desertification. In 1973, the Government launched a national soil conservation programme aimed at land reclamation and soil fertility restoration in the worst affected areas of Dodoma region under the Dodoma Soil Conservation Programme, known locally as Hifadhi Ardhi Dodoma (HADO). Among several of the measures taken was the removal of all grazing livestock from the severely eroded areas. There have been some achievements in the eroded areas in the context of land reclamation. However, total eviction of grazing livestock is suspected to have resulted in incidences of malnutrition in the closed areas (HADO areas) due to the subsequent shortage of milk and meat. A project on 'Development of Feeding and Management Systems for Stall-fed Improved Cows in the HADO Areas' was proposed, to look into possibilities of re-introducing livestock into the closed areas without the attendant land degradation problems. This paper highlights the general problems and achievements related to the HADO programme, and progress on the implementation of the project on stall-feeding and systems for management of improved dairy cows in the HADO areas. The technological package of stall-feeding and improved dairy cattle is widely accepted, but its expansion is constrained by inadequate numbers of foundation stock.
(ISBN: 92 9053 271 8).

Southern African Development Co-ordination Conference.
Economics of conservation. Proceedings from a Second Workshop held in Manzini, Swaziland, 28 November–2 December, 1988. Report SADCC Soil and Water Conservation and Land Utilization Programme. 1990, No. 23, 219 pp. Ministry of Agriculture and Marketing; Maseru; Lesotho.

Summary: This publication contains papers entitled: (a) Information needs, data collection and survey techniques; (b) The use of cost-benefit analysis (CBA) in project appraisal and evaluation; (c) The economic behaviour of the farming communities on conservation programmes: Swaziland and the SADCC Region; and (d) Data requirements and techniques. Progress reports from the member states (Botswana, Lesotho, Malawi, Swaziland, Tanzania, Zambia and Zimbabwe) are included also.

Stahl, M; Baum, E. (ed.); Wolff, P. (ed.); Zobisch, M.A.
Combating land degradation in eastern Africa – technical, institutional and social aspects: Acceptance of soil and water conservation strategies and technologies. 1993, 363–389. (Topics in Applied Resource Management in the Tropics, vol. 3.; 36 ref.).
Deutsches Institut fur Tropische und Subtropische Landwirtschaft GmbH; Witzenhausen; Germany
Summary: Factors causing land degradation in Eastern Africa are outlined. The patterns of degradation in the highlands and arid and semi-arid lands are described. Statements on the importance of environmental conservation from the governments of Kenya, Uganda, and Tanzania are outlined. Technical measures that have been undertaken in Kenya to delay and reduce rainwater [loss] in the highlands using terracing, contour bunding, agroforestry, and zero-grazing systems are described. Small-scale irrigation schemes have been introduced in semiarid areas of Kenya. The only sensible land use in arid lands was livestock farming. Adoption of soil conservation and agroforestry innovations are discussed in terms of the land users' capacity to undertaken investments and their motivation to do so.
(ISBN: 3 9801686 4 6).

Temple, P.G. (1973a)
Soil and Water Conservation in policies in Uluguru Mountains, Tanzania.
Summary: Examines the soil and water conservation policies in Uluguru mountains, Tanzania. He suggests the best ways of handling the problems of soil and water conservation. Challenges the policy makers to reflect the actual problems of the issue and Uluguru mountains pp. 110–123, (UDSM Library).

Temu, A.E.M.; Bisanda, S; Riej, C. (ed.) ; Scoones, I.(ed.); Toulmin, C.
"Pit cultivation in the Matengo Highlands of Tanzania". In: Sustaining the soil: indigenous soil and water conservation in Africa. 1996, 145–150. Earthscan Publications Ltd; London; UK.
Summary: A pitting technique of cultivation known locally as "*ngoro* or *ingolu"* is described which was developed by the Matengo ethnic group living in the Mbinga district in the southern highlands of Tanzania. The technique is probably over 200 years old, originating when the Matengo migrated to Mbinga and occupied the forested mountains, where they lived in caves. Faced with possible starvation, the Matengo had no option but to cultivate crops on the steep hillsides. The pitting techniques developed by the Matengo to control soil erosion and to improve soil fertility is still used today and serves as a good example of a successful indigenous technology which controls erosion on steep hillsides.
Book-chapter (ISBN: 1 85383 372 X)

Tibaijuka, A.K. (1987)
Woman's participation in soil and water conservation in the SADCC Region.
Summary: Concerned with woman's role in environmental conservation beings with the role of woman in the agricultural system in the SADCC region. Secondly, it discusses a popular participation strategy and finally puts forward specific measures to be taken to promote the active participation of women in soil and water conservation.
(UDSM Library).

Woytek, R. *et al.* (1988)
Soil Erosion control and Agroforestry in the West Usambara Mountains Evaluation of an Extension approach. Berlin: Faculty of International Agricultural Development.
Summary: The soil erosion control and agroforestry Project (SECAP) Lushoto Tanzania started in 1981 with a pilot phase and in 1984 entered into phase II. The project introduced its full extension package the 24 villages. Its objectives is the propagation of soil erosion control and agroforestry land use practices in order to contribute to an ecologically sustainable and economically viable utilisation of the potential of the land in the West Usambara Mountains. The Village community as a whole and the peasants as individuals are the target groups of the projects effort.
(UDSM Library – EAF Section).

References

Barbier, E.B. and MaCracken, J.A. (1988): Glossary of Selected Terms in Sustainable Economic Development. Sustainable Agriculture Programme, IIED, London.

Belsky, A.J. (1989): Landscape Patterns in a Semi-Arid Ecosystem in East Africa. Journal of Arid Environments 17 (2): 265–270.

Berry, L.T., Hawkins, R.W., Kates, L. and Parker P.W. (1972): Human Adjustment of Drought in Tanzania, Pilot Investigation. BRALUP Research Paper No. 13. University of Dar es Salaam.

Berry, L., and Townshend, J., (1973): "Soil conservation policies in the semi-arid regions of Tanzania, a historical perspective" pp.241–253, in *Studies of Soil Erosion and Sedimentation in Tanzania* edited by Anders Rapp, Len Berry and Paul Temple. Research Monograph No.1 1973. Bureau of Resource Assessment and Land Use Planning, University of Dar es Salaam.

Birch-Thomsen, T., (1996): Environment, people and land use: changes in natural resource utilisation during the past four decades in Ikuwala Village, Mazombe Division, Iringa District. SASA Notes and Working paper (draft). Roskilde University, Department of Geography and International Development Studies.

Blaikie, P., (1996): "New knowledge and rural development: a review of views and practicalities" A paper for the 28th International Geographical Congress, The Hague, August 5–10, 1996.

Boesen, J., Kikula, I.S. and Maganga, F.P. (1999). Sustainable Agriculture in Semi-Arid Tanzania. Dar es salaam: Dar es Salaam University Press.

Boserup, E. (1965):. The conditions of agricultural growth. The economics of agrarian change under population pressure, Allen and Unwin, London

Bradburry, M., Fisher, S. and Lane, C., (1995): Working with Pastoralist NGOs and Land Conflicts in Tanzania. A Report on Workshop held in Terrat, Tanzania, 11th–15th December, 1994. IIED, London.

Bruntland-Bericht (1987): World Commission on Environment and Development: Our Common Future. Oxford University Press, Oxford and New York.

Busse, Walter (1902): "Forshungsreise durch den Seudlichen Teil von Deutsch-Ostafrika. (Bericht, erstattet an das kaiserliche Gouvernment von Deustch-Ostafrika)" Beihefte zum Tropenplanzer 3.93–119.

Chambers, R., (1983): *Rural Development: Putting the Last First.* Longam: London.

Chambers, R., (1993): *Challenging the Profession: Frontiers for Rural Development*. International Technology Publications, London.

Chambers, R., Pacey, A. and Thrupp, L.A. (eds.) (1989): Farmer Innovation and Agricultural Research. London, Intermediate Technology Publications.

Chambers, R.; Pacey; A. and Thrupp, L.A. (1989): Farmer First: Farmer Innovation and Agriculture Research, IT Publications, London.

Christiansson, C. (1981):(ed.). Soil Erosion and Sedimentation in Semi-arid Tanzania. Studies of Environmental Change and Ecological Imbalance. Department of Physical Geography, University of Stockholm.

Cliffe, L., (1964): Nationalism and the Reaction to Agricultural Improvement in Tanganyika during the Enforced Colonial period. Paper to the E.I.S.R Conference. Makerere University, Kampala, Dec. 1964.

Collinson, M.P. (1972): The economic characteristics of the Sukuma farming system. ERB Research Paper No. 72(5), Dar es Salaam, Tanzania.

DANIDA (1998) DANIDA Identification Mission on Environmental Sector Programme. Overview of Donor supported Environmental Activities in Tanzania. Ministry of Foreign Affairs, Denmark.

Darkoh, M.B.K. (1982): Desertification in Tanzania. Journal of the Geographical Association No. 297, 67(4): 320–331

de Haas, H.J. and Friedrichsen, J. (1995): Promoting Sustainable Soil Management in Developing Co-operation. A Guide. GTZ. Federal Ministry for Economic Co-operation and Development (BMZ)

De Paw, E. (1983): Agricultural potential and constraints in relation to growing periods and their variability in Tanzania. Pe'dologie, 1983. Pp 147–170

De Paw, E. (1994): Development of land use planning and land tenure in Tanzania. Main Report. Technical Support Services Project, TSS1–URT/94/02T, Tanzania.

Dejene, A., Shishira, E.K., Yanda P.Z., and Johnsen, F.H. (1997): Land Degradation in Tanzania. Perceptions from the Village. The World Bank, Washington, D.C.

Dialla, B.E., (1994): "The Adoption of soil Conservation Practices in Burkina Faso" Indigenous Knowledge and Development Monitor, Vol. 2 No.1, pp.10–12.

Dorm-Adzobu, C. and Gilbert, F.E. (1994): Institutional Mechanism for Environmental Management in Africa: Tanzania National conservation Strategy for Sustainable Development. NESDA/WRI

FAO (1977a): "Assessing Soil Degradation" Soil Bulletin, No.34. Rome

FAO (1978): Methodology for Assessing Soil Degradation. Report on the FAO/UNEP Expert Consultation, Rome.

FAO (1979): Provisional Methodology for Soil Degradation Assessment, Rome.

FAO (1977b): Guidelines for soil profile description, third edition. Soil resources Development and conservation services. Land and water development division. Food and Agriculture Organisation of the United Nations, Rome.

Farrington, J. and Martin, A. (1988): Farmer Participation in Agricultural Research: A Review of Concepts and Practices. Agricultural Administration Network, Occasional Paper No. 9. London, O.D.I., UK.

Frost, P., Medina, E. J., Menaut; C., Solbrig; O., Swift; M. and Walker B. (1986): 'Responses of savannah to stress and disturbance: A proposal for a collaborative programme of research.' Biology International, Special Issue 10. IUBS, Paris.

Fuggles-Couchman, N.R., (1964): Agricultural Change in Tanganyika 1945 – 60. Food Research Institute, Stanford University.

Gillman, C. (1930): Notes on soil erosion in East Africa. Gillman Papers, Hans Cory collection. University of Dar es Salaam.

GLASOD (1990): Global Assessment of Soil Degradation. World Maps (4 Sheets). ISRIC and UNEP, Wageningen, The Netherlands.

Grove, A. (1977): The geography of semi-arid lands. Philosophical Transactions of Royal Society, London, B. 278:457–475.

Hall, A.E., Cannel, G.H. and Lawton, H.W. (eds.) (1979): Agriculture in Semi-arid Environments. Springer-Verlag, New York, USA.

Hall, J.B. and Asghedom, G.M. (1979): Assessment of *Eucalyptus camaldulensis* planting at Kigwa, Dodoma District, Tanzania, Division of Forestry, Faculty of Agriculture, Forestry and Veterinary Sciences (SUA), Morogoro.

Hatibu, N., Mahoo, H. F., Senkondo, E. M., Simalenga, T. E., Kayombo B. and Ussiri, D.A.N. (1994): Strategies for Soil-Water Management for Dryland Crop Production in Semi-arid Tanzania. Department of Agricultural Engineering and Land Use Planning, Sokoine University of Agriculture, Morogoro, Tanzania.

Heusler, S., (1995): "Listening to the People: the use of Indigenous Knowledge to Curb Environmental Degradation": pp. 179–188 in Stiles, D., (ed) *Social Aspects of Sustainable Dryland Management*. Chichester, Wiley

Hudson, N. (1987): Soil and water conservation in semi-arid areas, Soils Bulleting 57, FAO, Rome.

Hudson, N.W., (1991): A Study of the Reasons for the Success or Failure of soil Conservation Projects, FAO, Rome.

Hurni, H. and Tato, K. (1992): Erosion, conservation and small-scale farming, ISCO/Geographic Bernesia, Berne.

IFAD (1992): soil and Water Conservation in sub-Saharan Africa: Towards Sustainable Production by Rural poor. IFAD, Rome.

Iliffe, J., (1969): *Tanganyika under German Rule: 1905–1912.* Cambridge University Press: Cambridge

Iliffe, J., (1977): *Agricultural Change in Modern Tanganyika*. East African Publishing House: Nairobi.

Iliffe, J., (1979): *A Modern History of Tanganyika.* Cambridge University Press: Cambridge.

Kaale, B.K. (1984). Trees for village forest. Forest Division, Ministry of Lands, Natural Resources and Tourism, Dar es Salaam, Tanzania, 125 pp.

Kaduma, J.D. (1980): Prospects of Irrigated Agriculture in Semi-arid Areas of Tanzania. The Development Problems and Prospects of Semi-arid Areas in Eastern Africa. Proceedings of Workshop. April 9–13, 1980, Nazareth, Ethiopia.

Kaplan, D. and Manners, R. (1972*): Cultural Theory*. Englewood Cliff, New Jersey.

Kauzeni, A.S.; Kikula; I.S. and Shishira, E.K. (1987): Development in Soil conservation in Tanzania. **In:** History of soil conservation in the SADC Water Conservation and Land Utilisation Programme, Co-ordinating Unit Maseru, Lesotho. 23 pp.

Kikula, I.S. (1998): Twenty-five years of a Conservation Programme: Seven years of Research in Kondoa Highlands of Central Tanzania. What have we learnt? Paper presented to the Workshop "Man-land Interrelations Research Programme. 12th–15th October 1998, Dodoma.

Kikula, I.S., (1997*): Policy Implications on Environment: The Case of Villagization in Tanzania.* The Nordic Africa Institute, Uppsala, Sweden.

Kisanga, D.R. (1997): Environmental Resources and degradation problems in the slopes of mount Kilimanjaro: Peoples' perception and awareness. A research report presented as part of reconstruction and development in Kilimanjaro area project. Scientific Research Programme, Topical Mountains, Kilimanjaro. Geography Department of Geography, University of Dar es Salaam. (In press)

Kisanga, D.R. (1998.): Study of the impact of some plant species on soil and water management in the slopes of mount Kilimanjaro. A research report presented as part of reconstruction and development in Kilimanjaro area project. Scientific Research Programme, Topical Mountains, Kilimanjaro. Geography Department of Geography, University of Dar es Salaam. (In press)

Koziell, I. and Sosovele. H. (**forthcoming**): Environmental Governance in Tanzania. IIED, London and IRA, Dar es Salaam.

Lane, C. and Pretty, J.N. (1991): Displaced Pastoralists and Transferred Wheat Technology in Tanzania. Gatekeeper series No. 20. IIED, London.

Lane, C., (1996): *Pastures Lost: Barabaig Economy, Resources Tenure, and the Alienation of their Land in Tanzania.* Initiative Publishers: Nairobi

Liwenga, E.T. (1998): Household Food security in a Soil and water Conservation Project Area: The Case of Kondoa Eroded Area, Tanzania. In: Boesen, J. , Kikula, I.S. and Maganga, F.P. Sustainable Agriculture in Semi-Arid Tanzania. Dar es Salaam: Dar es salaam University Press, 1999, p.80–94.

LRDC, (1987): Tanzania: Profile of agricultural potential. Overseas Development Natural Resource Institute, Land Resource Development Centre (LRDC), UK.

Maddox, G., Giblin, James and Isaria, N. Kimambo (1996): *Custodians of the Land. Ecology and Culture in the History of Tanzania.* James Currey: London

Maguire, G.A. (1969): *Towards Uhuru in Tanzania*. Cambridge University Press: Cambridge.

Mbegu, A.C. (1996): The Problems of Soil Conservation and Rehabilitation Lessons from the HADO Project. In: Christiansson, C. and Kikula, I.S. (Eds.), Changing Environments: Research on Man-Land Interrelations in Semi-Arid Tanzania. Nairobi: Regional soil Conservation Unit, RSCU, 1996, p.147–157.

Mahoo, H.F. and Kaaya, A. (1993): Characterisation and Classification of soils at Hombolo Experimental Site. In: N. Hatibu, T. Simalenga (eds.). Proceedings of the Research Planning Workshop: SUA Soil-Water Management Research Programme, 37–43.

McCracken, J.A., Pretty, J.N. and Conway, G.R. (1988): An Introduction to Rapid Rural Appraisal for Agricultural Development. London, IIED.

Mnzava, E.M. (1980): Village Afforestation: Lessons of experience in Tanzania. Report for Food and Agricultural Organisation of the United Nations, Rome. 62 pp.

Mnzava, E.M. (1983): Tree-planting in Tanzania: A voice from villagers. Forestry Division, Ministry of Lands, Natural Resources and Tourism, Dar es Salaam. 88 pp.

Mushala, H.M. (1985): Land management for land degradation control in Tanzania. In: R. F. Hirji; H. M. Mushala; and I. Sindiga (Eds.) Public heath and the environment: Selected case studies from East Africa. Land management for land-degradation control in central Tanzania, Graduate School of Geography, Clark University, Worcester, USA.

Mwalyosi, R.B.B. (1992):. Land-use changes and resource degradation in south-west Maasailand, Tanzania. Environmental Conservation. 19(2) 145–152.

Naustdaslid J. and B. Aasen (1995): Rural Development and Local Government in Tanzania: A Study of Experiences with RUDEP and KIDEP and Discussion of Alternative Strategies to District Development in Tanzania. Evaluation Report No. 4.95. Report Commissioned by the Norwegian Ministry of Foreign Affairs. Norwegian Institute for Urban and Regional Research, Norway.

Ngana, J.O. (1993): Rainfall characteristics and their relevance to agricultural planning in semi-arid central Tanzania. In: N. Hatibu, T Simalenga (eds.). Proceedings of the Research Planning Workshop: SUA Soil and Water Management Research Programme, 21–36.

Nshubemuki, L. and Somi, F.G.R. (1979):. Water use by *Eucalyptus sp*. Observation and probable exaggerations. ODC 116, 1. Tanzania Silvi-culture Technical Note No. 44 (New Series). Forestry Division, Ministry of Lands, Natural Resources and Tourism, Dar es Salaam.

Oram, P. (1977): Agriculture in the semi-arid regions. Problems and Opportunities. In: Proceedings of an International Symposium on Rainfed Agriculture in Semi-arid Regions, April 17–22, 1977. Holiday Inn, 1200 University Avenue, California.

Oudwater, N. and Martin A. (1998): Indigenous knowledge on soil and water management. Paper for workshop: Combining Systematic and participatory approaches for developing and promoting strategies for sustainable land and water management. Sokoine University of Agriculture (SUA) Morogoro, October 1998, Morogoro, Tanzania.

Phillips-Howard, K. and Oche, C. (1996): 'Local farming in the former Transkei, South Africa.' In: C. Reij *et al*. (eds), Sustaining the soil: Indigenous soil and water conservation in Africa. IIED Drylands Programme, issue No. 67, Earthscan Publications Ltd., London, pp 228–234.

Pimbert, M.P. and Pretty, J.N. (1994): Participation, People and the Management of National Parks and Protected Areas: Past Failures and Future Promise. United Nations Research Institute for Social Development (UNRISD), IIED, and WWF.

Potkanski, T., (1994): Property-Concepts, Herding Patterns and Management of Natural Resources among the Ngorongoro and Salei Maasai of Tanzania. Pastoral Land tenure Series No. 6. IIED, London.

Pretty, J. and Chambers, R. (1994): 'Towards a learning paradigm: new professionalism and institutions for agriculture.' In: I. Scoones and J. Thompsons (Eds), Beyond Farmer First: Rural People' Knowledge, Agricultural Research and Extension Practice, IT Publications, London, pp 182–202.

Rapp, A., Berry, L. and Temple, P. (eds) (1973): *Studies of Soil Erosion and Sedimentation in Tanzania*. Research Monograph No. 1. Bureau of Resource Assessment and land Use Planning, University of Dar es Salaam.

Reij, C. (1991): Indigenous soil and water conservation in Africa, Gatekeeper series 27, Sustainable Agriculture Programme, IIED, London.

Richards, P. (1985): Indigenous Agriculture Revolution. London, Hutchinson.

Rigby, P. (1969): Cattle and kingship among the Gogo. London and Ithaca. Cornell University Press.

Rounce, N.V. (1972): The agriculture of the cultivation steppes. London, Longman, London UK.

Rutatora, D.F., Kajembe, G.C. and Neke, S.M. (eds) (1995): Indigenous Knowledge and Sustainable Development. Proceedings of a national Conference held at the Institute of Continuing Education, Sokoine University of Agriculture, Tanzania. 15th–16 September 1994.

Ruthenberg, H. (1980). Farming Systems in the Tropics. Clarendon Press, Oxford.

SARD/FAO, Netherlands (1991):. Report of the Conference on Agriculture and the Environment, 'S–Hertogenbosch, Netherlands, 15–19 April 1991. FAO, Rome.

Schmied, D., (1989): Subsistence Cultivation, Market production and Agricultural Development in Ruvuma Region, Southern Tanzania, Bayreuth African Studies, Germany.

Scoones, I. (1991): 'Wetlands in drylands: Key resources for agricultural and pastoral production in Africa", Ambio, vol. 20, pp. 366–371.

Scoones, I., and Thompson, J. (eds) (1994): *Beyond Farmers First: Rural people's knowledge, agricultural research and extension practice.* Intermediate Technology Publications.

Scoones, I.; Reij; C. and Toulmin, C. (1996): Sustaining the soil: Indigenous soil and water conservation in Africa. IIED Drylands Programme, issue No. 67, Earthscan Publications Ltd., London.

Semait, B. W. (1980): Climatic characteristics and life patterns in the semi-arid areas of Ethiopia: a survey. The Development Problems and Prospects of Semi-Arid Areas in Eastern Africa. Proceedings of Workshop. April 9–13, 1980 Nazareth, Ethiopia.

Semboja, J., and Therkildsen, O. (1991): *Handbook on District Administration in Tanzania.* Ministry of Regional Administration and Local Government. Educational Publishers and Distributors Ltd.

Shah, P. (1994): 'Participatory watershed management in India: The experience of the Aga Khan Rural Support Programme.' In: I. Scoones and J. Thompsons (Eds), Beyond Farmer First: Rural People' Knowledge, Agricultural Research and Extension Practice, IT Publications, London

Shivji, I.G. and Kapinga, W.B. (1998): *Maasai rights in Ngorongoro, Tanzania.* IIED/HAKIARDHI

Staples, R.R., (1933): Run-of and Soil Erosion Experiments. Annual Report. Department of Veterinary Science and Animal Husbandry. Dar es Salaam.

Stenhouse, A.S., (1944): Agriculture in the Matengo Highlands. East African Agricultural Journal. No.10

Stocking, M. (1985): 'Soil conservation policy in colonial Africa', Agricultural History, vol. 59, pp 148–161.

Tanzania Ministry of Agriculture (TNA 1) File 1 (no date). Land use Schemes, Central Province. Dar es Salaam.

Tanzania Ministry of Agriculture (TNA 4) File 4 (1929–36): Dodoma Regional Office, Dodoma, Soil erosion. Dodoma, Tanganyika.

Tchawa, P. (1996). 'Evolution of traditional techniques of soil conservation in the Bamileke region. West Cameroon.' In: C. Reij *et al*. (eds), Sustaining the soil: Indigenous soil and water conservation in Africa. IIED Drylands Programme, issue No. 67, Earthscan Publications Ltd., London, pp 228–234.

Temple, P.H. (1973). “Soil and Water Conservation Policies in Uluguru Mountains, Tanzania”. In: Rapp, Berry and Temple (eds.).

Temple, P.H., (1971): Conservation Policies in the Uluguru Mountains. Paper No. 24 Proceed. Second conference on Land Use in Tanzania, University of Dar es Salaam.

Tiffen, M., Mortimore, M. and Gichuki, F. (1994): *More People, less Erosion: Environmental Recovery in Kenya*. Chichester, Wiley.

UNCED (1992). Report of the United Nations Conference on Environment and Development, Rio de Jeneiro, 3–14 June 1992, New York.

UNEP/FAO/WMO (1977). Desertification Map of the World: Scale 1:25 million. Nairobi: UNESCO/UNEP.

United Republic of Tanzania (1977). The Threat of Desertification in Central Tanzania. A Technical paper prepared for the United Nations Conference on Desertification, 29 August–9 September 1977, Nairobi, Kenya. United Republic of Tanzania (URT), Dar es Salaam.

Van Rensburg, H.J. (1958) “Gully utilisation and erosion control”, East African Agricultural Journal, No. 23.

Van Rensburg, H.J., (1955): Run-off and Soil Erosion Tests at Mpwapwa, Central Tanganyika, East African Agricultural and Forestry Journal No. 20.pp 228–231.

Wallen, C. (1967): Aridity definitions and their applicability. Geografiska Annaler, Series A. 498:367–384.

Warren, D. (1991): Using indigenous knowledge in agricultural development. Discussion paper 127, World Bank, Washington D. C.

Watson, J.R. (1973): “Conservation problems, policies and the origins of the Mlalo Basin Rehabilitation Scheme, Usambara Mountains, Tanzania”. In: Rapp *et al*. (eds.) pp 221–226.

Webster, C.C. and Wilson, P.N. (1980):(Eds.). Agriculture in the Tropics. Second edition, ELBS/Longman Group Ltd, England

Yanda, P.Z. (1996). Soil Erosion and the Fate of Ntomoko/Mwisanga Water Supply Scheme in Kondoa, Central Tanzania. In: Christiansson, C. and Kikula, I .S. (Eds.). Changing Environments: Research on Man-Land Interrelations in Semi-Arid Tanzania. Nairobi: Regional Soil Conservation Unit, RSCU. 1996, p. 46–53.

Young, R, and Forsbrooke, H., (1960): *Land and Politics Among the Luguru of Tanganyika*. Routledge and Keegan Paul, London.