Improving water availability through Watershed Management in Africa: A review

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Abstract: Water scarcity and how it can be availed for general purposes is highlighted in this paper in relation to watershed management. An overview of different African countries is done and the major problems identified to be causing water scarcity were land degradation, population and mismanagement of resources. Researches carried out in different countries however highlights that land management, water management and participation of locals as components of watershed management can be used in water productivity. In most parts of Africa rain water harvesting in conjunction with good conservation methods has gain popularity as a way to avail water for different purposes.

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1. Introduction

People worldwide use more than half the available freshwater on the planet, in fact so large is the demand for freshwater that many rivers and streams are now drying up (Agnes, 2005). This stress is manifested in the seasonality of our streams and rivers giving rise to severe water shortages. Water problem has of late become of great concern to many African countries. At a conference attended by 1000 delegates in Addis Ababa, water experts said that Africa was facing a water crisis affecting 300 million people (Ruphael, 2004). For example Ghana is well endowed with perennial rivers and groundwater, although seasonal shortages are quite common (Kwame, 2005). In 1993 the Ruaha river (Rufiji basin) in Tanzania began drying up every year in the Ruaha National Park, and 10 years later this increased to zero-flow for almost for 4 months a year (Femke, 2005). During the past 2 decades and due to the decrease in the amount of river discharge and rainfall, coupled with repeated fires, the catchment areas of Mayas in Sudan have deteriorated drastically causing many of them to silt up to almost complete dryness (Salwa, et al., 1997). The great question behind this water shortages is what is the cause and how can this problem be rectified. Different countries in Africa have several causes and challenges but however it was seen that most of these causes and challenges were common. In Cross River State, Nigeria, for example, the main cause of water stress is the unsustainable use of watershed systems for farming, construction, settlement, gravel and sand extraction. Population increase means more people to work on the available land, while market demand means more land and trees cleared for farms or arts work (Laura, et al., 2006). This study intends to assess the level of the declining water quality and quantity that affecting both humans and livestock as it was one of the problems that were identified in many cases studies done in Ethiopia, Kenya and Tanzania (Lal, 2005; Winter, et al., 1998).

2. Interaction Groundwater and Surface water

In many situations, surface water bodies gain water and solutes from ground water systems and in others, the surface water body is a source of ground water recharge and causes changes in ground water quality. As a result, withdrawal of water from streams can deplete ground water or conversely, pumpage of

ground water can deplete water in streams, lakes or wetlands. Pollution of surface water can cause degradation of ground water quality and, conversely, pollution of ground water can degrade surface water. They are the locations at which ground water leaves the aquifer and flows to the surface. Ground water discharge occurs where the water table or potentiometric surface intersects the land surface. This is illustrated below.

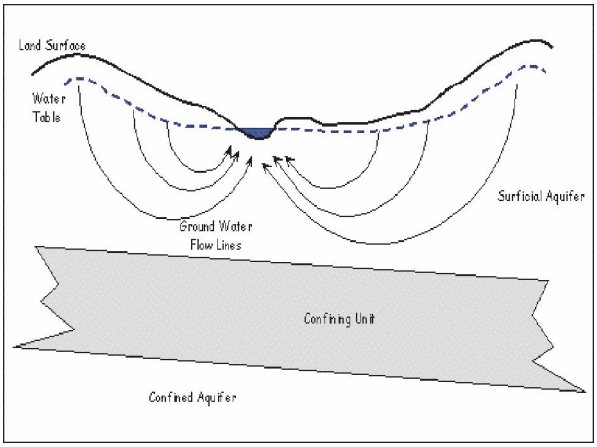

Figure 1 Discharge of groundwater to surface water.

Thus, effective land and water management requires a clear understanding of the linkages between ground water and surface water as it applies to any given hydrologic setting. Therefore to avail groundwater watershed management should also focus of surface water bodies.

3. Watershed management and Initiatives

3.1 Watershed Management Concepts

Concern about widespread soil degradation and scarce, poorly managed water resources has led to the spread of watershed management investments throughout Asia, Africa and Latin (Ffolliott, et al, 2000). Watershed management in its truest form is the conservation management of the soil, plant and water resources of a catchment to benefit humanity. It involves managing the land and human resources of the drainage in a manner that sustains adequate levels of water, soil, food and fiber production. Recognition of the importance of watersheds can be traced back to some of the earliest civilizations; ancient Chinese proverb which states that "Whoever rules the mountain also rules the river," and "Green mountains yield clean and steady water." (Salwa, et al., 1997; Winter, et al., 1998; Ffolliott, et al, 2000). Jain (2004) prefers to look at watershed management as having three main components which are land management, water management and biomass.

Interdisciplinary approaches to project design are needed that integrate the technical and human dimensions of watershed management. This requires an understanding of cultures and traditional land use practices. Socioeconomic research and participatory techniques need to be incorporated early in the conceptual design and planning stages of projects (Ffolliott, et al, 2000). How then can watershed management be used for improving water availability in Africa.

3.2 Land Management

Some forms of land use have a negative impact on the availability and quality of water resources (Jean-Marc and Santiago 2005; Hoff, 2006). Research shows that land use affects the infiltration of water into the soil, and any change in land use that compacts the soil or diminishes porosity will increase runoff and peak flow during rainfall events and, arguably, flooding. Accelerated erosion, produced by changes in the biotic and hydrologic components of natural drainages (watersheds), creates unprecedented large-scale siltation of developed lowlands (Salwa, et al., 1997; Winter, et al., 1998). Effective land management can improve the productivity of green water (mostly by reducing unproductive losses), which can contribute significantly to alleviating water scarcity in many regions in which renewable blue water is already fully exploited. So at local to regional scale, deforestation or irrigation in upland watersheds can significantly change downstream water availability. Ploughing and intensive hoeing should be replaced by ripping, direct planting or pitting. These conservation farming techniques, complemented by the breaking of hardpans, contribute to a better water infiltration and reduce losses of precious rainwater as runoff (Hoff, 2006; Johan and Kurt, 2005).

3.3 Water Management

Water characteristics like inflows (precipitation, surface water inflow, ground water inflow) water use (evaporation, evapo transpiration, irrigation, drinking water) outflows (surface water outflow, ground water out flow) storage (surface storage, ground water storage, root

zone storage) are the principal factors to be taken care of in sustainable water management**.** The broad interventions for water management can be rain water harvesting, ground water recharge, maintenance of water balance, preventing water pollution and economic use of water.

Rainwater harvesting forms the major component of water management. The rainwater collected can be recharged into the ground (Ffolliott, et al, 2000). Economic use of water and avoidance of affluence in use of water at individual and community levels may be the major concern for water management in the years to come. The green-blue water concept, which emphasizes precipitation as the key water resource to be managed, rather than river runoff or ground water only, can promote a better understanding of waterland interactions and eventually improved upland watershed management that is based on scientific evidence rather than popular believes (Hoff, 2006). Other opportunities are provided by upstream-downstream arrangements where the overall, basin-wide water productivity is increased through reallocations of water, e.g. from crops to higher value products. From this perspective, conservation farming is a form of water harvesting, where runoff is impeded and soil water is stored in the root zone of the crop. This means that conservation farming constitutes a very interesting approach to achieve improvements in water productivity, and "crop per drop" increases, in line with the newly launched global dialogue on water for food and environmental security (Johan and Kurt, 2005). In situations where basins are reaching "closure", i.e. the blue water resources are fully allocated, upstream measures such as soil conservation or rainwater harvesting, that reduce runoff, or improved water infrastructure with higher blue water withdrawals, can reduce downstream water availability (Salwa, et al., 1997; Ffolliott, et al, 2000; Hoff , 2006).

3.4 Biomass Management

Biomass management focuses more on the following: eco-preservation,biomass Regeneration, Forest Management & Conservation, Plant Protection & Social Forestry, Increased Productivity of Animals, Income & Employment Generation ; Activities, Coordination of Health & Sanitation Programs, Better Living Standards for People, Eco-friendly life style of people and Formation of a learning Community. Large-scale removal of forest lands by humans in the nineteenth and early part of the twentieth century's created significant changes in the hydrologic function of watersheds this resulted in downstream flooding occurring more frequently, with subsequent increases in loss of life and damage to infrastructure (Winter, et al., 1998; Jain, 2004). Gulley formation and low-quality water in the mid-altitude areas are associated with springs that are used commonly, but located on private land. Deforestation and cultivation of riparian areas are associated with privatization of riverine areas, together with ineffective enforcement of rules on the use of those areas (Brent, et al, 2005). Brent goes on to emphasize that lack of public infrastructure for water management is partially associated with the lack of public or collective land on which to locate water storage structures. Payments for environmental services also are a good ways of improving quality and quantity of water. The watershed services that would be sold are: 1. Soil/stream bank stabilization to ensure the quality of downstream water, and

2. Catchment forest conservation to improve the reliability of water flows. The author also goes on to highlight that at a later stage the biodiversity conservation, carbon sequestration services and aesthetics will also be sold as part of a bundle of ecological services.

3.5 Participatory

Furthermore, the role of local people and the importance of changing land use practices by those people are critical factors in achieving successful programs (Ffolliott, et al, 2000). Common sense tells us that to develop sustainable programs, land and water must be managed together and that an interdisciplinary approach is needed. In order fully to recognize human dimensions in water and land management, it is vital that the partners concerned, in intervention structures and in the village communities, are made aware and are convinced of the advantages of this approach, i.e. the mobilization of the rural communities and their greater involvement in development programs and projects (Jean , 2005).Without coincident local participation, top-down approaches alone often have inconsistent and unpredicted results, even though they may be technologically sound. Administrative and institutional structures should be developed that recognize watershed boundaries, without becoming overly complex (Ffolliott, et al, 2000). Flexibility in planning and management is

essential. Regional training and networking programs at all levels should be promoted, building upon existing networks. Long-term funding support for technical professionals, managers, and policy makers should receive the same attention as operational field projects (Ffolliott, et al, 2000). Participatory watershed management attempts at ensuring sustainability of the ecological, economic and social exchanges taking place in the watershed territory (Jain, 2004). The study tries to highlight some of the activities that can be done to improve watershed management as follows: Spring protection with Eucalyptus woodlots: Spring owners and spring users where eucalyptus is grown (Jean-Marc, 2005; Laura, et al., 2006)

- For springs with no trees or conservation structures: Owners of land around springs and spring users. Spring management
- Farmers who contributed to spring construction and farmers who did not contribute but may want to use springs in the future (negotiating use rights relative to maintenance responsibilities so that the interests of both groups are respected, i.e. new users contributing something for what they failed to contribute in labor/ materials/money during construction, but making this contribution affordable to them).Soil conservation
- Upslope farmers and downslope farmers, given that the former benefit least from soil conservation structures but can damage crops of downs lope farmers if they fail to conserve.
- Conserving farmers and non-conserving farmers, given the need to establish common drainage channels and avoid damaging each other's structures.
- Farmers with neighboring landholdings (who must negotiate the location of common waterways and contributions for gulley stabilization) (Laura, et al., 2006).

3.6 Initiatives towards water productivity

In Africa some of the methods for improving water availability through watershed management have been implemented and some are still ongoing. Also a lot of research has been done in different countries on this issue. Regional Land Management Unit (RELMA, 2005). highlights a GIS Overview project that researched on rain water harvesting in Africa and the case study covered ten countries Botswana, Ethiopia, Kenya, Malawi, Mozambique, Rwanda, Tanzania, Uganda, Zambia and Zimbabwe. It highlighted that Africa has a huge untapped potential for rainwater harvesting. This information was intended for awareness creation. The adoption of pans, rooftop rain water harvesting, runoff harvesting and flood for water productivity in many parts of East Africa and Sourthen Africa, especially for livestock (Bancy, et al., 2005).The green water principle was entered in to South Africa's National Water Act from 1998, which levies streamflow reduction activities, such as forest plantations (Hoff , 2006). A Green Water Credit pilot project was implemented in eastern Africa, which depends for its water supply largely on the major water towers around Mt. Kenya. The area is undergoing rapid land use change –e.g. marijuana cultivation replacing thousands of hectares of forest cover. Deforestation in this area is generally associated with erosion and siltation of downstream reservoirs. It is an application of the green-blue water concept, integrating bio-physical and socio-economic aspects of upstream-downstream linkages (Hoff, 2006; Laura, et al., 2006). In 1998, Zimbabwe adopted a new water law that sought to reverse decades of discrimination in water allocation that had been built into previous water acts. The new law is designed to provide for more inclusive involvement of stakeholders in water management, greater efficiency in water use entitlements, water permits to replace water rights, catchment water use plans, and minimum allocations of water for the environment. Ghana has taken a similar approach, investing in large-scale water storage and a national system for water monitoring and management. Researches that brought about development of conceptual models have been done in different parts of Africa for example Nyando basin in western Kenya, the model was on catchment property rights, which was applied in an analysis of the effects of property rights on management and use of resources in the badly degraded basin. The analysis relates people's livelihoods to the evaporation and transpiration of water (green water), noting that the relatively poor are particularly dependent on green water for generation of income and subsistence food production (Jean-Marc, 2005). The study of detailed data collected throughout the catchment over the last ten years showed that land management had large effects on both groundwater recharge and surface runoff (Mugabe, 2005). The amount of runoff generated during storms is affected by cultivation, which increases infiltration and reduces runoff. In particular, high drainage was observed above contour bunds, along lines of surface water drainage and along storm drains. Experimental results from the research indicated that improved fallows can

increase infiltration and reduce soil loss significantly, with the amounts and the statistical significance depending on the soil type (Anja and Alain, 2005). For instance, farmers, primary school teachers and extension workers from Tanzania, Uganda, Kenya and Zambia visited market focused watershed management areas in Ethiopia. A lot of land management practices were learnt from these trips. For instance, on sloppy land, the management of water and runoff over many small farms is done through intricate negotiations to get farmers to cooperate in constructing drainage and conservation works (Azene and Gathiru, 2006; Division of Water Resources, 2007)

4. Conclusions

Economic stress still affect implementation of water productivity projects in most African countries. To ensure the availability and effective use of water resources, today's multiple arrangements should be rationalized - guided by the principles of equitable rights and sustainable and efficient water use. Therefore, there is an urgent need to take a critical look at the motives for watershed management, the beneficiaries, and methods used to reach specified objectives. However, some 'modern' approaches do not recognize the potential of using local knowledge in conservation and management of water resources including springs, riverbanks, marshes and swamps and it strongly emphasizes that weaknesses of river basin organizations should be addressed in line with best practices in Africa and elsewhere.

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