Integrated Watershed Management in Eastern Nile Countries

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ABSTRACT

The integrated watershed management became a focal trend for cooperation between countries shared in one river in the field of water resources. Within the Nile Basin Initiative, the Eastern Nile countries (Egypt, Ethiopia, and Sudan) have planned and singed an integrated watershed management project to develop, manage, and utilize the water resources of their basin. The main objectives of the project are to improve the standard of living within the selected watersheds of the EN basin, improve agricultural production, and decrease erosion, sediment transport and morphological changes along the river.

In 1993 China started implantation of integrated watershed management for a mild basin of the Yellow River (Loess plateau project). This project area has many conditions and parameters similar to the situations in the EN countries. During 19 - 30 Sep 2004, a study tour for a technical team from the EN countries was organized to the project area to visit and learn from the Chinese experience in this field.

Based on the results of this tour this paper aimed at studying how to utilize, transfer and apply the used techniques into the EN countries for selected watershed areas. Moreover, it focuses on the benefits for each country that the main expected outputs which are increasing the agricultural production and income in Eastern Nile countries, in addition to reduce soil erosion and minimize sedimentation problems in the end reach of the Nile River.

KEYWORDS: Watershed management in Eastern Nile region, Nile Basin Initiative; River Nile; Eastern Nile.

INTRODUCTION

Water and soil conservation is closely related with the continuous development of the social economy of the country. Soil erosion not only destroys the earth's productivity, deteriorate the ecological environment, but also endanger the safety of the people's life and properties. The problem of watershed degradation in Eastern Nile is huge and complex. The local communities, governments, international agencies and donors have put numerous efforts to arrest the degradation problem without much success. New approaches need be adopted to combat the massive degradation of the Eastern Nile watersheds otherwise problems of loss soil, productivity, and resulting sedimentation, flooding, drought and famine will continue.

Over the past few decades a number of programs and studies have been implemented aimed at increasing cooperation between the countries of the Nile Basin. With the support of the United Nations Development Program (UNDP), a number of Nile Basin countries succeeded in establish the Hydromet Project which functioned from 1967 to 1992. The Project developed a program entitled TECCONILE that established a form of co-operation between Nile Basin countries called Nile Basin Initiative. The Nile Basin Initiative (NBI), a partnership between the Nile Basin Countries, was officially launched in 1999. The shared vision of the NBI is to achieve sustained socio-economic development through the equitable utilization, and benefit from all NB countries. NBI developed a Strategic Action Program comprising two complementary programs: The Shared Vision Program, a program to build trust and capacity, involving all member countries, and two Subsidiary Action Programs aimed towards cooperative investments: one in the Nile Equatorial Lakes Region NELSAP and one in the Eastern Nile Region ENSAP. Through the ENSAP, the Eastern Nile countries

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- Egypt, Ethiopia, and Sudan - are initiating a regional, integrated, multipurpose program with a first set of investments that confirm tangible win-win gains and demonstrate joint action for the Eastern Nile countries.
Recently, the most badly eroded watersheds in the world are; in china, the watersheds of the middle basin of the Yellow River (loess plateau region), and in Eastern Nile Countries EN (Ethiopia – Sudan – Egypt).

Due to the increasing problems of population and poverty, it is important to conserve soil and water resources into these areas. In 1993, China government in cooperation with the World Bank started executing a project for conservation of soil and water at the loess plateau basin. It was to increase the agricultural products, incomes and to reduce erosion, sediment through an efficient and sustainable use of land and water resources in the tributaries of the yellow river. ENSAP identified seven projects for efficient water management, optimal use of the resources. The Watershed Management Project is one of the fast track projects. It is aiming to establish a fundamental steps and guidelines to suggest a strategy plan to be a national policy to manage and develop the selected watershed areas in the region.
During 19 - 30 Sep 2004, a study tour for the Loess plateau project in China was organized and funded by World Bank under the umbrella of ENSAP. The study tour sites were selected for their geographic, climatic and topographic conditions to be most relevant to the situation and challenges faced in the Eastern Nile region. It is strongly recommended to learn and utilize from the China experience in the field of watershed management.

CHINESE EXPERIENCE IN LOESS PLATEAU PROJECT

Yellow river's watershed problems

The Loess Plateau covers an area of some 640,000 km2 in the upper and middle parts of the drainage basin of the Yellow River. The project covers nearly 2 million ha in 12 river basins of the Loess Plateau in 37 counties in Shanxi, Shaanxi, and Gansu Provinces, and the Autonomous Region of Inner Mongolia as shown in figure (1).

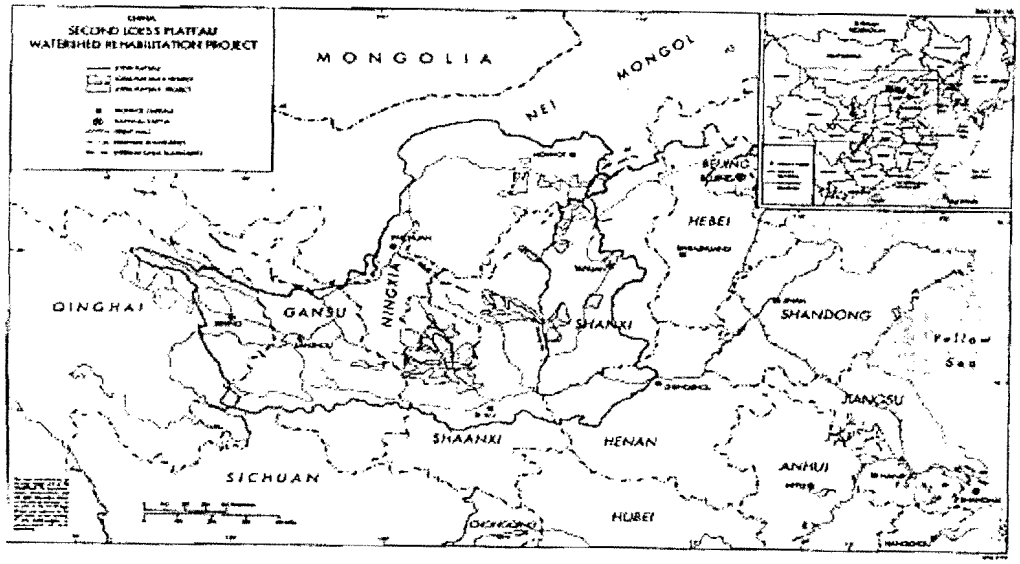

Figure No (1): Loess Plateau Project Area

These areas included severity of soil erosion, poverty level, and low experience with soil and water conservation works. Erosion causes 1.6 billion tons of sediment to flow every year from the Loess Plateau of northwest China into the Yellow River. The increased sediment load causes the riverbed of the Yellow River to rise and results in severe floods; consequently, riverside communities have elevated dykes by approximately one meter every 10 years to

keep up with the increased sediment deposition. Free grazing was found to be a major cause of soil erosion in the Loess Plateau and the project counties have now adopted strictly enforced grazing bans. Downstream flood risk, however, is only one part of a broader, interrelated problem: in the Loess Plateau, poor resource endowment and high population pressure, combined with unsustainable agricultural practices, have resulted in widespread endemic poverty and massive environmental degradation.

Loess plateau project

The Chinese government has supported soil and water conservation efforts since decades. The devastating Yellow River floods in the early 90's, combined with the need for sustaining multi-purpose 2 infrastructure for power production and river regulation made the need for watershed management a high national priority. The objectives of the Loess Plateau project, started in 1993, were to increase agricultural production and incomes through a more efficient and sustainable use of land and water resources in tributaries of the Yellow Plateau which it included severity of soil erosion and poverty level. Experience with soil and water conservation works, development potential and repayment capacity, strong leadership and commitment at the local government level and proximity to science and research organizations have been involved in this project. The Xiaolangdi dam Project is another component of the project. Its main objectives are: flood protection to more than 100 million people; reduction in the deposition of loess in the 800 km long lower reaches of the river; maintaining an environmental flow in the Yellow River; irrigation for 2 million ha, drinking water for the cities, industrial water; lower reaches ice control; and hydropower generation. The overall project interventions are geared towards stabilizing the soils, reestablishing vegetation cover, increasing agricultural production and increasing income and employment.

Chinese experience in watershed management

Terracing

Terraced land retains water and resists soil erosion. Terrace widths range from 5 to 15 meters depending on slope as shown in figure (2). They give farmers the opportunity to plant a wider range of crops with much higher yields than on slopeland. In a year of average rainfall, grain yields on terraces can reach 2 to 3 times those on slopelands. The high yields in the good years provide insurance for the drought years.

Figure No (2): Terraces.

Sediment control structures

Sediment control dams built to retain sediment, control flooding, create land for crop production, and store water for irrigation and village water supply. The creation of Land by the deposition of sediment is called warping. Warping dams, about 3-10 m in height, which built in the gullies with the main purpose of intercepting sediment and creating land. It takes about three years for land to be ready for farming behind the dams. Key dams construct to control sediment runoff and floods from drainage basins and dams fill with silt in between 8-10 years. Gullies will be stabilized through building small check dams of rock or brushwood

that slow down the flow in the gullies and prevent undercutting of the gully sides and by building low dikes and planting shrubs at the heads of gullies.

Water harvesting structures: "One dam – one pond"

Irrigation works consist of small water reservoir such as ponds, which located to catch run off from roads. These provide insurance during periods of prolonged drought. The "one dam - one pond", consists of an earthen dam built uphill and is combined with a lower lying pond for water storage as shown in figure (3). The earthen dam is built in a wide gully to retain seasonal floodwater. Due to the soil properties, with a large sand content, water is seeping through the earthen dam, and is captured below the dam in a pond, that is lined with an impermeable clay/soil layer or a plastic liner. The pond is relatively deep to minimize evaporation and lining with concrete or

Plastic to reduce the seepage. The water is primarily used as water supply for nearby households, for animal watering, and for supplemental small-scale irrigation schemes.

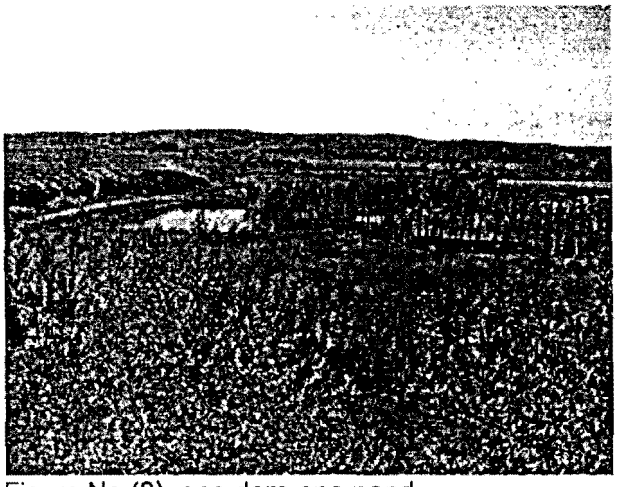

Figure No (3), one dam-one pond.

Afforestation and Vegetative Cover

The main objective of this component is to increase the vegetation cover and erosion control capacity in the project watersheds through planting and protecting trees. Decrease the number of grazing sheep and goats, and increase in pen feeding may be the single most important factor in permanently restoring vegetation cover. Here are examples for types of vegetation cover and planting:

Sea buckthorn planting areas

Intensive research and field trials led to the selection of a native shrub, Sea buckthorn, as most suitable for re-vegetation in these sandy and drought affected areas. Sea buckthorn has the advantage of being adaptable to a wide range of soil conditions, being drought tolerant, and having a variety of economic benefits, as its fruits and leaves can be used for a variety of purposes. Sea buckthorns have been successful in stabilizing the soils and requiring 4-5 years to be productive.

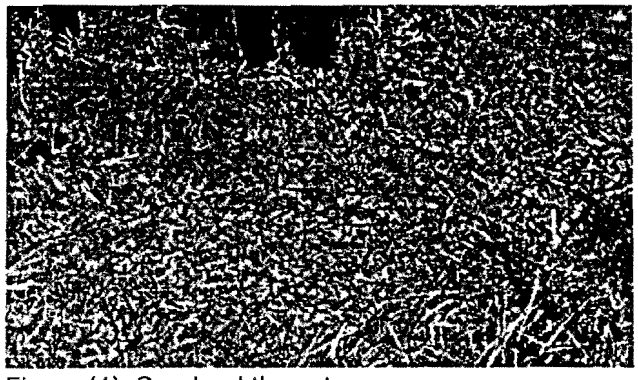

Figure (4): Sea buckthorn trees.

It allows for other native grasses and other vegetation to reestablish, and this way improving the quality of the land as well as reducing erosion in the watershed as shown in figure (4). The sea buckthorn fruit contains a large number of vitamins and is used for medicinal purposes, juices, and cosmetics; the leaves for tea; and the branches can be harvested for firewood. Therefore, local agroindustry was established for processing of the fruits, creating secondary economic benefits to the community.

Reforestation – tree planting:

To prevent overland flow and soil loss from areas between gullies, small ditches and weirs have been built. All ditches are established in parallel to the contour lines and have proven very effective in sediment/erosion control in addition to support of reforestation efforts. Rows of small ditches are spaced 1-2 meters apart, which are catching moisture and protecting newly established trees from wind. The ditches are planted mostly with Chinese pine, or with other trees or shrubs as shown in figure (5).

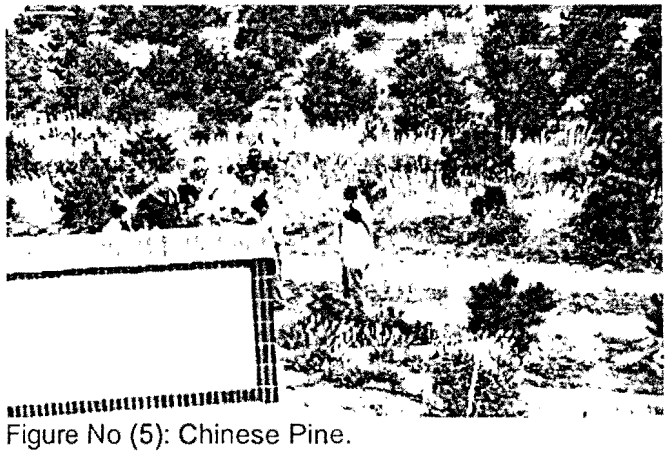

Figure No (5): Chinese Pine.

Sand Willows:
The main vegetation planted were Sand Willows, which are hearty for the regional conditions. They are fast growers, stabilize the soil while increasing it's quality with organic matter. After stabilizing the soil with the sand willows aerial seeding with improved grasses could be done and additionally the original vegetation started to re-establish. In addition to soil improvement, the land rehabilitation resulted in an increase in the wildlife biodiversity in the area. Sand willow plantings can be done 2-3 times a year depending upon the rainfall as shown in figure (6).

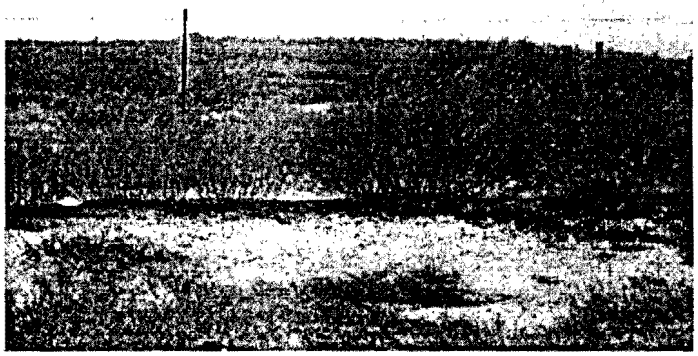

Figure No (6): Sand willow planting area

Sand Dune Stabilization:

Sand dune stabilization is done in phases and treatment requires about five years for stabilization. The processing of sand dune stabilization are: sand fixation through securing the dune area with stakes/twigs in a diamond pattern; planting of trees and shrubs in diamond-shaped squares are vegetated with a variety of different species including Chinese pine, sand willows, and sea buckthorns; fencing of area to allow vegetation to establish as shown in figure (7). Farmer benefits are mainly from selling grass seeds and cut grass for fodder, which is possible after about a two-year period. Certain regulations and permits apply to grass cutting in order to assure sustainability.

Figure No (7): Vegetation in Diamond and Square Shapes.

Losses Plateau Project Benefits

More farmers income and Land reclamation

The project has completed over 80,000 hectares of terracing. Farmers have replanted twice that area with forest trees. Within two years, crop yields doubled and even tripled in some micro-catchments due to the terracing and conservation techniques. At the same time, the barren hills have been replanted. About, half a million farmers have improved their standards of living because of this project. Each farmer holds about 3 ha. Fees for the land contracts are low and over 30 to 50 years. Erosion was reduced through re-vegetation and grazing bans. The farmers receive training on good practices and support to build storage bins, slope protection and vegetation planting. Grazing management imposed by counties and township has full support of the farmers due to the better yields and livestock health. After stabilizing the soil with sand willows, the land rehabilitation resulted in an increase in the wildlife

biodiversity. Sand willows planting can be done 2-3 times a year depending upon the rainfall. Farmers are able to harvest the sand willow branches for a number of uses, for paper products, basket production, fodder, and firewood.

Less sand to the Yellow River

From the national and regional scope the environmental/sediment control benefits equally important as farmers' benefits. Heavily degraded sandy soils are now re-vegetated with sand willows plantings, which have been very successful in soil erosion protection which lead to minimize the sediments in the Yellow River. Other vegetation planted including sea buckthorn- mainly in gullies and grasses contributed in reducing sediments to the Yellow River. As well as the construction of warping, key, and check dams reduced the sediments.

Flood Agriculture

Flood irrigation, used in project area, has increased farmland productivity. The sediment-laden river water is diverted to dike-structures surrounding an average of 3-5 ha of farmland. Within 2-3 years, the silt deposited creates productive land for farming, enhances the land quality, and increased land areas per farmers by an average 0.16 ha/farmer. Food production in these enhanced and formerly food insecure areas increased to 500 kg/mu from around 50 kg/mu before the project. The silt is very productive and no fertilizer has to be used during the first 3-5 years under production, while fertilizer addition is required in subsequent years. Farmers' incomes have risen over the project life from an average of around 600 to 1200 Yuan. This is an amount by which these farmers are considered above the poverty line. While the various levels of benefits outline earlier are hard to quantify and especially downstream benefits. It is imperative that on-farm benefits are high enough to render investments in on-farm and common structures – such as water harvesting structures, warping and check dams, etc. Investments of downstream communities, provinces or states in upstream investment may come over time once successes have been shown.

Agro-industry

Some trees and replanting the gullies such as sea buckthorn and Chinese pine have multi used beside protection. The combination of new approaches and products with local agroindustry is a good way to gain more local income and job opportunities and keep value added in the region. This has contributed to indirect social benefits and positive spill- over effects of the project and participants felt that it should be more systematically pursued in their countries.

EASTERN NILE INTEGRATED WATERSHEDS MANAGEMENT

The EN region is one of the varied landscapes ranging from rugged highlands of Ethiopia to wetland areas of Sudan to desert in northern part of Sudan and Egypt. It includes three main tributaries from eastern basin of the Nile; Blue Nile, Atbara and Sobat as well as White Nile and main Nile. About 83% of the total water of the Nile comes from Lake Tana, 1,800 meters above sea level in the Ethiopian mountains as shown in figure (8).

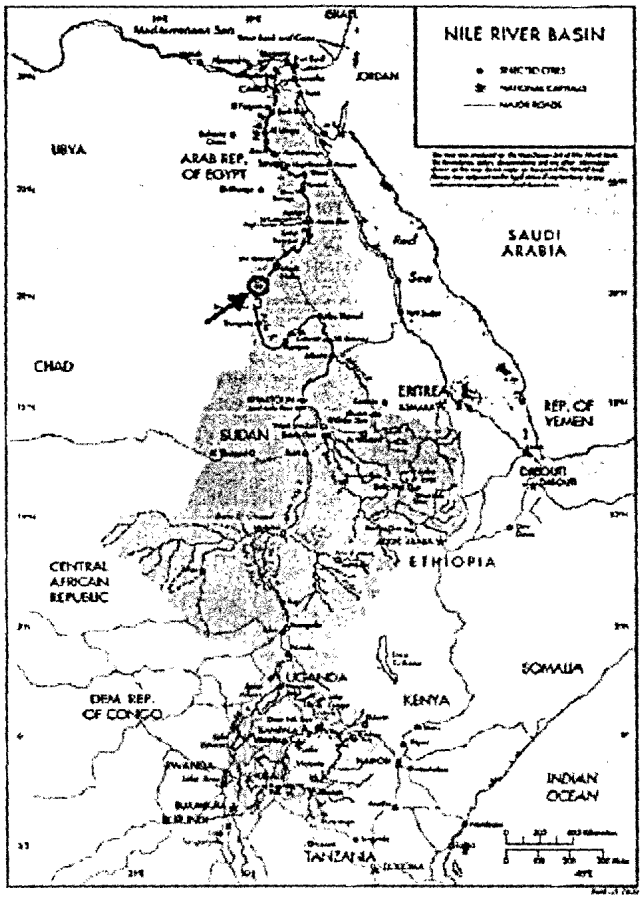

Figure No (8): Nile Basin Map

The lake flows over every summer providing for the flood that today is tamed by the dams of Sudan and southern Egypt (4).The climatic variations make the region subject to droughts and floods. As mentioned in the introduction, the Project Identification Document (PID) for ENSAP has outlined seven potential areas of cooperation. One of them is the Integrated Watershed Management program (6). This pprogram will cover some selected sub-basins proposed from the EN countries in their TOR as shown later. Erosion in highland areas are exacerbated by deforestation, population growth, overgrazing, and use of marginal lands. It causes downstream sedimentation, which decrease the existing reservoirs lifetime, reduce the hydropower, erode bank slopes and damage habitat. Therefore, Soil erosion is the serious and main problem of the watershed management in the EN countries. It causes a lot of economic, social, environment difficulties on the EN regions. Problems of the watershed management in the EN countries can be summarized in the following points:

1. Severity of soil erosion due to wind and rainfall in large regions of EN countries,
2. poverty level in large scale of population in EN countries,
3. low experience with the soil and water conservation works,
4. Sediments transfer and accumulation in most reservoir on the EN countries,
5. Environmental degradation in large areas in EN.
6. Low farming and irrigation experience.

Watershed Problems in Egypt

High Aswan Dam (HAD) constructed in 1968, 7 km upstream the Aswan Old Dam to save the lost water amounted by about 22 Milliard cubic meters per year, which goes to the Mediterranean sea every year. HAD has created one of the largest man-made reservoir called Lake Nasser and its Sudanese portion called Lake Nubia. Its total length is approximately 500 km, about 350 km in Egypt, and the rest 150 km in Sudan with average

width of 12 km and depth between 12 ~ 90 meters as shown in figure (9). The Lake areas in Sudan and Egypt are threatened by serious sand encroachment. It was reported that substantial amounts of sand are pouring yearly into Lake, decreasing its capacity, and changing its morphology. Nevertheless, nothing has been done to mitigate the problem. The annual results of the Egypt and Sudan monitor and analyze deposited sediment in Nasser Lake show that deposition is increasing.
Egypt proposed management framework in its TOR (6) covers the whole lake area in both Egypt and Sudan. Continuous deposition of sediment decreases the reservoir live storage capacity, increases bed levels at the reservoir entrance, and could form an internal delta. Moreover, the Lake water levels versus its surface area and volume curves should be updated due to increase the transfer and accumulation sediment.

Suggested solutions
Implementing complete hydrographic survey for the Lake to have better and accurate estimation of sediment deposition volumes and their distributions in the Lake and then established a data base system for monitoring for sediments (volume, shape, rate...). From the experience of the study tour to China, it can be noticed that the flushing technique is not suitable for the case of the HAD reservoir to reduce the sediment deposits. For that reason, investigation and design a suitable technique to get ride of or to minimize the sediments deposited in the Lake are required.
Sand dune stabilization around the Lake is needed to reduce the wind erosion through selected the suitable planting and vegetation in diamond and square shapes.

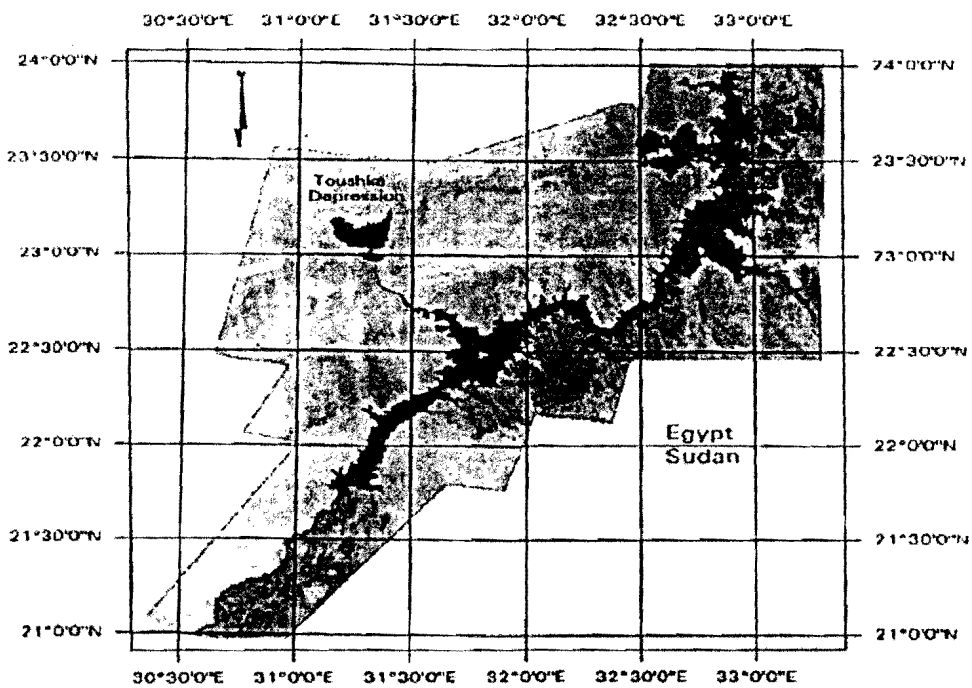

Figure N0 (9), lake Nasser.

Wateshed Problems in Ethiopia
Ethiopia comprises four sub-basins, namely Tekeze, Abbay, Baro-Akobo and Mereb. It is located in the east Horn of Africa and has one of the most rugged terrains in Africa. Its terrain is divided into five major formations: the western lowlands, the western highlands, the eastern lowlands, the eastern highlands and the Great Rift Valley of East Africa that bisects the central highlands into east and west. The highlands are deeply incised by major rivers, which originate in the highlands and flow to the lowlands, most of which eventually cross the

international border into neighboring countries. The topography ranges from 160 to 4620 masl, and about 60% of the country lies above contour line 1500 masl, and the rainfall increases with altitude whereas temperature decreases. Deforestation in the Ethiopian highlands is speeding up, and the use of the land for cultivation and grazing without adequate protection has dramatically increased soil erosion, which its annual rate is about 1 billion tons. The majority of it leaves the country as suspended matter. Downstream sedimentation is causing damage to crops and infrastructure, reducing the life of reservoirs, increasing the frequency and intensity of flooding, and deterioration of the land, water, forests, and biodiversity (8). Therefore, there is a necessity for a watershed management technically feasible, socially acceptable.

The proposed study area (8) is highly rugged with steep mountains and is divided into two units:

- The western and south-western parts of the basin (46% of the area) as low as 400 masl at the Sudanese border, and
- The northern, eastern, central, and southern parts are above 1500 masl.

Ethiopia's TOR objectives are to improve the standard of living of the populations residing within the study area, increase land productivity, reduce erosion and sediment transport, and decrease pressure 7 on resources. The first assignment covers two of the four proposed sub-basins: ekeze – Setit–Atbara; Abbay–Blue Nile; Baro/Akobo–Sobat; and Mereb–Gash.

Suggested Solutions

Preparation studies and field trials are required to assign and design the fitting solutions of the problems of the watershed in Ethiopia. Suggested solutions are to choice the proper techniques to reduce soil erosion, increasing land productivity, replanting and vegetation the gullies and hills, and sediment control. Cropland improvement can be done through selected the right techniques according the climatic, geology, and hydrology condition. For example terracing technique is preferable for the highland in the western and south-western parts where, retains water and resists soil erosion and thus improves soil and water regime. This technique will mainly contribute in increasing the agriculture land and directly will raise the farmers' income. Sediment control dams such as key, warping, and check dams are recommended in the highlands regions and gullies. The main objectives of the earthen dams are to hold sediment, control flooding, create land for crop production, and store water for irrigation and village water supply. Afforestation and vegetation cover are important to increase erosion control capacity in the watershed regions through planting and vegetation in a diamond and square shapes according to the wind direction, speed and attitude. Flushing technique is suitable technique for the annul storage reservoir to control sediments deposits and increases the lifetime of reservoirs.

Watershed Problems in Sudan

Sudan has an area 2.5 million Km2 extending between Latitude 4o -22o N and Longitude 22o- 38o E. The annual rainfall ranges between 25 mm in the dry north and over 700 mm in the tropical rain in the south. The mean annual temperature ranges from 30oC to 40oC in summer and from 10 oC to 25 o C in winter. The rainy season is generally short extending for three to four months in most of the country. Potential evapo-transpiration ranges from 3000 mm in the north to 1700 mm in the extreme south The Eastern Nile tributaries extend from those of Sobat in the south to those of Atbara in the north. The three tributaries form Sobat River joins the White Nile at Malakal. The Blue Nile joins the White Nile at Khartoum to form the Main Nile. The tributaries of Atbara, Basalam meet Setit (Tekkazi) at Showak to form Atbara River. The Main Nile then proceeds as one course through the Sahara Desert to Egypt and the Mediterranean. The banks of the Blue Nile are very steep and subject to bank failure and erosion. Atbara river has steep gradients and deeply incised in its substratum. The Dinder and Rahad rivers are characterized by erosion and sedimentation along their banks and bed. Sobat-Baro-Akobo-Pibor, its landscape is flat with some depressions and suffers from floods and inundation. The Main Nile, from Khartoum to Aswan High Dam suffers from sedimentation, bank erosion, and sand encroachment. Over grazing of the

grassland resulted in the degradation of the watershed. Efficiency of Roseires, Sennar and Khashm el Girba dams and their reservoirs are reduced due to siltation. Efforts to reduce poverty and ensure sustainable development will be faced with a multitude of complex and intricate environmental problems. In view of the multi-sectoral nature of the problem involving land degradation, fuel wood demand, population pressure, lack of alternative sustainable livelihood including energy, etc. A comprehensive and integrated approach to address watershed management that analyses and addresses the root causes of degradation are required. According the Sudan' TOR (7), the first consultancy assignment in Sudan is going to study the sedimentation in the reservoirs, the off-takes of the pumps stations, bank erosion and sedimentation by wind erosion (sand encroachment). This first consultancy assignment in Sudan is going to cover two of the five sub-basins selected,

- Setit, Basalam and Atbara up to the confluence with the Main Nile;
- Dinder and Rahad up to their confluence with the Blue Nile;
- The Blue Nile, Baro-Akobo-Pipor-Sobat, and
- The Main Nile between Khartoum and Aswan High Dam.

Suggested Solutions

As mentioned before about EN countries' topographic, geology, description of the watershed problems, and suggested solutions, it can be noticed that the southern part of Sudan is similar with the situation of Ethiopia. But the conditions of the northern part of Sudan are almost near to the situation in south Egypt. Therefore the techniques of such terraces and sediments control dams are fit with highlands in the southern region of Sudan. Sand dune stabilization is preferable in the area attacked by wind erosion. Flushing technique is the best solution for reducing the deposited sediments in the of Roseires, Sennar and Khashm el Girba dams to extend their lifetime.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The integrated watershed management project is good opportunity to apply the win-win approach in the cooperation between the EN countries. The expected results can be watched in the ground. For example slopeland protection in the upper catchments of EN (in Ethiopian and Sudan), will increase agriculture productivity and rise the live standard, at the same time will reduce the sediments transfer and accumulation in the downstream reach of EN (Sudan and Egypt). The combination of the warping, key, and check dams which retain sediments, provide flood protection and create local, multi-purpose benefits could be very useful in some sub-watersheds in the EN especially in Ethiopia. Soil erosion protection techniques should be tailored to fit with local region conditions. For example, terracing is not economic in the sandy and less productive soils in low rainfall areas but other methods for land conservation and reclamation are used that match the climate as well reflect a reasonable ration between inputs needed (work and investment) versus farmer benefits. Speciation of the planting species for soil dune stabilization should satisfy the following measures:

- Protect the soil effectively;
- Improve ecology and environment; and
- Have multi-purpose, commercial use to make the planting effort worth to the farmer.

The approach of land security through long-term leases – is one of the practical ways to assure effective land security and ownership of land. Land leases should be equally accessible to all groups independent of gender and/or other social status. Farmers should be completely aware of grazing regulation and livestock kept away from newly treated areas. Water harvesting techniques such as the one-dam- one pond system could possibly be very practical for lighter soils and gully treatment in more sandy areas where the seepage allows water to accumulate below the earthen dam. The ponds are used to supply water for supplementary irrigation, which is very much needed in many regions of the Eastern Nile due to the high rainfall variability and short growing season.

Recommendations

Participants of the study tour for the three countries should be the core and focal points of the EN watershed project. They visited and watched different techniques and learned lessons, which handling and managing the watershed components in the China Loess plateau project. They can assist and contribute in transferring and applying the suitable techniques to the watershed management project in EN. Comprehensive programs for monitoring, evaluation and maintain for all project components and activities are important for the improving and sustainable the project. Researches and experiments with the cooperation and coordination with the agriculture experts are essential in the field of the choice of the suitable species of panting and vegetation cover in project areas. Furthermore, the species should not be foreign to the region. It is essential to design and identify the participatory process, to gather knowledge about villagers' successful experiences with limiting erosion and suitable types of panting and tress. In addition to farmers should be aware with the components and activities of the projects and the link between each other. An effective institutional set-up and clear implementation mechanisms are essential. Building capacity should be established through local and overseas training for farmers and technicians to be familiar with farming on slopes, initiating large-scale terracing, building silt-retention structures, and planting slope-land protection, natural re-vegetation, and rotational grazing and animal management right away. Preparation, studies and planning time for the project should take enough time to design the implementation steps, and learn from ongoing interventions and consultations in the field. The study exchange trips to pilot areas between three countries are important.

Expected results

The expected outputs can be predicted as following:

- Increasing the living standard.
- Support the cooperation, coordination and build trust and confident in implementation of shared projects between EN Countries.
- Extend the lifetime of the exiting reservoirs.
- Income generation.
- Decrease erosion and sediments
- Food security
- High productivity agriculture land

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