APPENDIX VIII

ENVIRONMENT ASSESSMENT AND

WATERSHED MANAGEMENT

Attachments

ATTACHMENT 1
TERMS OF REFEERENCE (TOR)
FOR
THE PREPARATION OF ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
FOR
MEKI IRRIGATION AND RURAL DEVELOPMENT PROJECT

1. BACKGROUND INFORMATION

1.1 Project Background

Economic stagnation and poverty were the major challenges facing the Government of Ethiopia (GOE). In response to these challenges, the Federal Democratic Republic of Ethiopia (FDRE) identified the agricultural sector as a priority strategy to alleviate poverty. Consequently, in its National Economic Development Plan of 1995/96 – 1999/2000, the GOE aims to achieve its development targets through (i) food self-sufficiency, (ii) supply of raw materials for domestic industries, (iii) creation of employment opportunity, (iv) foreign currency saving, and (v) environmental conservation. Thus, the GOE embarked on far-reaching policy reforms intended to restore macroeconomic stability and improve efficiency of resource allocation and utilisation in order to accelerate sustainable economic growth. However, though accelerating economic growth and restoring the developmental momentum remained principal policy objectives, it was also realised that poverty and related social problems (gender equality, social infrastructure development and environmental conservation) should receive additional attention through the rehabilitation of the social infrastructure and financial support for well-targeted projects. In 1996, the GOE requested the Government of Japan to extend technical assistance for a study that would prepare a master plan to ensure environmentally sustainable irrigation and rural development.

The study area is located in Dogda Bora Wereda (district) in East Shewa Zone of Oromia Region, which is the largest region in Ethiopia, occupying 34% of the national territory and has 37% of the total national population (Figure 1). The study area is situated in the Ethiopian Rift Valley System, which divides the country into north western Highlands and south eastern Highlands. The Rift Valley has unique environmental issues. It is characterised by localised and limited quantities of water with fair to poor chemical qualities. All streams are intermittent except for few perennials, which are often turbid with high sediment yield. Fluoride content in ground water is known to be the highest in the country (up to 10 mg/l compared to WHO permissible level of 1.5 mg/l), and salinity levels are high (more than 3000 ppm). Other problems include over-grazing, high rate soil erosion and sedimentation, inadequate optimisation of multi-purpose water resource use (irrigation, hydropower generation, water supply and fisheries). Both sheet and gully erosion is widespread in the country. Fertile soil losses due to erosion is estimated at 42 tons of top soil per hectare. It is estimated that soil erosion amounts to 1.5 billion tons per year, and 0.5% of the highlands of Ethiopia is being eroded annually. And, a century ago, closed forest covered 40% of the country, but barely 4% is left today, suggesting that deforestation rate has been and continues to be very high. With an average annual rainfall of between 300-500mm, drought is a recurring feature in many parts of the country, where up to 50% or more of the livestock is decimated. The most devastating droughts were those of 1972-74, 1975-76, 1978-79, 1983-84 and 1990-91, during which over 2.7 million people in Oromia Region alone were affected.

These problems are now threatening sustainable agricultural development. Although small irrigation is practised along the Meki River and around Lake Ziway, crop productivity is low and unstable, prompting the Oromia Regional State to call for urgent improvement in existing farming system and the livelihood of the Oromo people through both irrigation and rural development. Given the alarming rate of land and water degradation in the region, the Oromia State recognised the need to integrate appropriate measures for environmental and watershed management into the overall project activities.

To address these issues and in response to the request by the GOE, the Government of Japan dispatched a preliminary Study Team to hold a series of discussion with the Government of Ethiopia and both sides agreed on the scope of work (S/W) on March 28, 2000. The scope and details of the study agreed cover six programs, namely (i) irrigation development, (ii) rain-fed agriculture improvement, (iii) animal husbandry modernisation, (iv) environmental conservation, (vi) capacity building for OIDA and Wereda Staff and (vi) community development and co-operative promotion. Within the environmental component, Initial Environmental Examination (IEE) was to be conducted. Of the six programmes, only irrigation development was considered for the purpose of IEE because the rest of the components are expected to have no significant environmental impacts, rather, their implementation will help improve environment and natural resources. In this context the IEE is carried out for a large-scale development based on the Meki Irrigation and Rural Water Supply Project.

Three options were considered for the IEE: (i) no action option, (ii) irrigation by headworks, and (ii) irrigation by dam. The no action alternative does not seem feasible since there is enormous local population and government pressure to have sustainable agricultural production. Of the other two options, irrigation by dam is environmentally undesirable because it will drastically reduce downstream water flow, significantly affecting ecological balance. Consequently, the diversion weir option on which the IEE was based is chosen for the irrigation development.

The proposed site for the diversion weir is located on the Meki river, approximately 2.5 km upstream of Meki town. The river has cut a steep-sided narrow gorge of 10 to 20 m deep. The average gradient of the Meki River is 1/500, and the river bed elevation is El. 1655.0 m. The height of the weir would be 10 m from the river bed. Other general features are: (i) catchment area:2,433 Km^2, (ii) area of total storage: 10 ha, (iii) total area to be irrigated: 2,300 ha, and (iv) annual intake capacity for irrigation: 7.11 MCM for 105% cropping intensity.

According to the Environmental Assessment Guidelines Document (2000) of the Environmental Protection Authority (EPA) of the FDRE, the proposed Project falls under Category I (Schedule I) in that it will require a full EIA due to its potential adverse and irreversible environmental impacts.

1.2 Purpose of the Terms of Reference (TOR)

The purpose of the TOR is to describe the requirements for the EIA to be prepared by the Oromia Irrigation Development Authority (OIDA) - the project implementing agency, so that the resulting EIA will be suitable for review and evaluation by EPA

1.3 Responsibility for Preparing the EIA Report

The preparation of the EIA is the responsibility of the EPA, which will ensure that the report meets EPA's standards. The EPA will employ a consultant to undertake the EIA.

1.4 General EIA Guidelines

Several guidelines for assessing environmental impacts have been published and are listed in the bibliography and can be obtained from the EPA or the institutions and agencies that prepared them. The Contractor's ultimate guideline is the "Environmental Impact Assessment Guideline Document (2000)" prepared by the EPA of the FDRE.

1.5 Specific Background Studies and Reports

1.5.1 Demography

(1) Population

The Oromia Regional State is administratively divided into 12 zones and 180 weredas, which are further sub-divided into about 10,000 peasant associations (PAs), the lowest administrative unit. The study area – Dogda Bora Wereda comprises two (2) urban centres and rural areas divided into 54 PAs. According to the latest population census, the Wereda has a population and households of 134,454 and 28,688 respectively. Based on the 1994 census and past growth rate, the projected population in the year 2000 is about 163,000 with population densities ranging between 169 and 36 per km^2.

(2) Ethnic Groups and Religion

The Oromo people form the major ethnic group (73%) in the Dogda Bora Wereda, followed by Guragie (14%) and Amhara (8%). About 95% of the Wereda population belong to Orthodox religion, followed by Muslims (2%), traditional (1.3%), Catholic (0.8%), and protestants (0.6%).

(3) Literacy Rate

The literacy rate in the Wereda was 22% in 1994. The gender gap in the literacy rate was large (29% for male and 15% for female).

1.5.2 Economic Activities

The economically active population is 68% in East Shewa Zone, 75% in Oromia Region 72% in Ethiopia. While unemployment in 1994 in East Shewa Zone was 6%, Oromia Region 3% and Ethiopia 2%, it was 12% in Meki town (Dogda Bora headquarters).

In Oromia Region, 93% of the total employment was created by agriculture, forestry and fishery sectors in 1994 followed by service sectors: wholesale and retail trade (2%), hotel and restaurant (2%), government employees (1%), and manufacturing (1%).

1.5.3 Farm Economy and Poverty Incidence

In 1995/96, the respective medium class annual income and expenditure for rural households in Oromia Region was Birr 4,700 and 5,300 respectively, while the national average was Birr 4,000 and 4,400 respectively. The income sources in the region are from agriculture (72%), gifts (14%), and non-agricultural income (6%). Major expenditures in the region are on food (53%), followed by rent, fuel, power and water (15%) and clothing and footwear (10%).

1.5.4 Land Holding and Land Tenure

A typical farm household in the study area allocates land to (i) homestead, (ii) crop production,and (iii) fallow and grazing. Farmland usually consists of several scattered plots. Land holding size in the study area is presented in the table below.

< 1ha	1-2 ha	2-4 ha	4-6 ha	6-8 ha	8-10 ha
25%	50%	10%	7%	5%	3%

Source: Dogda Bora District agricultural Bureau, 2000

Major crops grown in the study area are (i) cereal crops (maize, teff, wheat, barley and sorghum (ii) pulse crops (harricot beans, horse beans, peas, chickpeas and lentil), and (iii) vegetable crops (tomato, red onion, cabbage, chilli, carrot, beet root, watermelon, cucumber, eggplant, sugarcane and garlic).

Food crops are grown on about 67,826 ha (83.5% of the total farmland). Of the total food crops, five major crops occupy 95% of the cropland: teff (28%), wheat (24%), maize (27%), harricot beans (12%) and barley (4%). Horticulture occupies only 2.7% of irrigated land and crop intensity in the study area is as high as 83%.

1.5.5 Water Use

The study area has 9 major water bodies that form an interconnected system: Rivers Katar, Meki, Bulbula and Horakelo, and Lakes Ziway, Abijata. The Meki, Katar, Bulbula and Godemso rivers, as well as Lake Ziway are the stable sources of irrigation water. However, increasing competition and conflicts are mounting for these water resources due to competing demands for irrigation, domestic and livestock use, industrial activities, and for protecting precious ecology (especially, in Lake Abijata-Shalla National Park). Only 30% of the population in Oromia region has access to clean water supply, rural areas (24%) and urban centres (78.6%). There are 66 community water supply schemes in Dogda Bora: 45 boreholes, 16 shallow wells and 2 hand-dug wells with 112,000 beneficiaries (71.9%) of the population.

The potential for irrigation development in Oromia Region is large and equals about 1.7 million ha, but only 5% of this potential has been developed so far. Major constraints in irrigation development include, lack of irrigation policy, inadequate research and extension services, lack of inventory of traditional irrigation schemes, poor organisation and management and lack of monitoring and control of irrigation schemes (e.g. efficiency and volume of water use).

1.5.6 Flora and Fauna

(1) Terrestrial Fauna and Flora

Oromia has about 3 million ha of forestry and it is estimated that about 50,000 – 100,000 ha of natural forests are lost annually due to shifting and commercial agriculture, fuelwood collection, forest fires etc. Virtually no extensive areas of undisturbed forest and wildlife habitat remain in the study area. And the area covered by bushlands and shrubs is estimated to be only about 11.3% including various species of Acacia, Boswllia, Commiphora, Balanites, Euphorbia, combbretum, Croton, Oxythantera, and Protea. This represents currently a biomass of between 10 and 50 m^3/ha for woodlands and 5 and 30 m^3/ha for bushlands. Due to the open access system, their harvest has exceeded their annual growth. The annual incremental yields are only 1.2 m^3/ha for woodlands and 0.2 m^3/ha for bushlands. Dogda Bora Wereda with a population of about 162,750 will need to plant at least 9,765 ha to meet the current total demand of 146,475 – 195,300 m^3/year.

(2) Aquatic Fauna and Flora

Only common aquatic flora such as grass weeds, marsh hydrophyte bulrush, and riverine reeds including *Sorghum virigatum* and *Sporobolus* species are prevalent along the rivers in the Study area. Other common species of riparian and swamp vegetation along River Meki and Lake Ziway includes *Ficus sycomorus, F. vasta, Tamarindus indica, Syzyphus mucrnata, Maytenus senegalensis,* and Acacia species. As for aquatic fauna, while there is no information on the ecological and economic importance of fishery in Meki River, Bulbula River and Lake Ziway are reported to have fisheries of economic importance (e.g. Tilapia, Clarias, Common carp, Barbus and Crucian carp). Ziway Lake has a potential fish production of 3,000 tonnes per year, and fishing provides rural employment for about 2,000 people in Oromia Region. Due to ineffective conservation measures, fishing activities along Lake Ziway and River Bulbula are reducing the population and diversity of fish species.

Also, the reduction in water level due to on-going irrigation activities and the frequent droughts are already contributing to the decline in fish population and diversity. The introduction of alien fish species in Lake Ziway is likewise threatening native fish species with extinction.

1.5.7 Watershed Erosion and Sedimentation

According to the preliminary investigations in this study, a tendency of soil erosion at present along the Meki River is not so serious at the proposed weir and intake sites because of the relatively gentle topography. However, in the uppermost catchment area, over 90% of which lies in the Southern region, erosion is observed to be serious as characterised by deep and wide gullies. The effect of erosion and the resultant sedimentation can reduce the lifetime of the proposed diversion weir, and irrigation structures, increasing maintenance and operating efficiency and costs. Since suspended load measurement data for the Project area and erosion rates in the catchment area are unavailable, it is difficult to quantitatively assess sedimentation in the backwater flow at the proposed intake, and silt or run-off downstream area.

1.6 Publications on the Environment and Natural Resources

The number of publications which deal with environmental and natural resources in Oromia Region, and in particular the proposed Meki Project Area are very scarce. Specifically, environmental impacts of dams/reservoirs and irrigation projects in Ethiopia have been documented in limited environmental studies. However, the following studies, which relate to Oromia Region and other parts of Ethiopia may be useful references for the proposed EIA:

(1) FDRE, 1997. The Conservation Strategy of Ethiopia, Vol. I - IV
(2) FDRE, 1997. The Environmental Policy.
(3) FDRE, 2000. Federal Negarit Gazeta, Ethiopian Water Resources Management Proclamation.
(4) FDRE, 2000. Ethiopian Water Resources Management Policy.
FDRE, 2000. The Environmental Impact Assessment Guideline Document
Oromia Council, Bureau of Agriculture, 1998. Land Use and Socio-Economic Aspects and their Impacts on the Biological diversity of Rift Valley Lakes of Oromia (Ziway, Langano, Abijata and Shalla).
(5) Oromia Regional Government, 1999. Regional Conservation Strategy, Vol. I – III.

2. GENERAL BACKGROUND STUDIES AND REPORTS

Some references of special value for the proposed EIA study are listed in the Bibliography and can be obtained from the EPA or the institutions and agencies that prepared them.

2.1 Specific EIA Guidelines

2.1.1 EIA Study Area

Major components of the proposed irrigation development, which covers approximately 3,200 ha are the construction of a diversion weir, an intake, canals, drains and water supply system in the project area. On this basis, the Study area can be broadly divided into the following seven (7) ecological regions as shown in Figure 2.

Region I :	Catchment area of the diversion weir
Region II :	Head work area
Region III:	Meki river channel (from the diversion weir to Lake Ziway)
Region IV:	Proposed irrigation area
Region V:	Lake Ziway system
Region VI:	Bulbula river channel (from the Ziway lake to the Abijata lake)
Region VII:	Abijata- Shalla lake system

2.1.2 Summary of IEE Results

Based on the data and information related to existing environmental conditions and potential impacts of the Project, the significance and magnitude of the impacts have been preliminarily examined using 21 environmental attributes for each of ecological regions. The results of the IEE are presented in Table 1. Of the 21 attributes, the following six (6) *minimum* items are expected to cause significant impacts, largely due change of river flow regime, and will be the focal points for further studies as summarised below.

2.1.3 Conflicts with Water Supply Rights

The diversion of water from the Meki river for irrigation in Region IV will reduce water for downstream users especially, in regions III and VII. This can lead to competition and conflicts among various water users (WUAs of irrigation schemes, the Soda-ash enterprise near Lake Abijata, fishery enterprises, and local communities including pastoralists) within the influence of the project.

2.1.4 Social Impacts

Approximately 2,300 ha in Region IV will be irrigated under the Project. Although this command area is not yet selected, some 1,000 to 2,000 Households (HHs) live within this farmland. No communities will be resettled to other areas, but parts of their farmland will be reallocated to other communities under the project. This may cause significant social impacts in that, the communities will loose part of their land and will have to cope with influx of new people and the resulting social discomfort.

2.1.5 Change of River Flow Regime

The Project will cause a change of current flow regime in the Meki and Bulbula rivers due to diversion of the Meki river for irrigation in Region IV. The magnitude and significance of expected impacts should be established based on ecological studies, hydrological data and plan of operation of the Project. Currently, there is no policy on minimum flow requirements in rivers, and minimum water levels in lakes, and this guideline is urgently needed to ensure equitable apportionment of water resources.

2.1.6 Water Quality Change

Water quality deterioration is expected through changes of existing river flow regime and additional pollution loads from the proposed irrigation area, especially, through a return flow from Region IV into Lake Ziway. This would contain agro-chemicals with deleterious effect on human and animal health. The water in Lake Abijata will also become more saline due to reduced water levels in the lake.

2.1.7 Depreciation of Fisheries

Diversion of the Meki river will cause reduced flow downstream, affecting the ecology of fish. This may reduce fish population and diversity, especially in the lower reaches of the Meki river, Lake Ziway and Lake Abijata. The two lakes are economically important sources of fish. Moreover, reduction of fish in Lake Abijata due to change in water flow into the lake may reduce the current earnings from tourism and diminish the international status of Lake Abijata-Shalla wetlands as a would-be RAMSAR site.

2.1.8 Impacts on Precious Ecology

Like in (2.1.6) above, precious ecology that is host to phytoplanktons, zooplanktons, fish and water fowls in the water bodies in the ecological Regions III and V-VII will be disturbed significantly due to change in water flow regime.

2.2 Technical Specifications for EIA

According to the IEE results, the proposed project falls under Category I (Schedule I), which requires a full EIA, as its adverse impacts may be sensitive, irreversible, and diverse. The impacts relate mainly to reduced water flow for existing irrigation schemes, pastoral and domestic water use, fisheries, and reduction of waterfowl population (especially, Pelicans and Flamingo) in the proposed RAMSAR site. These impacts were identified during the limited period of the IEE, which is characterised by inadequate data, and so, the IEE results are not considered decisive on the project's viability at this stage. Therefore, EIA will be directed to assess the above major issues and the most serious likely biophysical and social impacts.

2.3 Objective of the EIA

The objectives of the EIA are to:

1. provide adequate environmental and socio-economic information to OIDA on how best to safeguard ecological functions, ensure responsible natural resource use and protect the values of the Oromo people by developing a 2,300 ha irrigation scheme;
2. identify mitigation measures to minimise environmental impacts of the project;
3. determine minimum maintenance flow in River Bulbula and minimum water level in Lake Abijata to ensure ecological balance; and
4. assess opportunity costs and trade-offs of conserving Lake Abijata-Shalla ecosystem as compared to the benefits of the proposed Project.

3. SCOPE OF WORKS

3.1 Issues to be Addressed to Improve the Quality of the EIA

The status and trend of the environment and natural resources in the area shall be analysed and both positive and negative impacts of implementing the Project (hereinafter referred to as the "Project") shall be assessed. For negative impacts, mitigatory measures shall be proposed. Special attention shall be paid to the following crucial issues:

3.1.1 Inter-sectoral Coordination

The EIA should promote coordination between different line ministries/bureau at the federal, regional and Wereda levels to prevent or minimise environmental impacts.

3.1.2 The Present Policy, Institutional and Legislative Framework and Future Needs

The EIA should undertake policy and institutional analysis in relation to environmental monitoring and management. Specifically, the EIA should assess:

(1) delivery mechanism – the adequacy of existing policy and laws, which provide the legal requirements for OIDA and WUAs to perform the environmental activities including water use monitoring;
(2) the administrative procedures and organizational structure of OIDA and the Wereda agencies should be adequately assessed for effectiveness and to support implementation of environmental management;
(3) the number of staff assigned to implement environmental management, their experience and motivation; and
(4) if there is need for assistance from NGOs.

3.1.3 Identification of Likely Biophysical and Socio-economic Impacts

The identification and measurement of biophysical and socio-economic impacts of the Project should be systematic. The magnitude of the likely impacts should be determined according to (i) the severity of the impact, (ii) the size of the area to be affected, (iii) the nature of area to be affected (e.g. ecologically sensitive area, etc.), and (iv) the number of people likely to be affected.

3.1.4 Classification of Likely Environmental and Socio-economic Impacts

Each likely impact should be classified as to whether it is potentially significant or too insignificant to require further study, and a detailed justification should be given in classifying any impact as insignificant.

3.1.5 Quantification and Description of Significant Impacts

The EIA report should state the *minimum* impacts that need to be studied further and:

1. confirm the length of time and geographic area over which the significant effects of the Project will be felt by assessing among others, the number of people affected and how much of a particular resource would be degraded;
2. establish how quickly a natural resource may deteriorate and how much time is available for its stabilisation or enhancement;
3. establish: the degree of irreversible damage to ecosystem;
4. quantify as far as possible, all the important biophysical and socio-economic changes (on-site and off-site) of the Project in terms of their physical effects on human health and welfare, and on ecosystems, and when these changes can not be quantified, they should be noted qualitatively and preserved in economic analysis; and
5. evaluate the risk of occurrence for each significant impact – the analysis should determine the likely effects and affected populations for each significant impact.

3.1.6 Quantification of Economic Values of Impacts

To be able to weigh environmental losses and gains against the financial costs and benefits of the Project, the EIA study should include economic evaluation of environmental costs and benefits, which can be quantified. A benefit-cost analysis of the Project, which does not include the values of environmental impacts implicitly values these impacts as zero. The economic valuation will allow the Oromia Regional State and OIDA to compare the environmental trade-offs against more tangible outputs of the proposed project. The following steps may be followed for the economic valuation:

(1) using appropriate economic valuation methods, estimate monetary values of each anticipated environmental and social impacts;
(2) estimate cash flow tables 'with and without' the project in real terms and discounted with a rate reflecting the opportunity cost of capital and the rate of social preference;
(3) the monetized environmental benefits and costs should be pooled with conventional project costs (e.g. capital equipment, operations and maintenance, depreciation), and benefits, and incorporated into the project cost-benefit analysis to give a more accurate picture of a project's true value;
(4) the environmental cost and benefit streams should be compared by standard investment criteria: net present value (NPV) and economic internal rate of return

(EIRR);

(5) a sensitivity analysis must be conducted for key project variables, (environmental & financial); risk and sensitivity analysis should be extended to cover those environmental costs and benefits that can not be valued and such impacts should be described in detail; and risk and sensitivity analysis for both monetised and non monetised impacts should be validated through interviews with key local experts in Ethiopia.

3.1.7 Mitigation Measures

The EIA findings must be followed by the design of mitigatory measures for each impact designed as a safeguard against negative social and environmental impacts. For all adverse effects which are delineated and quantified, the EIA should propose corrective measures including discussion of alternative approaches, the recommended measures, the costs of such measures, and suggested means of financing. The EIA report should demonstrate that, at a minimum, the Project will meet legal requirements for use of water for irrigation and rural water supply and comply with applicable environmental regulations. Ideally the report should demonstrate that the project impacts are mitigated to within sustainable limits.

3.1.8 EIA Timing and Analysis of Alternatives

It is important that the EIA is planned early enough in the project cycle to enable its recommendations to be incorporated into the project design of the diversion weir, irrigation and rural water supply system to minimise costly design changes. Analysis of alternatives should also be undertaken to review the design technology of project components, and evaluate alternatives as viable options to mitigate or prevent impacts and achieve the original Project objectives. In addition to the project options presented in the IEE report, the EIA study is encouraged to identify other alternatives.

3.2 Collection and Analysis of Existing Data

The EIA study shall collect and analyse information on the status and trend on: (i) the environment and natural resources of each ecological region (Regions I-VII) which project will affect; (ii) health and sanitary conditions; (iii) use of agro-chemicals; and (iv) water use and management.

3.3 Analysis of the Impact of Change in River Flow

The EIA will elaborate the significance of the expected change in river flow on down stream development activities and Lake Abijata ecosystem.

3.3.1 Existing Irrigation and Other Development Activities

An inventory of existing irrigation schemes, water user associations (WUAs), Soda

Ash factory and their practices in the study area shall be carefully studied, and recommendations shall be made on (i) water use and management; (ii) irrigation practices; and (iii) water "user pays" policy.

3.3.2 Analysis of the Relationship between Water Level, Surface Area and Ecological Balance

Quantitative information on the relationship between water level and salinity in Lake Abijata and the aquatic life including fishery and waterfowls shall be analysed using computerised models and biological and chemical water quality analysis. Existing data on the status and trend of waterfowl population in Lake Abijata-Shalla National Park shall be collected and analysed using meteorological data and water quality data. Based on information generated from this analysis and water demand for various water users, recommendations shall be made for minimum maintenance flow in Bulbula and Meki rivers and minimum water level for optimum ecological balance in Lake Abijata.

3.3.3 Environmental Cost Benefit Analysis

A detailed environmental cost-benefit analysis shall be made to establish the opportunity costs and trade-offs in conserving Lake Abijata-Shalla ecosystem as compared to the expected economic returns from the proposed project. The main concept applied for assessing opportunity costs is the *opportunity-cost approach*, which uses standard economic analysis, based on market values, to determine the net economic benefits associated with alternative use of one or more resources.

3.3.4 Socio-economic Profile of the Beneficiaries and Environmental Benefit Monitoring and Evaluation

A socio-economic profile of the Study area, especially, Region IV shall be undertaken to establish the actual beneficiaries, social issues and indicators for monitoring benefits. Particular attention should be paid to land allocation and the impact on diminution in land holding, environmentally sustainable management of farmland. The EIA should:

(1) identify a few indicators of the achievement of the Project's output(s), purpose(s) and goal(s) for each environmental management component in the project;
(2) determine if OIDA has an effective system for benefit monitoring and evaluating (i) the delivery and use of water by farmers, (ii) the effects or benefits from environmental protection and irrigation, and (iii) improvements needed;
(3) determine if the WUAs have adequate internal capability for monitoring and managing the delivery, allocation and use of water among members; and
(4) if necessary, specify procedures and indicators to monitor and evaluate the operation and maintenance of the WUAs.

3.3.5 Environmental Monitoring and Management plan (EMMP)

The EIA report should include an environmental monitoring and management plan (EMMP), which should include field observations/sampling/analyses for assessing the actual project impacts during project operations. The EMMP should also describe monitoring of likely environmental stressors, which could be unhealthy, harmful or cause significant environmental damage or loss from implementing the project. The monitoring plan may involve physical parameters such as water levels and salinity in Lake Abijata, water use in the project area, waterfowl population, project benefits etc. The EMMP as the most important part of the EIA should:

1. describe the needed monitoring program including discussion of applicable parameters, field/sampling stations, measurements/analyses, frequency of measurements/sampling, presentation and collation and interpretation of data, format for preparation of monitoring reports, suggested distribution of reports etc.;
   a list of parameters which are comprehensive and should be limited to significant, measurable, achievable elements, based on experience and common sense judgment;
2. present estimates of costs of the proposed monitoring and management and suggestions for assignment of responsibility for carrying out and financing the EMMP;
3. prepare EMMP budget to include (i) mitigation, (ii) monitoring, and (iii) capacity strengthening;
4. specify the duration of the EMMP to correspond to the nature of the impact to monitor;
5. clearly specify that the EMMP should be used as a tool for internalising environmental costs and benefits into the overall economic analysis of the project by being referred to in the legal contracts and budget; and
6. emphasise the need for the EMMP to be implemented on an agreed schedule, by an agreed budget, and by agreed on disciplines.

4. EIA STUDY PROPOSAL

The consultant shall prepare a detailed EIA proposal as summarised below.

4.1 Work Tasks

The proposal for conducting the EIA study should consider the total EIA study as comprising a number of specific tasks, and describe each task sufficiently so that the work effort required to do it can be visualized and quantified. The proposal should also estimate the types and number of professional skills and supporting personnel required along the lines suggested below. Also, summary tabulations should be prepared showing the needs for each task and for the overall job. For the proposed Project, it is envisioned that the following specialized skills will be needed:

1. An environmental analyst with a multidisciplinary background (with an

advanced degree in environmental economics) as a team leader and to carry out environmental cost benefit analysis;
2. A water engineer/irrigation engineer to assess water use demand and changes in water flow regime;
3. An ornithologist to study the impact of the Project on the ecology of waterfowls;
4. A socio-economist to study the socio-economic profile of the beneficiaries; and
5. Counterpart officers from OIDA/EPA.

4.2 Study Team

A description of the proposed EIA study team should be presented, including biodata for all key personnel. Of particular importance is the individual to be in charge of the study. A single individual should be designated as EIA Study team leader, who should be assigned for the duration of the project.

4.3 Involvement of Stakeholders and Beneficiaries in EIA Study

The EIA study should ensure that all parties whom the Project would affect have many opportunities to voice their concern or support of the Project. The EIA proposal should specify how the team will include at least the following steps:

(1) inform all interested parties, including NGOs, communities, legislators and zonal and Wereda agencies about the proposed Project and the potential impacts at the earliest stage in the EIA process (ideally, in the early stages of the Project design);
(2) assist the stakeholders identify their options and what they would like the Project to do to: (i) address the problem that the Project is intended to remedy, and (ii) mitigate project impacts;
(3) provide a forum for these parties to give feedback to the EIA and the design teams;
(4) explain the affected and interested parties how their concerns and input are incorporated in the Project plans;
(5) provide a forum for these parties to respond to proposed project changes, mitigation measures, and monitoring plans; and
(6) provide a tentative schedule for these community involvement tasks.

4.4 Identification of Training and Institutional Needs

The EIA Study should identify the training, materials and equipment, institutional arrangements, and legislative/regulations needed to properly implement the EMMP. The EIA should evaluate these needs in the relevant regulatory agencies including the EPA, OIDA, Regional, Zonal and Wereda agencies, and at community levels.

4.5 Study Schedule

The study proposal should by means of appropriate bar graphs and simple critical path charts, the proposed plan for carrying out the EIA study should be indicated, so that the project will be completed within the period required (see Section 4.8 below).

4.6 Review Sessions

For expediting acceptance of the EIA report, the project work plan should provide for periodic reviews of the study at seminars or workshops to be attended by representatives of EPA, OIDA and relevant agencies of the FDRE and Oromia Regional State (e.g. Ministries of Water Resources, Agriculture, Health, etc.) and advisors as may be desirable.

4.7 Printing or Reproduction of EIA Report

The EIA budget should include provision for reproduction or printing and delivery of the final EIA report in six (6) copies in English with a floppy disk of format 1.44 MB within seven (7) days after the receipt of comments on the draft report.

4.8 Time Constraints

The EIA report for the Project should be completed within six (6) months.

4.9 Budget

The estimated budget for the EIA study is approximately US$150,000. For this amount it is expected that an EIA report can be prepared which will meet EPA and OIDA requirements. The proposals will be evaluated on the basis of the quantity and quality of work proposed within the budget.

Table 1 Result of IEE of Meki Irrigation and Rural Development Project

Environmental Items	Catchment Area Region-I	Headworks Area Region-II	Meki River Channel Region-III	Irrigation Area Region -IV	L. Ziway system Region-V	R. Bulbula Channel Region-VI	Abijata-Shalla System Region-VII
A. PROBLEMS DUE TO PROJECT LOCATION							
1. Impacts on minority ethnic group	x	x	x	x	x	x	x
2. Resettlement	x	x	x	x	x	x	x
3. Impacts on land use	++/B	x	--/C	++/A	--/C	--/C	--/C
4. Impairment of transport system & existing infrastructure	x	++/C	x	++/C	x	x	x
5. Inundation of minerals	*	x	*	x	*	*	*
6. Inundation of historical assets	*	x	*	x	*	*	*
7. Encroachment on precious ecosystem	x	--/C	++/C	++/C	++/C	x	x
8. Watershed erosion & sedimentation	x	x	*	x	*	*	*
9. Conflicts with water supply rights	--/C	x	--/C	x	--/C	--/B	--/B
B. PROBLEMS RELATED TO CONSTRUCTION							
10. Air pollution, noise & vibration	*	--/C	x	--/C	*	*	*
11. Soil erosion & silt run off	x	--/C	--/C	--/C	--/C	x	*
12. Sanitation in workers' camp & wastes	x	--/C	x	x	x	x	*
13. Aesthetics & Landscape	*	x	x	x	*	*	*
C. PROBLEMS DUE TO PROJECT OPERATIONS							
14. Change of river flow Regime	*	--/B	--/A	*	--/B	--/A	--/A
15. Deterioration of down stream water quality	*	*	--/B	*	--/B	x	--/B
16. Depreciation of Fisheries	*	x	--/C	*	--/B	x	--/B
17. Impacts on precious Ecology	x	x	x	x	x	x	--/B
18. Eutrophication of back water flow	*	--/C	*	*	*	*	*
19. Vector borne parasitic diseases	x	--/C	x	--/C	*	*	*
20. Change of micro Climate	X	x	x	x	x	x	x

Notes:

++/A	:	Upper parts stands for the direction of impacts and the lower part shows the magnitude of impacts
A	:	Relatively high magnitude of impact expected
B	:	Relatively moderate magnitude of impact expected
C	:	Relatively low (minor) magnitude of impact expected
X	:	No effect is expected
*	:	No relationship
++	:	Positive effect is expected
--	:	Negative effect is expected

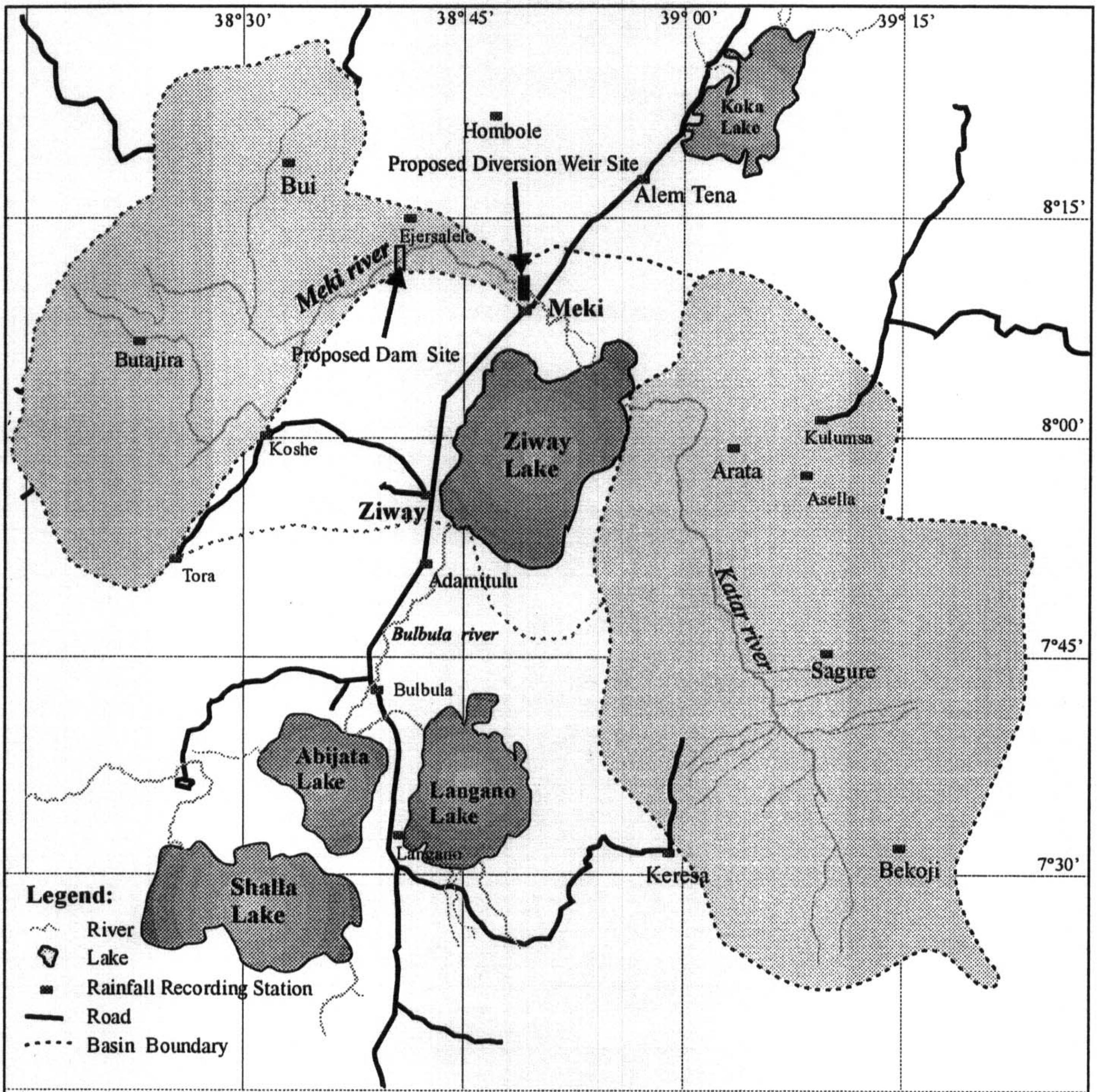


Figure 1 Project Area

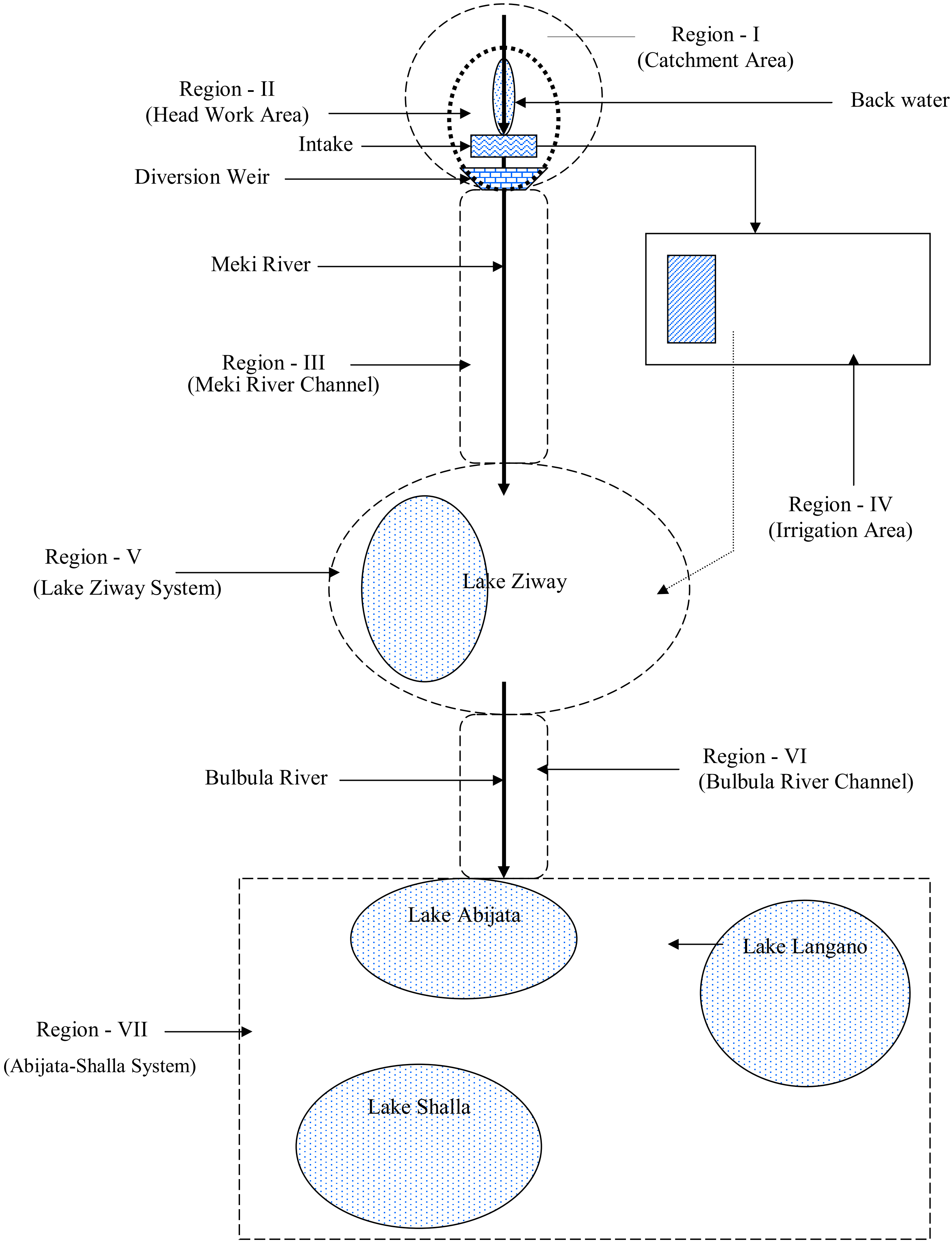


Figure 2 Ecological Regions of the Project Area

ATTACHMENT 2

TECHNICAL GUIDELINES FOR ENVIRONMENTAL CONSERVATION AND SOCIAL ENVIRONMENT

1 Watershed Management

1.1 Concept of Watershed Management

A watershed or catchment is any surface in which rainfall is collected and conveyed to a common waterway surface. One catchment is separated from another by a crest line that marks the highest point of the land. It can vary from a few hectares to several thousand square kilometers in size. The main causes of watershed degradation like in Ethiopia stem from indiscriminate human interference with the natural ecological balance, from abuse and mismanagement of the forests, soils, and grazing land, and at times, from extending settlements into watershed areas.

1.2 Objectives of Watershed Management Plan

To improve soil and water conservation in water catchment areas including grazing land to ensure sustain agricultural production in Dogda Bora Wereda, Oromia Region.

2 Watershed Management Practices

There are two main implications of improper or inadequate watershed management: (i) sedimentation in reservoirs, irrigation canals, and (ii) changing patterns of stream flow. Sedimentation reduces the storage capacity of reservoirs, block intake of diversion weirs or dams, significantly reducing the operation of these systems. This often increases the cost of operation and can seriously damage economic and long-term sustainability or life span of irrigation or hydropower projects. Therefore, it will be necessary to take the following watershed management measures to address these problems.

2.1 The Catchment Approach

The "Catchment Approach' as applied in Kenya is comparable to the "Top-down" approach now used by WFP in Ethiopia. The catchment approach aims to systematically and effectively conserve one area at a time, so as to hasten the pace of conservation and to increase production in a sustainable manner with minimum damage to the environment. The main actors within the catchment are the farmers who individually and/or collectively identify their own needs, prioritise them, mobilise the needed resources and the technical input from extension personnel to execute the task. The conservation measures suggested is often comprehensive and includes plans for crops, livestock, pastures and incomes.

2.2 Gully Control: Runoff Control

The first step in controlling a runoff is to identify the catchment of the gully, whether cropland, grazing land, roads, compounds or a combination of these. There are three ways of controlling runoff; (i) conservation of the water within the catchment of the gully, (ii) diversion of the water from flowing into the gully, (iii) conveyance of the water through the gully.

(1) Conservation of Water within the Catchment

Most gullies develop because of inappropriate use of cropland or grazing land or because of uncontrolled runoff from roads or compounds. If the catchment can be treated to retain more of the water, the control and reclamation of a gully will be easier.

Runoff from cropland can be reduced by agronomic and vegetative measures, such as mixed cropping, mulching and grass strips, together with structural measures such as retention ditches and level bench terraces.

Runoff from grazing land will only be a problem where grass cover has been destroyed through over-grazing, trampling, burning or prolonged drought. Such conditions lead to surface sealing. Good pasture management, which balances livestock numbers with the potential of the land, will help in controlling runoff. Attention should also be given to the proper location of watering points and water harvesting structures. Bare ground should be re-seeded with drought resistant grasses.

Proper management of road runoff is important. Instead of concentration the water through one culvert or mitre drain, the water can be shared by farmers along the road so that each farmer gets a portion of the runoff. This can usually be infiltrated in the farm using appropriate structures such as retention ditches. Scour checks in road drains also reduce runoff velocity and improve infiltration in the road reserve. This can reduce the amount of waster entering the farmland.

Water from compounds and built-up areas causes gullies because there is limited chance for infiltration. Where possible the runoff should be spread over a wide area. Alternatively, excess water can be diverted safely through a well-designed drainage system. Collaboration between authorities responsible for the infrastructure is very important. Rainwater harvesting from roofs will also help to reduce the volume of runoff to be handled and at the same time conserve clean water for drinking.

(2) Diversion of Water from Flowing into the Gully

In some situations, it is not possible to conserve the water within the catchment either because there is a high discharge at a specific point or because retention of water might lead to crop damage or cause a landslide. The runoff must then be diverted from the gully ahead by use of a diversion ditch. Careful consideration should be given to the disposal area. Unless a safe disposal area can be provided no attempt should be made to construct a diversion ditch as it could cause other gullies. A typical diversion ditch is depicted in Figure 1.

Conveyance of Water through the Gully

If it is not possible to infiltrate the water in the catchment or divert it away from the gully ahead, it must be conveyed through the gully without causing any further erosion (paragraph (3)). This is only possible if the gully head, floor and sides have been stabilized.

2.3 Gully Control: Gully Stabilization

Stabilization involves the use of appropriate structural and vegetative measures in the head, floor and sides of the gully. Though structures are often necessary in gully stabilization their long-term effectiveness is limited by inherent weaknesses. They can be undermined or by-passed by heavy runoff, and if made of poles they can be destroyed by termites. However, the effectiveness of vegetation improves with time as it establishes and spreads. The structures therefore give temporary relief while vegetation becomes established. They also create conditions that improve water infiltration and deposition of the silt load in the flowing water. This is conductive to re-vegetation and reclamation of the gully. Since vegetation is so important it will be discussed before structures.

(1) Use of Vegetation in Gully Control

The use of vegetative material in gully control offers an inexpensive and permanent protection. Vegetation will protect the gully floor and banks from scouring. Grass on the gully floor slows down the velocity of runoff and causes deposition of silt. It can also be of economic value to the land user. There are two ways of establishing vegetation in the gully: (i) natural recover and (ii) use of planting material. A gully will re-vegetate naturally if the water causing erosion is conserved or diverted before it reaches the gully and if livestock are kept away. Costs are minimal but recovery will be slow if the soil is poor. Furthermore, if the gully sides are steep, vegetation may not establish itself.

Where establishment of natural vegetation is too slow to cope with the erosion or where a particular species is desired, planting should be done. The establishment of vegetation either naturally or artificially has to contend with the hostile environment. The top soil has been eroded away leaving sub soil that is usually lacking in plant nutrients and organic matter and has poor water holding capacity.

In selecting the type of vegetation the conservationist will be guided by the use to be made of the stabilized gully. Material for the floor should grow thickly and should have a deep and dense rooting system. It should have a spreading habit and form a mat. Examples of common grasses used are Star grass (*Cynodon* spp.), Paspalum spp, Kikuyu grass (*Pennisetum clandestinum*) and Rhodes grass (*Chloris gayana*). Although Vetiver (*vetivaria zizanioides*) is not a spreading grass, it can be used to form barriers at intervals across the gully floor. Where the inflow has been stopped, Napier grass (*Pennisetum purpurem*) can be useful but if there is a high discharge, it may cause runoff to cut round the sides and enlarge the gully. In such a situation it can be planted at the foot of the sidewalls. In dry areas, grasses may be difficult to establish and succulents such as sisal and finger Euphorbia (*E. tirucalli*) can be useful. Trees should not normally be planted in the bed of the gully but can be planted on the gully sides if they are not too steep.

(2) Planting techniques

To overcome the hostile gully conditions and give vegetation the best chance to thrive, special planting techniques are needed. Some bank sloping can be done to create conditions under which vegetation can establish. Planting splits or seedlings is usually better than trying to establish vegetation directly from seed. The desired plant species, if not available locally, can be established in a nursery.

The splits or seedlings are transplanted into holes, in the gully floor or sides, which are filled with good soil collection from elsewhere. This technique can be carried a step further where sacks, filled with fertile soil, can be embedded flush with the gully deposition, structural measures may also be necessary. Vegetation should be established after the period of peak rains when there is still sufficient water for growth but less risk of damage from storms.

(3) Structures for Gully Stabilization

To give vegetation an opportunity to establish, runoff control structures may be needed in the gully. Gully control structures are either temporary or permanent. Temporary structures are not watertight and are expected to last just long enough to allow vegetation to establish. Permanent structures are used where the temporary ones cannot work because of poor or unstable soil or the gully is a natural waterway and runoff cannot be diverted elsewhere.

The choice of the measures and extent of their use will depend on the amount of the runoff and the status of the gully whether young and actively eroding or mature and stabilizing naturally. Good judgment is required in determining what inexpensive measures to use. Ways of stabilizing the gully head, floor and sidewalls should be considered. The gully head is often the most difficult to handle, especially if it is above 2 m high because of the erosive power of falling water. Control structures for large gullies require an engineering design, and are costly.

If the stabilization of a gully head appears too costly or difficult, there are two approaches. One is to divert runoff away from the gully head so that it ceases to erode. The other is to place a check-dam close enough to the gully head so that it will trap sediment, raise the floor level and submerge the head. The following recommendations are for the stabilization of gully heads where runoff cannot be arrested or diverted.

(4) Check-dams

Check-dams are constructed across the floor of the gully to reduce the gradient, slow the runoff and trap sediment. They facilitate the establishment of vegetation, which will eventually stabilize the gully and protect it from further erosion. They can also be used to build up the floor of the gully to the original ground level. Care is needed in the design and construction of check-dams to avoid waste of resources and to ensure that they function as intended. The following types of check-dams are used in gully control. The first five are the most common: (i) single row post-brush check-dam, (ii) double row post-brush check-dam, (iii) double row post-stone check-dam, (iv) single row post-stone check-dam, (v) stone wall check-dam, (vi) cushion dams, (vii) masonry dams, (viii) gabion dams.

The following points should be considered when designing check-dams:

- Catchment area and peak flow: flows of > 1 m^3/s will require post-stone check dams.
- Actively eroding gullies with steep gradients need stronger and durable check-dams.
- Durability of structure: the structure should withstand pressure until vegetative cover can establish: where vegetation is slow to establish, post-stone check-dams are advised.
- Availability of materials: Wherever possible locally available materials should be used.
- Costs: gully control is expensive and therefore cost-effective measures should be used.
- Where the gully is used as a permanent waterway, the structures should be permanent.
- Live posts, which root and grow are useful: if timber posts are used they must be treated against termites and decay. Stone is preferable as brushwood lasts a short time.

<u>Check-dam Spacing</u>**:** The spacing of the check-dams should be such that the spillway crest of one check-dam is level with the base of the next check-dam upstream. The following table can be used to determine the spacing of 3 types of check-dam. The percentage gradient is the gradient of the gully floor.

(5) Types of Check-Dams for Stabilizing Gully Floors

<u>Single row post-brush check-dam</u>**:** These check-dams can be used where the flow is less than 0.5 m^3/s. The structure is temporary and its durability will depend on the quality if posts used. If possible live posts should be used. Otherwise they must be treated. Flexible branches are cut and woven around the posts.

Spacing Check Dams

	Height of crest above gully floor								
	0.3 m	0.3 m	0.3 m	0.6 m	0.6 m	0.6 m	0.9 m	0.9 m	0.9 m
Gradient Of floor %	Wood & Gabion	Post-brush stone	Stone wall with 1:1 slope	Wood & Gabion	Post-brush/ stone	Stone wall With1:1 slope	Wood & gabion	Post-brush/ stone	Stone wall With1:1 slope
4		15			30			45	
6		7.5			15			23	
8		5.2			10			15	
10		4.0			7.7			12	
12		5.2			6.3			9.3	
14		2.7			5.3			7.8	
16		2.3			4.6		6.7		7.4
20		1.8		3.7		4.5	5.4		6.7
24		1.7		3.7		3.9	4.5		6.1
28	1.4		1.7	3.1		3.4	3.9		5.4
36	1.1		1.5	2.1		3.0	3.0		4.4
40	1.0		1.4	1.9		2.9	2.7		4.2

Source: Wenner, 1984

Double row post-brush check-dam: These check-dams are suited where flow is less than 1 m^3/s. The construction of the dam starts with an excavation in the floor and into the sides of the gully to a depth of 0.3-0.5 m. Two rows of posts, 5-10 cm in diameter are hammered, or put into holes, across the floor of the gully to a depth of 0.5 m. The height of the posts in the centre should not exceed the height the spillway or the flow may be blocked and water may be forced round the sides. The spacing between the posts is 0.45 m. After the posts have been put in position, a bed of straw is laid in the excavation. Brushwood or branches are packed between the posts, the smaller ones being put at the bottom and larger at the top. To prevent the brushwood being washed away a wire can be used to join the two rows of posts at the top. large stones can also be placed on top to serve the same purpose. Figure 2 shows the construction features of the check-dam. The spacing of the check-dams will depend on the gradient of the gully. The dam should have a spillway whose depth will depend on the expected flow as shown in the following table.

Depth of Spillway Required for Different Widths and Discharges
(Figures in body of table are discharges in m^3/s)

Depth of Spillway (m)	Average Width of spillway (m)						
	0.6	1.2	1.8	2.4	3.0	3.6	4.8
0.15	0.05	0.10	0.15	0.20	0.25	0.30	0.35
0.30	0.10	0.25	0.40	0.50	0.60	0.75	0.90
0.45	0.20	0.50	0.70	0.90	1.20	1.40	1.50
0.60	0.35	0.70	1.10	1.50	1.80	2.20	2.50
0.75	0.60	1.50	2.00	2.70	3.30	3.90	4.70

Source: Wenner, 1984

Example: If width of spillway = 2.4 m
Discharge = 0.9 m^3/s
Then, depth of spillway = 0.45 m

Single row post stone check-dam: An excavation 0.5 m deep and 0.3-0.5 m wide is made across the floor of the gully where the check-dam is to be constructed. A row of posts is hammered 0.5 m into the ground on the downstream edge of the excavation. The distance between the posts is 0.3 m. The posts are strengthened by nailing wooden cross-members. Small stones are laid first in the trench for close contact with the ground. The big stones and boulders are laid on as carefully as possible to minimize voids between them. The posts and stones should reach 0.5 m into the sides of the gully. The central spillway must be lower than the sides. The depth of the spillway can be determined from the above table. An apron filled with stones should be provided at the downstream side (Figure 3). The apron is constructed on an excavation 0.5 m deep. Small stones should be laid first followed by the big stones. This arrangement is important to offer strength to the apron and prevent undermining.

Double row post-stone check-dam: The use of a double row of posts means that fewer stones will be needed. The design procedure is the same as for the brushwood check-dam. The only difference is that instead of brushwood, stones are used (Figure 4). The stone fill should reach 0.5 m into the sides of the gully and 0.5 m into an excavated trench across the gully. This will prevent the dam from being by-passed round the ends or undermined from below. The stones must be very carefully packed with small stones at the bottom and filling the spaces between the big ones above. As mentioned earlier, the posts should not protrude above the spillway to avoid obstruction of the flow.

A stone apron or stilling basin should be provided on the downstream side. This apron will prevent the undermining of the dam. If only small stones are available, a wire mesh can be placed across the rows of posts to hold the stones in position. This check-dam is stronger than the double-row post-brush check-dam. However, its durability depends on the quality of the posts. The two rows of posts should be tied together with wire as shown for a brushwood check-dam in Figure 2.

Stonewall check-dam**:** This check-dam is recommended where stones are abundant, discharge is low and the slope is gentle. It is constructed by laying stones carefully across the floor of the gully. Spaces between the large stones should be filled with small ones (Figure 4). The construction starts with an excavation across the floor into the sides of the gully. The trench should be not less than 0.3 m deep and 0.5 m wide and should reach 0.5 m into the gully sides. The small stones and pebbles are laid out first on the excavation. The big stones are carefully packed to minimize voids. If large stones are not available the check-dam can be encased in wire mesh to prevent the stones from being washed away. An apron should be provided.

Cushion check-dam**:** This is temporary measure for humid areas while vegetation is being established. /the most common type is made of gunny bags filled with soil. The bags are laid across the floor of the gully such that a spillway is formed at the middle. The bags are held in position by a single row of posts. An apron of stone should be provided downstream.

Masonry and gabion check-dams**:** Masonry structures are relatively expensive and should only be used if sand and stones are readily available and no other method is feasible. Such masonry structures have been used successfully by some farmers. A masonry dam must have a strong foundation; otherwise it can crack or be undermined. Gabion structures are also expensive. Although they have the advantage that they can be used without a special foundation there can be difficulties if dimensions of the gabion boxes do not fit conveniently into the gully. Gabion structures must be properly embedded into the floor and sides of the gully and be provided with an apron on the downstream side as with other check-dams. The stones should be carefully packed so that there are no voids through which water can jet and undercut the dam. For the same reason sods of earth should be packed tightly on the upper side (Figure 5).

3 Proposed Designs for Different Structures in Soil and Water Conservation

3.1 Design of Fanya Juu Terraces

(1) Definition and Functions of Fanya Juu Terraces

A *fanya juu* terrace is made by digging a trench and throwing the soil uphill to form an embankment. The cross-sectional profile comprises an embankment to impound water, soil and nutrients; a storage area above the embankment to prevent overtopping by runoff and a berm or ledge to prevent the embankment soil from sliding back into the trench (Figure 6). The trench below the embankment may or may not be retained. *Fanya juu* terraces are sometimes called converse terraces. A *fanya juu* terrace is often the first stage in the development of a bench terrace.

Fanya juu terraces are very popular on smallholder farms particularly in semi arid areas in Kenya and now in Ethiopia where they are very effective in conserving moisture and nutrients. They are applicable in areas where they are very effective in conserving moisture and nutrients. They are applicable in areas where soils are too shallow for level bench terracing and on moderately steep slopes (e.g. below 20%). They are not suitable for stony soils. They normally develop into outward sloping bench terraces after a few years depending on the amount of soil, which moves down slope and lodges above the embankment. There is currently no rigid distinction between a *fanya juu* terrace and an outward sloping bench terrace but the latter should have reduced the slope of the cropland. If well maintained, fanya juu terraces can also develop into level bench terraces.

The choice of *fanya juu* terraces by farmers in different agro-climatic zones of Ethiopia is influenced by many factors such as the need for moisture conservation, the depth and erodibility of the soil, the slope of the land, and the availability of labour. Some farmers prefer to enlarge the trench from which the soil has been dug and used as a retention ditch for planting bananas. They may even channel water into these ditches from roads or compounds. Others prefer to dig soil from a shallower but wider area and level the ground so that the whole area between the terraces can be cropped in the same way.

(2) Design of Fanya Juu Terraces

Fanya juu terrace dimensions: Although *Fanya juu* terraces are widely used in Ethiopia especially under the WFP, little attention has been paid to the design principles. Essentially, the terrace should be designed to trap runoff above the embankment because if it passes over the top the terrace will be eroded. Furthermore, if there is no trench below the embankment the runoff will pass on down-slope and cause further damage. The first step is to determine storage capacity required above the embankment and the second is to determine how high the embankment should be on the upper side to provide the required storage. The following procedure is based on the assumption that the terrace is designed to retain water and not to discharge it. For dry areas this is usually the aim.

The cross-sectional storage area required above the embankment can be found if the distance between the terraces, the slope of the land and the infiltration capacity of the soil, whether good, fair or poor, are known.

With these details, the height of the embankment on the upper side can be determined from the following table. Also, the following section gives an example of a *fanya juu* terrace design.

Fanya Juu Terrace: Typical Dimensions and Labour Required for Different Situation

Land Slope (%)	Terrace Spacing VI (m)	Terrace Spacing HD (m)	Trench excavated to build terrace Width (m)	Trench excavated to build terrace Depth (m)	Trench Area (m^2)	Shoulder bund height (upper side) to retain runoff when infiltration Low	Medium	High	Labour days per 100 m	Labour days per ha
5	1.00	20	0.50	0.50	0.25	32 cm	29 cm	26 cm	8.3	42
10	1.35	14	0.50	0.55	0.28	37 cm	34 cm	30 cm	9.3	66
15	1.73	12	0.60	0.55	0.33	41 cm	38 cm	33 cm	11	91
20	1.80	9	0.60	0.60	0.36	41 cm	37 cm	33 cm	12	133

Notes. The figures for terrace spacing are based on the terrace spacing with a VI of 1.8 m, which allows the terraces to develop into level benches in time. The dimensions of the trench are typical but can be varied to suit local conditions. The shoulder bund height to trap runoff is based on a 1 hour storm of 65 mm with a return period of 10 years. Where the rainfall amount is lower the bund height can be reduced slightly. The infiltration rates assumed are 10 mm/h (low), 20 mm/h (medium) and 30 mm/h (high). The labour required is based on an assumption that one person can dig 3 m^3 per day.

Fanya Juu Terrace Design Example

A farmer in a semi-arid part of Machakos district has decided to terrace his 0.4 ha cultivated land. In order to prevent erosion and to retain rainfall in situ, he decides to make fanya juu terraces and requests assistance with the layout. The slope of the land is 15% and the proposed spacing of 12 m between terraces is acceptable. The soil has a high infiltration rate. A line level is used to mark out terraces that are exactly on the contour and the farmer is advised to dig trenches 60 cm wide and 55 cm deep. The embankment created by throwing the soil to the upper side should be well compacted during construction to prevent breakage during the rainy season and it should have a small berm to prevent soil falling back into the trench. The top of the embankment (shoulder bund) should be 33 cm above the ground on the upper side in order to retain the expected runoff without overtopping. The farmer decides to plant Makarikari grass to stabilize the embankment and to plant bananas in the trenches. The digging is estimated to take about 40 man-days and he thinks that he and his son can complete the job in about one month. Planting grass and bananas will be done when the rains begin.

Fanya Juu Terrace Spacing

If *fanya juu* terraces are made with the intention that they should gradually develop into bench terraces then the spacing should be appropriate for level benches and the vertical interval should not be more than 1.8 m. However, terraces are sometimes made at twice this spacing on the assumption that a further terrace will be constructed in between at some time in the future. In this way the demands for labour can be spread over a longer period, but this procedure is not ideal because of the risk of breakage during heavy storms.

Fanya Juu Terrace Gradient: *Fanya juu* terraces can be graded at 0.4% to discharge runoff but where they have proved most useful, in the semi-humid and semi-arid areas, they are normally made with zero gradient, i.e. level from end to end.

Notes on the Design of *Fanya Juu* Terraces and Retention Ditches

The following notes explain how the figures in the above table were derived and the assumptions used. The following notes are based on the assumption that *fanya* *juu* terraces and retention ditches should be designed with zero gradient to retain the heaviest storm rainfall that can be expected in a 10 year period. This is referred to as the design storm. The design storm should be the one, which leads to the greatest *volume* of runoff. Storms with the greatest intensity in mm/h are of short duration, but provide a small amount of rainfall and are not likely to produce the largest volume of runoff. Storms of lower intensity but longer duration will provide more rain but also allow more time for infiltration to occur. The volume of runoff to be stored by the structure will therefore depend on the duration of the storm, the intensity of the storm and the infiltration capacity both of land producing runoff and the structure, which is designed to retain it.

Data on rainfall intensity and duration is available from the Rainfall Frequency Atlas of Ethiopia. Data on infiltration is available from various experiments. Although the data available is still quite limited it suggests that for a *fanya juu* terrace the design storm should be that with duration of 1 hour (or occasionally 3 hours) whereas for a retention ditch the design storm duration should be 6 hours. The difference arises because with the *fanya juu* terrace the emphasis is on the infiltration over the whole area between the structures whereas with the retention ditch the focus is on the infiltration within the ditch itself. The procedures discussed below should be treated as provisional until a more comprehensive analysis has been carried out.

Design of Fanya Juu terrace

If the terrace embankment is well compacted during construction and properly stabilized with grass it should be able to retain runoff and prevent it overtopping. The key factor is the depth of storage above the embankment. The following equation has been developed for finding the depth of storage (d).

$$d = [2A/(\cot\alpha + 1)]^{0.5}$$

where:

d = depth of storage above the embankment (m)

A = cross-sectional area of storage required (m^2)

α = the slope of the ground in degrees

$\cot\alpha$ = the co-tangent of the slope (i.e. the reciprocal of the tangent)

The areas of storage $A = (R-I) \times L$

where: R = maximum depth of rainfall in 1 hour for 10 year period (m)

I = maximum depth of infiltration between terraces in 1 hour (m)

L = spacing between terraces (m)

(3) Example of Fanya Juu Terrace Design

A farmer near Machakos plans to install fanya juu terraces to capture all runoff. The peak rainfall amount for a 1-hour storm with a 10-year return period is 65 mm. The slope of the ground is 10% (5.7˚) and the terrace spacing is 14 m. The soils are estimated to have moderate infiltration of 20 mm/h.

- Find the area of storage required $A = (0.065 - 0.020) \times 14 = 0.63\ m^2$
- Find the cotangent of a 10% slope. A slope of 10% is equivalent to a tangent of 0.1 and the cotangent is 1/0.1 = 10
- Find the depth of storage required $d = [(2 \times 0.63)/(10 + 1)]^{0.5} = 0.34\ m$

This is the procedure used to compile the table above.

Note that no freeboard has been added. It is assumed that on the rare occasions when overtopping may occur, runoff can be trapped in the ditch below the embankment which many farmers use for planting bananas. However, not all farmers leave the ditch below the embankment. Some prefer to level off the ground to make more room for crops such as maize and beans. In this situation, a freeboard of 10 cm should be added. If runoff is not trapped above the embankment, it must be trapped below the embankment. It should not be allowed to pass from one terrace to the next, overtopping each and accumulating greater volume and power to erode as it proceeds. If the farmer prefers to rely on the ditch to trap runoff then the ditch must be made large enough (as explained for retention ditches) and the embankments must be very well grassed so that they will not erode. However, trapping runoff above the embankment should be the aim because in this way soil is trapped and the development of bench type terraces is facilitated.

3.2 Design of Retention Ditches

The design of retention ditches is based on the heaviest rainfall that can be expected in a 10-year period. The table in (2) above is based on an assumption of 30% runoff from the area of land or catchment, which contributes runoff to the ditch. This is arbitrary but calculations for different runoff percentages can also be made if required. The retention ditch is assumed to have a bottom width of 0.5 m. The storage required will depend on the rate rates of 5, 10 and 20 mm/h have been used for the purpose of calculation. It is assumed that both the rainfall rate and the infiltration rate are uniform throughout the storm period, and the volume of storage required is therefore the difference between the total volume runoff reaching the ditch in a 6 hour storm and the total volume of water lost by seepage during the same period.

3.3 Labour Costs for Excavation of Bench Terraces

Bench terraces can either be constructed by excavating soil or developed from grass strips of fanya juu terraces by the natural process of erosion and deposition.

Although the former method involves much more labour and may affect soil fertility if topsoil is buried, the method gives quick results and is sometimes used where labour is available. As the labour input is high it is useful to estimate the cost in terms of cubic metres of soil to be moved under different situations. The following equation applies.

$$V = h^2 / 8[(1/\tan \alpha \ - (1/\tan \phi)]$$

where:

V = vol cut per m terrace (m^3)

α = slope of land in degrees

ϕ = slope of riser in degrees

The following table shows the terrace dimension and quantities of earth to be moved on different slopes within 1 m and 2 m vertical intervals. The rise angle is kept constant at 0.5:1 (63˚). The labour required has been calculated on the assumption that one man can move 3 m^3 per day but this will vary depending on local circumstances. The figures should be taken as an approximation.

Labour Requirements for Excavation of Bench Terraces on Steep Slopes

Slope (%)	VI (m)	HI (m)	Riser width (m)	Bench width (m)	Vol. cut per m length (m3)	Length bench per ha (m)	Vol. cut per ha (m)3	Labour required (man days/ha)	Area of riser as % of total area (%)
20	1	5.0	0.5	4.5	0.56	2,000	1,120	373	10
30	1	3.3	0.5	2.8	0.35	3,000	1,061	353	15
40	1	2.5	0.5	2.0	0.25	4,000	1,000	333	20
20	2	10.0	1.0	9.0	2.25	1,000	2,250	750	10
30	2	6.7	1.0	5.7	1.42	1,515	2,151	717	15
40	2	5.0	1.0	4.0	1.0	2,000	2,000	667	20
50	2	4.0	1.0	3.0	0.75	2,500	1,875	625	25
60	2	3.3	1.0	2.3	0.58	3,030	1,757	585	30

The following conclusions can be drawn from the above table:

- Assuming the VI and riser angle remain constant, the % of land taken by risers increases with increasing slope.
- For any given slope, the same amount of land is taken up by risers whatever the VI.
- The number of man days per ha of land terraced doubles (approximately) if the VI doubles.
- Although wider spacing involves higher risers and more labour it facilitates cultivation and leads to less competition between crops and riser vegetation.
- In unstable soils reduced VI and lower risers or reduced riser angle will be needed.
- In stable soils reducing VI will allow steeper riser angles e.g. 0.2:1 (80˚)

3.4 Design of Check-Dam Spillway

(1) The table in 3.2.3 (5) above has been calculated using the equation for a broad-crested weir:

$q = CLh^{0.67}$ and therefore $h = (q/1.65L)^{1.5}$

q = discharge (m^3/s)

L = width of spillway (m)

h = height of water above weir crest (m)

C = discharge coefficient for broad crested weir (this is taken as 1.65)

The depth of spillway (d) is found by adding a freeboard (f) of 20-25 cm as a safety margin to the height of water (h) determined above.

(2) Example

A gully is 2 m deep and 3 m wide and the estimated discharge of runoff (q) into it is 1.8 m^3/s. The slope of the land (S) is 20 per cent. What should be the depth of spillway (d) and the spacing of check-dams (D)?

Let the length of spillway (L) be 2 m. This will allow shoulders of 0.5 m on either side.

$h = [1.8/(1.65 \times 2)]^{1.5}$

h = 0.4 m

Depth of spillway = h + f = 0.4 + 0.2 = 0.6 m

Let the height of the check-dam above the gully floor of the next above, and then the distance between them (D) is calculated as follows:

S = 100H/D therefore D = 100H/S = 100/20 = 5 m.

Where, d = depth of spillway

h = maximum height of water above spillway

f = freeboard

L = length of spillway crest

3.5 Labour Costs of Terracing by the Fanya Juu Method

(1) The Cost of Terracing

The cost per hectare for terracing made by hand labour depends on the method of construction, the slope of the land, the spacing of the terraces and the ease or difficulty of digging. Fanya juu terraces can be made by digging a small trench or a larger one depending on the labour available, and whether the aim is to develop level bench terraces as soon as possible, or to allow the more gradual formation of terraces over a longer period.

The figures in the following table are based on an assumption that the trench to be dug is 0.6 m deep and 0.6 m wide. It therefore has a cross-sectional area of 0.36 m^2. Assuming that a man can dig 3 m^3 per day, he will construct 3/0.36 = 8.3 m per day. The figures can be adjusted up or down if the circumstances are different. For example, if the trench dug is 0.5 m deep and 0.5 m wide with a cross-sectional area of 0.25 m^2, the length constructed each day would be increased by a factor of 0.36/0.25 m^2, the length constructed each day would be reduced by a factor of 0.25/0.36 = 0.69.

The following table shows the labour cost in man-days for three situations. In the first, the VI between terraces is based on the formula for terrace spacing below. In the second, the VI between terraces is based on half the above which would be appropriate where the objective is too develop level bench terraces without delay. In the third situation, the VI is fixed at a maximum of 1.8 m which would be appropriate for bench terraces but allow them to be spaced further apart at low slopes. In all situations the work output is assumed to be 8.3 m per man-day. The cost in shillings can be found be multiplying the figure for man-days per hectare by the daily wage for casual labour.

Labour Costs of Terracing by the *Fanya Juu* Method.

Normal terrace spacing				Terrace spacing for bench formation using half			Terrace spacing for bench formation using maximum VI of 1.8 m		
Slope %	VI m	HI m	Labour man days per ha	VI m	HI m	Labour man days per ha	VI m	HI m	Labour man days per ha
5	1.0	20	60	0.5	9.8	123	1.8	35.0	57
10	1.4	14	86	0.7	6.9	175	1.8	18.0	76
15	1.8	12	100	0.9	5.8	208	1.8	12.0	100
20				1.1	5.3	227	1.8	9.2	131
25				1.3	5.0	241	1.8	7.3	165
30				1.4	4.9	246	1.8	6.1	198
35				1.5	4.7	256	1.8	5.2	232
40							1.8	4.6	262
45							1.8	4.0	301
50							1.8	3.7	326
55							1.8	3.4	354

Source: Adapted from Wenner C. G. (1981), p. 100

(2) Terrace Spacing

The general formula for terrace spacing is given as follows:

$$VI = \frac{(\%\ slope + 2) \times 0.3}{4} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots..(2)$$

where VI= vertical interval between terraces in meter, S= % slope

The vertical interval can be converted to the horizontal interval using the formula

$$HI = \frac{VI \times 100}{\%\ slope} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(3)$$

where HI= horizontal interval in meters.

3.6 Tree Seedling Centre

The following guidelines are suggested to enhance afforestation in Dogda Bora Wereda, and implement the proposed Tree Seedling Centre at Meki, Dogda Bora Wereda.

(1) Leadership

The Oromia Irrigation Development Authority (OIDA) should develop leadership by creating an Environmental Management and Monitoring Unit (EMMU) to lead the proposed tree seedling centre through a conservation and afforestation programme in close collaboration with the Oromia and Dogda Bora Agricultural Bureau. The leadership should know the stakeholders, resource managers and users and formulate a vision and plan for the programme.

(2) Social and Governance

OIDA should take into account both science, data, information and appropriate technology as well as cultural and organizational issues of the local communities in tackling the conservation and afforestation programme.

(3) To Foster Stakeholder Participation

All stakeholders should be involved as full partners in planning and implementing the programme (policy makers, community leaders, provincial administration, private land-owners, farmers, tour operators, indigenous communities etc.).

(4) To Link Conservation and Restoration Activities with Socio-economic Goal

It is important to initiate the conservation programme with activities that first address stakeholders' perceived needs. For example, attention should be given to the concerns of the Oromo people, including poverty alleviation, transportation, personal health, cattle diseases, fishery etc.

(5) Policy for a Permanent Tree Security and Land Tenure

The FDRE through Oromia Regional State and the Bureau of Agriculture is the chief determinant of the fate of forestlands, even if it does not directly control them. The Government through the relevant agencies including OIDA should be firmly committed to developing social forestry. This means protecting such forestlands from conversion to non-forest uses is it by the local communities or the Government itself. Probably crucial in this regard is that, communities and forestry agencies all need secure and long term tenure if they are to use forest reserves and production forests sustainably. Only then can the social forestry be adopted effectively in Dogda Bora.

3.7 Preliminary Action Plan for the Tree Seedling Centre

Currently deforestation in Ethiopia and in Oromia Region in particular, exceeds the annual incremental yields. Therefore, it is proposed that all activities carried out by the Agricultural Bureau in Dogda Bora Wereda should be reviewed and the future activities should among other areas focus on the following:

(1) Nursery Rehabilitation at Meki

The rehabilitation of the nursery should include: reconstruction of the necessary facilities such as water tank, potting shade, seed bed and stores for increasing the capacity for seedling production, and introducing diversified tree species, fruit trees like mangoes, oranges, bananas, trees with medicinal value (e.g. Neem tree), and other tree species that thrive well under local conditions.

(2) Prompt Planting of the Proposed Seedlings in the Nursery for the Year 2000

It is recommended that, the planning scheme in Dogda Bora in the following table should go ahead as planned. The technical designs specified above for the various structures should be followed along with the institutional approach adopted by WFP be followed (Annex 1).

Items	Unit	No. 54 Dalota Mati	No. 15 Menjegso Weji (Lubaena Tungungi)	No. 15 Menjegso Weji (Menjegso)	No.16 Jero Raka (Jero Raka)
Catchment		Mati	Wede Weji	Lube	Jero Raka
No. of Beneficiaries	No.	955	451	450	360
Average coverage	ha	787	1,493	1,100	1,157
Implementation Schedule		2000-2005	2000-2005	2000-2005	2000-2005
Work Items					
• Fanya juu terrace	km	66	233	105	164
• Hillside terrace	km	200	90	143	74
• Cut-off drain	km	-	16	15	15
• Check dam	m	-	161,900	800	1,200
• Road construction	km	-	10	12	8
• Micro basin	No.	285,000	500,000	471,000	600,000
• Pitting & repitting	No.	682,000	1,260,000	1.5 mil.	1,300,000
• Seedling planting	No.	682,000	1,260,000	1.5 mil.	1,300,000
• Seedling production	No.	682,000	1,260,000	1.5 mil.	1,300,000
• Seed collection	Kg	90	125	150	150
• Farm bounding	No.	90,000	-	150,000	150,000
• Homestead planting	No.	50,000	170,000	100,000	50
• Roadside planting	No.	1,000	250,000	100,000	200,000
• Planting degraded areas	No.	1,000	40,000	48,000	12,000
• Pond construction	No.	-	300,000	160,000	2
		-	2	2	
Total Labour Requirement	Man-days	127,483	229,700	234,075	217,450
Total Oil Requirement	ton/lit	352 14,070	689 27,564	702 28,089	652 26,094

Source: Zonal Agricultural Bureau, East Shawa, 2000

(3) Social Forestry

The concept of social forestry should be promoted in Dogda Bora Wereda and the local communities should be enlightened on the importance of tree planting in terms of environmental conservation, wood resources supply, fruit crop production and effectiveness of agroforestry. The establishment of small-scale tree nursery in each PA (in addition to the existing satellite nurseries) and the succeeding reforestation and afforestation activities should be implemented by the villagers with the effective involvement of community groups such as churches, schools and clubs.

(4) Estimation of Indicative Costs for the Tree Seedling Nursery

The cost of rehabilitating the Meki Nursery will be based on: (i) the target for establishing social forestry, (ii) the tree species, (iii) the sivilcultural practices including spacing for planting, and use of polythene tubes, (iv) other production inputs (fertiliers, nutrient supplements) etc. However, based on experience in Ethiopia and elsewhere, the indicative costs will be guided by considering the parameters in the following table.

Guidelines for Estimating Indicative Costs for the Meki Tree Seedling Centre

A. SEED PROCUREMENT
No. of ha to be planted at a spacing of 2m x 2m, 2.5m x 2.5 m etc. with 10 20% allowance for loss of tree seedlings will require Y seedlings or X kg of seed. **B. NURSERY COSTS**
1. Bed preparation (man-days x cost/man-day) 2. Soil collection (man-days x cost/man-day) 3. Manure/Fertilizer application (man-days x cost/man-day) 4. Potting (man-days x cost/man-day) 5. Polythene tubes (kg x cost/kg) 6. Root prunning (man-days x cost/man-day) 7. Weeding in nursery (man-days x cost/man-day) 8. Pesticides/fungicides (litres x cost/litre) 9. Fuel (litres x cost/litre) 10. Protective clothing & incidentals 11. Fertilizers
C. FIELD ESTABLISHMENT
1. Staking and lining (man-days x cost/man-day) 2. Spot weeding (man-days x cost/man-day) 3. Hole making (man-days x cost/man-day) 4. Planting and hole filling (man-days x cost/man-day) 5. Plant transport (man-days x cost/man-day) 6. Boundary maintainance (man-days x cost/man-day) 7. Construction of fire-breaks (man-days x cost/man-day)
D. STAFF AND STAFF OVER-HEADS
1. There would be 1 forester, 2 forest assistants, 2 nursery technicians, 1 sociologist, 5 group experts for 54 PAs, and 500-community labour in 54 PAs. (6 staff x 30 days x 24 months x cost)
2. Participatory Rural Appraisal (9 persons x 4 PRAs (bimonthly) x 2 years)
6 Resource persons (forester + 2 assistants + 2 sociologists + 1 2 Agriculturalists) 6 persons x 3 days x 6 PRSs x 2 years)
GARND TOTAL (A+B+C+D)

(5) Tree Planting Specifications

It is assumed that emphasis will be given to indigenous trees and fruit trees in the proposed program. The following table shows trees that are currently grown in Dogda Bora Wereda.

Number of Seedlings Planted in 1999/2000

No.	Type of Seedling	Seedlings Planted by Individuals	Seedlings Planted by WFP Project	Seedlings Planted by Government	TOTAL
1	Eucalyptus spp.	1,135,319	80,113	10,403	1,225,835
2	Shinus molle	145,969	32,370	1,310	179,649
3	Acacia saligna	113,533	58,120	5,500	177,153
4	“Muliyaa”	129,750	18,018	3,850	151,618
5	Lucenea	97,314	25,310	7,000	129,624
6	Dovyalis abyssinica	-	17,200	5,570	22,770
7	Casurina equisetifolia	-	2,210	5,518	7,728
8	Delonix regia	-	-	1,205	1,205
9	Spathodea campanulata	-	5,013	1,895	6,908
10	Pawpaw	-	-	786	786
11	Moringa oleifera	-	8,600	1,600	10,200
12	Gravillea spp	-	750	741	1,491
13	Jacaranda	-	8,496	9,272	17,768
14	Cordea africana	-	3,010	-	3,010
	TOTAL	1,621,885	259,210	54,650	1,935,745

Source: Dogda Bora Agricultural Bureau, 2000

Spacing for the seedlings will depend on tree species, soil type, whether trees are planted for hill side revegetation or afforestation. For example, common spacing used in Ethiopia and Kenya for Eucalyptus species range from 1 m x 1m , 2 m x 2m to 2.5 m x 2.5 m. The details of the actual spacing requirement shall be worked by the conservationist/forestor after carefully establishing the types of trees to be planted, the purpose and the soil conditions.

A crude analysis shows that assuming a demand of 0.9 m^3/person/year (normally 0.7 – 0.8 m^3/person/year), planting is at 2,500 trees/ha (at a spacing of 2m x 2m), and production at15 m^3/ha/year (estimates range from 15 – 20 m^3/ha/year), each 1000 head of population will need 60 ha of woodlots at a cost of Birr 19,500 or Birr 20/person/year. Thus, Dogda Bora with a population of about 162,750 will need to plant at least 9,765 ha to meet the current total demand of 146,475 – 195,300 m^3/year.

4 Summary of Draft Master Plan for the Environmental Sector

4.1 Environmental Conservation

(1) Land

Currently, land-related constraints facing environmental conservation include: (i) lack of land tenure security, (ii) land fragmentation, (iii) diminution of size of landholding, and (iv) landlessness. This draft Master Plan recommends the following measures:

- No systematic assessment of traditional land tenure system has ever been done before the promulgation of proclamation of No. 31 of 1975, which declared all rural lands in Ethiopia the collective property of the people. Therefore, basic studies should be undertaken to identify the weaknesses of the present land tenure system so as to recommend ways of improving ownership security to promote environmental conservation, hence sustainable development;
- As for land fragmentation, studies are needed to determine "minimum farming units", i.e. economically viable units of the household type which is indivisible;
- Dimininution of size of land holding can be overcome through intensification of production and by changing the cropping system to high yielding crop types such as enset and vegetables.

(2) Soil Erosion

Major soil erosion constraints include (i) lack of systematic soils inventory, (ii) inadequate multipurpose soil survey, and (iii) inadequate attention to assessing basic soil surface water problems and traditional soil management systems. The following measures should be taken:

- the Regional States should restructure its institutions to provide for soil survey and laboratory analysis experts for proper land planning and conservation measures;
- research should target basic soil problems and traditional soil management practices;
- data should be generated on soil erosion and sedimentation rates;
- soil loss due to rills and gullies in crop and grazing land should be intensified under the WFP program – areas with a very high risk of soil loss (e.g. steep slopes greater than 16°) be enclosed and allowed to regenerate through natural revegetation or afforestation);
- the existing tree nursery such as at Meki should be rehabilitated as specified under Section 3.3.7 and 3.3.7 in this report; and
- technical guidelines for the design and construction of structures for soil and water conservation should be guided by specifications suggested in Chapter 3 of this report.

(3) Water Resources

Water resources issues include: (i) lack of guidelines on water use, (ii) inadequate monitoring and management of irrigation schemes and other development activities that use water resources, (iii) lack of inventory of irrigation schemes, and (iv) inadequate water quality analysis. It will be necessary to plan the following measures for developing sustainable use of water resources:

- Environmental Impact Assessment (EIA) should be undertaken to provide the following information:
- the significance of the expected change in river flow on down stream development activities and Lake Abijata ecosystem;
- quantitative information on the relationship between water level and salinity in

Lake Abijata and how these changes relate to the aquatic life including fishery and waterfowls;
- environmental cost-benefit analysis to establish the opportunity costs and trade-offs of conserving precious ecosystem (Lake Abijata-Shalla System) as compared to economic returns from alternative development options e.g. irrigation;
- guidelines on minimum river maintenance flow and minimum water level for optimum ecological balance in the proposed water resource development project areas in Oromia; and
- effective countermeasures, environmental monitoring and management plan for the proposed irrigation project.

(4) Forests

Major forest constraints include (i) lack of clear forest policy, (ii) inadequate research on social forestry, (ii) inadequate data on the status and trend of forest resources, (iii) uncontrolled grazing, and (iv) lack of tree security and land tenure. The Master Plan will leave the conservation of the state forests and regional forests to the respective government agencies, but will assist in developing social forestry by rehabilitating the Meki Nursery to:
- rehabilitation of Meki tree seedling nursery;
- promotion of social nursery in Dogda Wereda;
- training the Wereda staff in social forestry practices.

(5) Rangeland Ecosystem Conservation

Overgrazing is a serious problem of conservation especially in semi-arid parts of Ethiopia, largely because livestock carrying capacity has exceeded the recommended rate of 8 ha per TLU by up to 4 times. This has contributed to severe erosion. The Master Plan will develop dairy technology as a model for farmers in Oromia Region and this is expected to reduce the current carrying capacity on grazing land. In addition, the following measures are needed:
- closure and resting of badly degraded grazing, rotational grazing land through sensitization of the reducing community, especially, the pastoralists;
- reducing runoff and promoting infiltration through promotion of structures such as terraces, retention ditches, cut-off drains etc.
- better distribution of rural water supply systems to spread the grazing pressure more uniformly and reduce the concentration of livestock around permanent water sources.
- understanding of the rangelands ecosystem and appreciation of the contribution of pastoralists to the natural resource conservation and development should be considered;
- the management of rangelands should also strictly consider the carrying capacity of pastoral lands to maintain species of native fauna, flora, and raise livestock and ensure the livelihoods of pastoral people;
- to the pastoralists in order to continue their practices in an improved and enhanced to tackle the changing living situations and natural environmental conditions.

4.2 Social Environment

The Master Plan is expected to address three major issues of (i) social issues relating to loss of land by farmers to new claimants in the proposed irrigation project in Dogda Bora, (ii) competition and conflicts in water use arising from diversion of Meki River for the proposed irrigation project, and (iii) outbreak of vector borne diseases.

(1) Social Issues

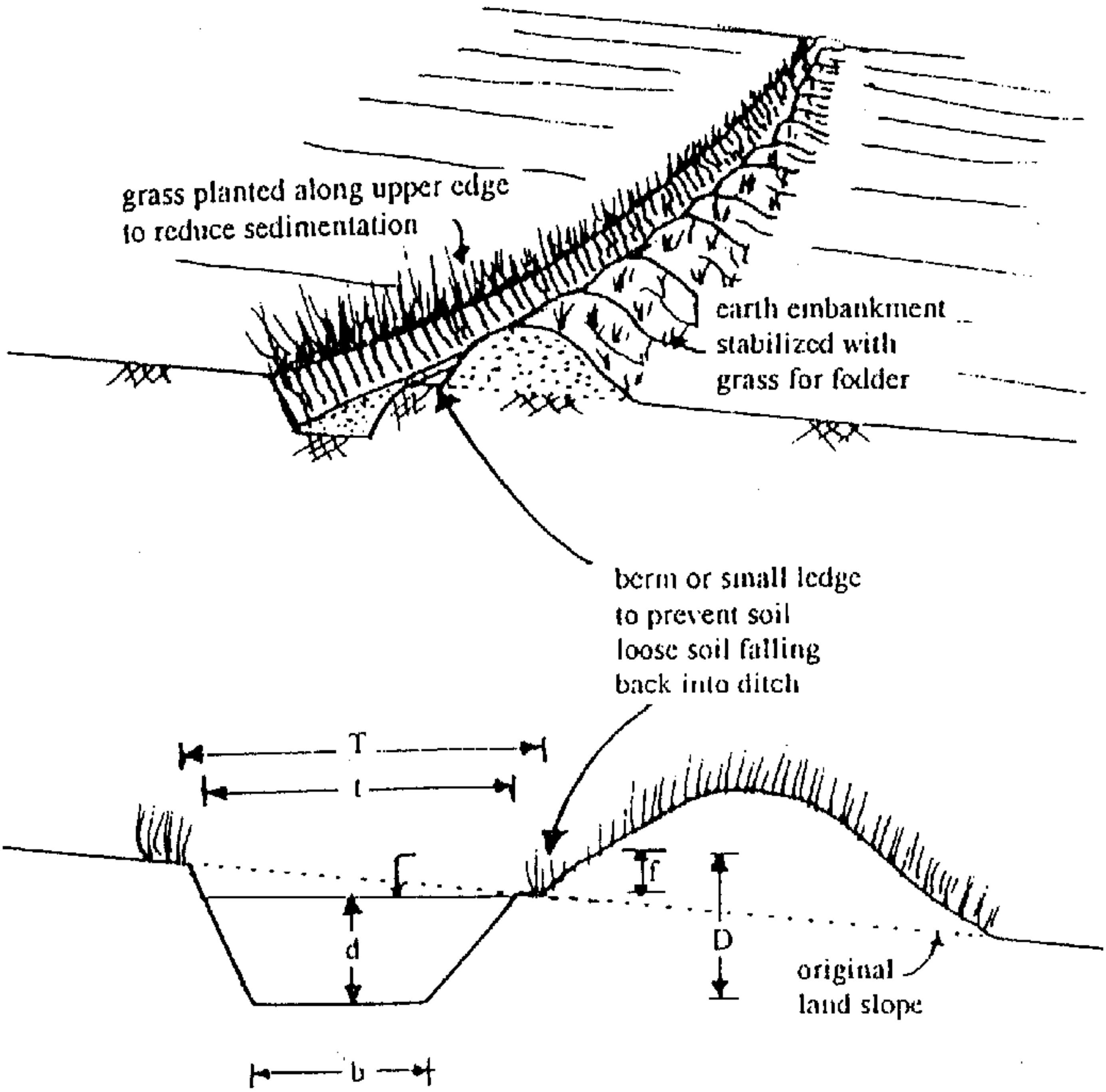
To minimise the expected social friction expected from influx of new farmers to the proposed project area, and loss of land by existing farmers in the proposed project area, it is necessary to undertake a careful socio-economic profile study of the area. The study should establish the actual number of beneficiaries, the modality of land reallocation, social issues, and identify indicators for monitoring benefits. Ways should be devised to compensate or reward those who will loose their land to new claimants and maintain harmony among these communities.

(2) Water use Conflicts

A careful assessment of current water demand in the existing irrigation is needed along with water use practices to be able to plan appropriate water apportionment. Depending on the outcome of this study, further water resources development projects should be stopped if the current water use is found unsustainable. Furthermore, effective water use monitoring and management should be put in place.

(3) Environmental Health

Changes in the ecosystem with the creation of more water surface area for irrigation could increase the incidence of malaria and schistosomiasis. The Project in collaboration with the Dogda Bora Health Bureau will need to develop emergency measures including preventive means to contain any upsurge of these diseases. However, it is expected that the problems arising from the proposed Project will be minor.



b = bottom width
d = depth
t = top width
f = freeboard
T = top width with freeboard
D = depth with freeboard

Figure 1 Diversion Ditch Layout and Cross Section

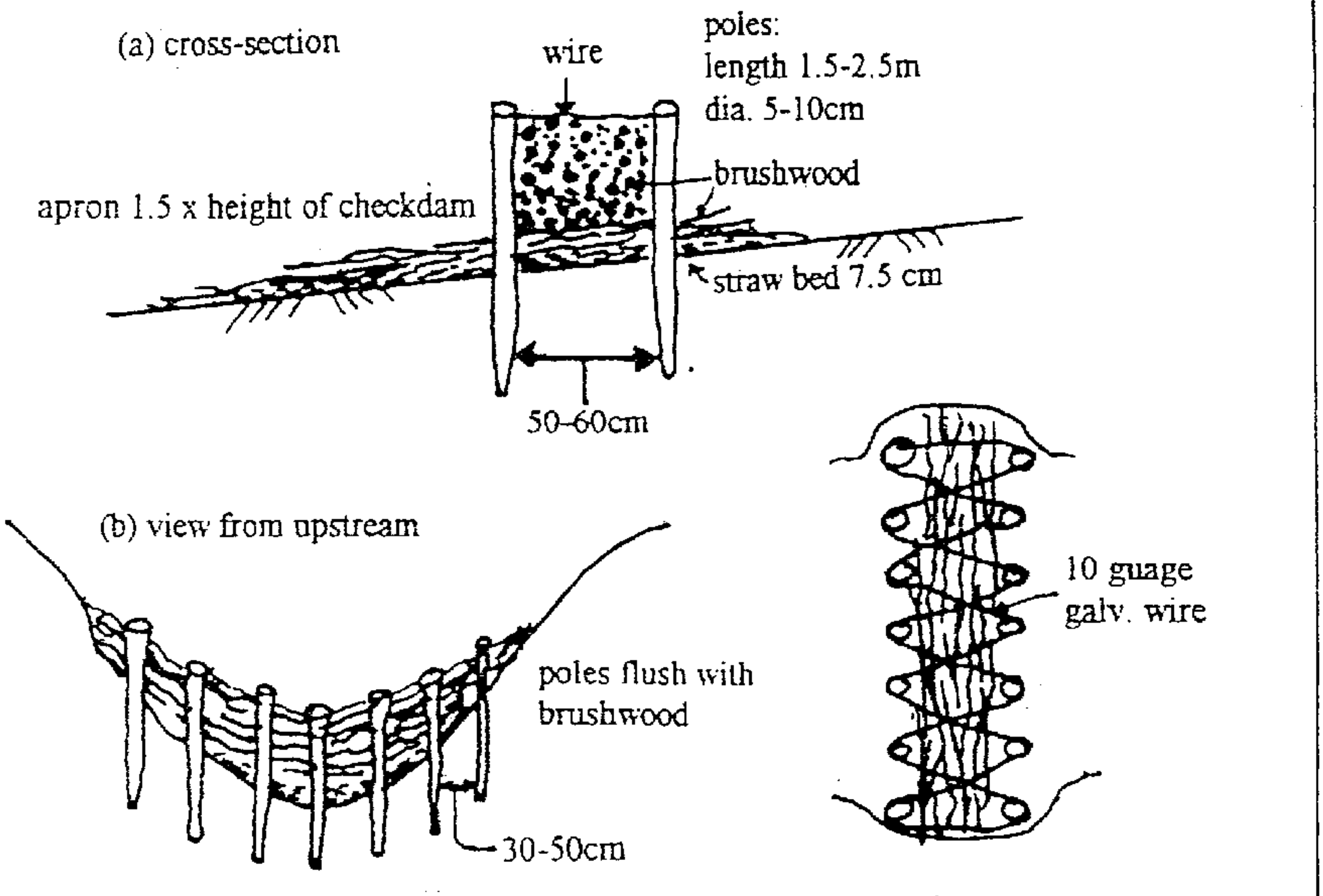


Figure 2 Double Row Post-brush Check Dam

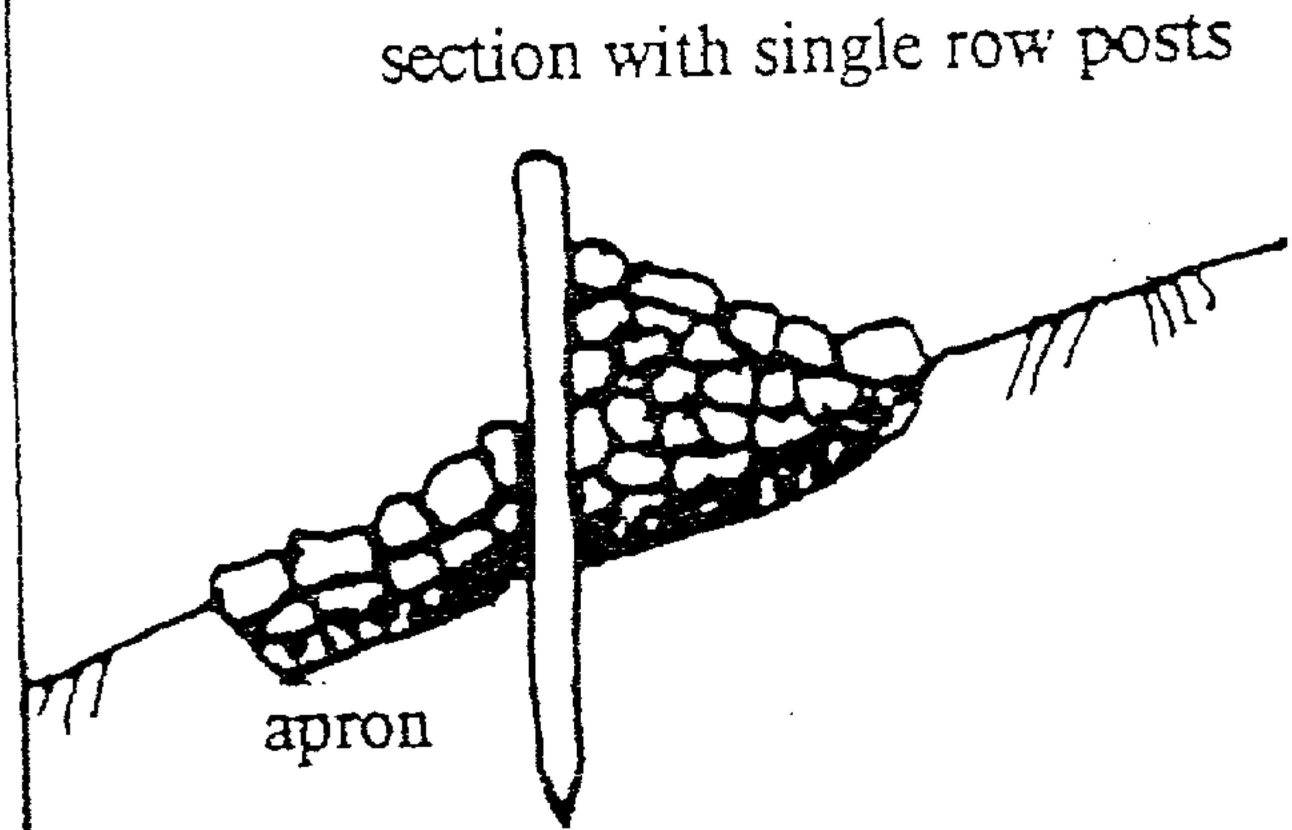


Figure 3 Single Row Post-stone Check Dam

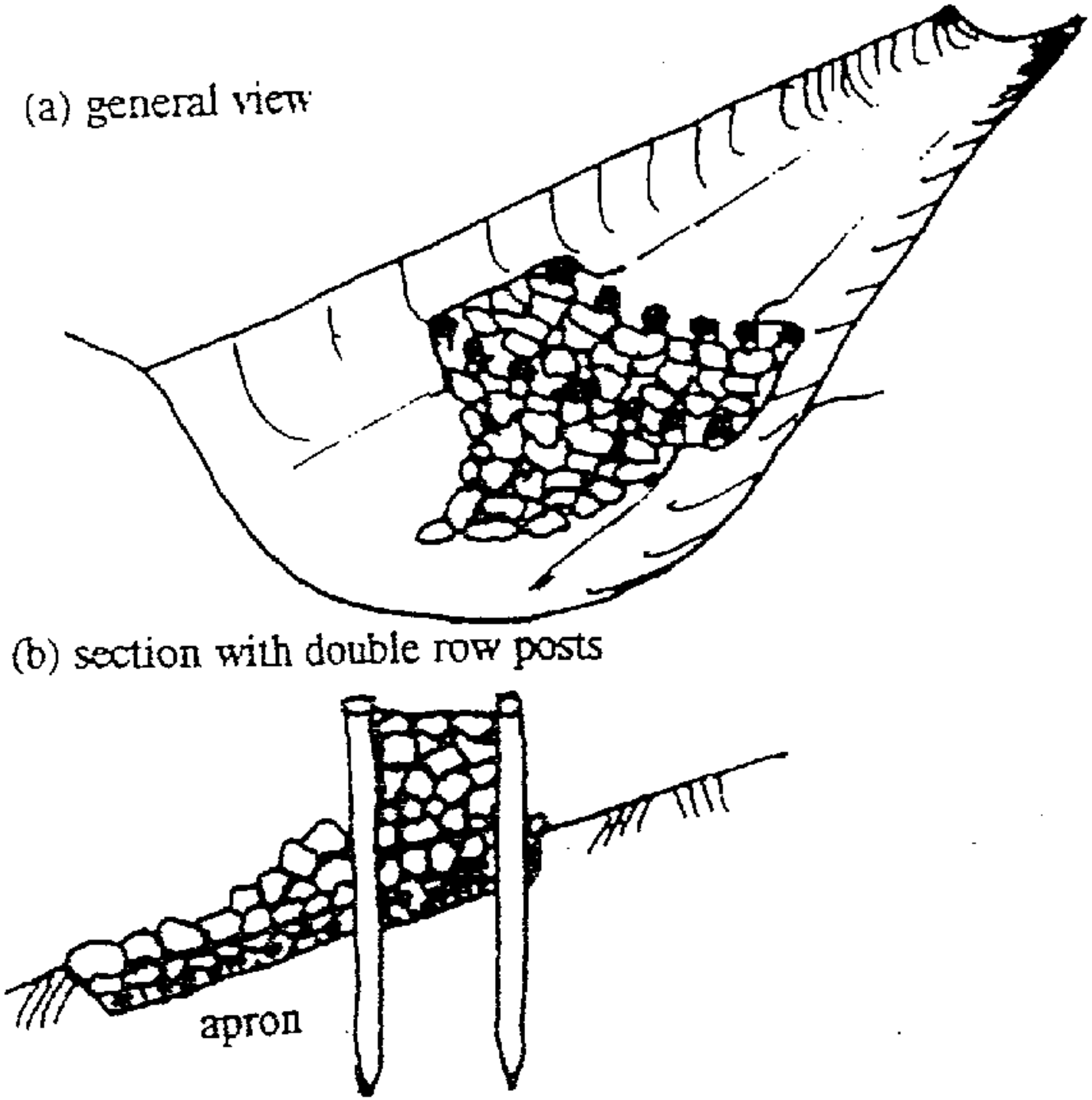
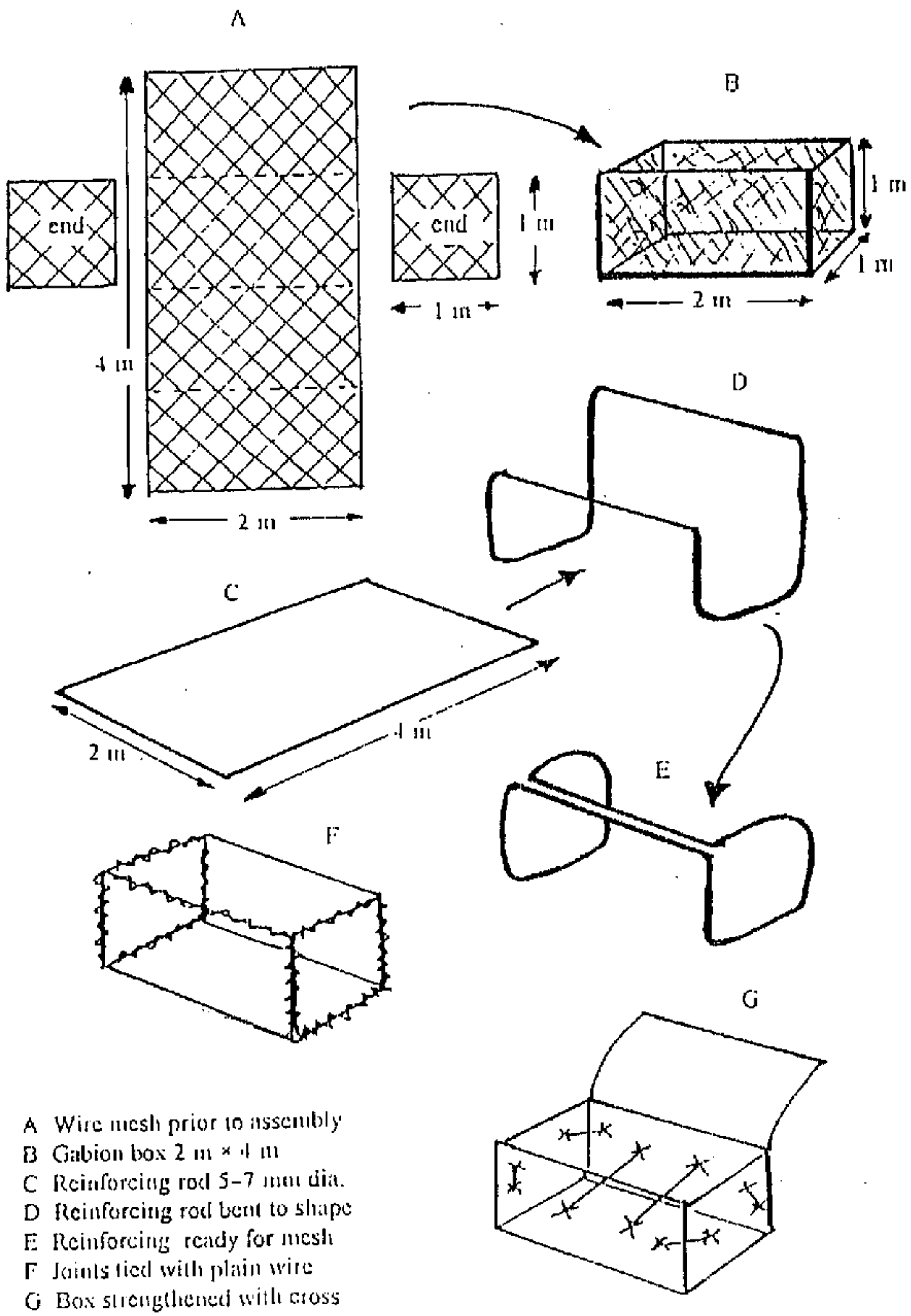


Figure 4 Double Row Post-stone Check Dam



A Wire mesh prior to assembly
B Gabion box 2 m × 4 m
C Reinforcing rod 5–7 mm dia.
D Reinforcing rod bent to shape
E Reinforcing ready for mesh
F Joints tied with plain wire
G Box strengthened with cross ties and ready for filling

Figure 5 Fabrication of a Gabion Box

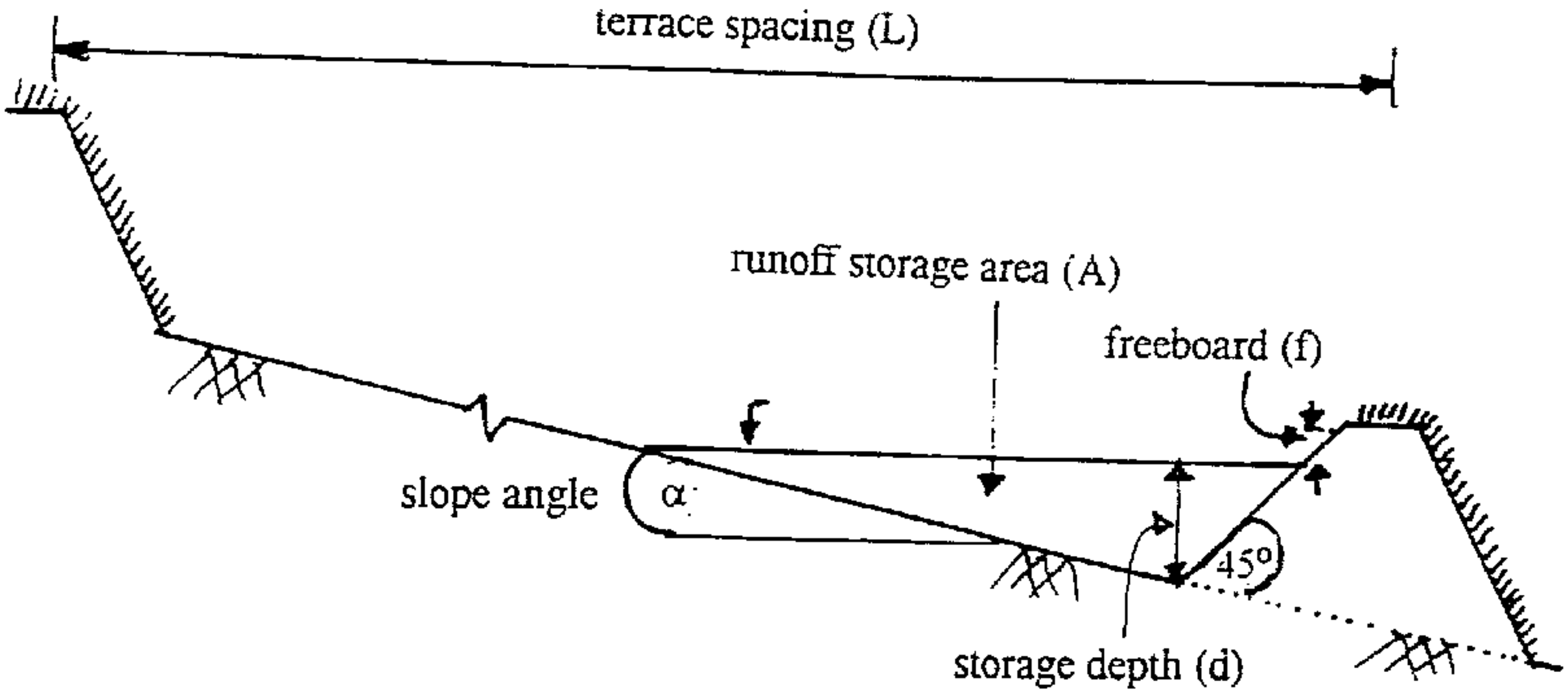


Figure 6 Fanya Juu Terrace for Rainfall/Runoff Retention

Annex 1 A Case Study of Soil and Water Conservation by WFP

1. Introduction

The soil and water conservation measures, which are described above in the main report are now being attempted in Ethiopia with the support of the WFP. The WFP started implementing its conservation activities in Ethiopia in 1980 with the Development Project Ethiopia 2488: "Rehabilitation of forest, grazing and agricultural lands". The activities of Project 2488 over its 20-year life span is presented in the table below.

Summary of WFP Activities (1980 –2000)

Period	Project	Beneficiaries	Food (tons)	Cost to WFP (US$)	Total Cost (US$ million)
1980-82 (Original)	Ethiopia 2488	1,280,000	145,000	49	66
1982-87 Phase I	Ethiopia 2488/I including two-year bridging operation	5,340,000	350,000	105	137
1987-94 Phase II	Ethiopia 2488/II including two-year bridging operation	5,040,000	378,278	86.3	96
1994-99 Phase III	Ethiopia 2488/III	936,000	137,000	50	60
1999-04 Phase IV	Ethiopia 2488/IV	1,427,000	320,000	122	161

1.1 Concept of Food-for-Work of the Project

The broad objectives of the project are to improve future agricultural productivity in degraded catchments and sub-catchments by applying suitable soil and water retention techniques of vegetation and structural conservation on land used for food crops, grazing and forest products. The original strategy was to implement this project in catchments in Tigray, Wollo and Harraghe, but the project is national in scope, and the authorities may choose catchments in other regions during their annual work plan reviews. The project also aims to demonstrate to the local population that soil and water conservation and, hence food productivity is linked to better land use practices.

Food-for-Work is a concept in which food ration is provided as an incentive to farmers who perform work and observe practices, which improve water and soil conservation. Since 1980 WFP dominated the provision of project food aid as opposed to distribution of or program food aid. The Program provides an average of 27 million workdays per year, with an average participation rate of 90 days per household and has supported the livelihoods of up to 300,000 families a year.

The ration helps to improve the inadequate diets of farmers and their dependants, particularly in areas where both drought/famine conditions are endemic and food is eagerly accepted or even preferred to cash wages. Very little food (about 15%) is sold to meet other basic needs. An example of WFP food-for-work activity is presented in the following Box.

Box 1: Kachema Community (Adama Wereda): Area Enclosure

A major lesson learnt from this project is that area enclosure with afforestation as one of the measures of watershed management is possible in Ethiopia. A total of 240 households of Kachema PA with WFP/FAO support through Food-for Work program, enclosed a free grazing area of 120 ha. This is part of the WFP program of "Local Level Participatory Planning Approach (LLPPA)".

Major activities carried out at the site include:

- planted with Eucalyptus and acacia species (105,000 seedlings planted);
- Hillside terraces to harvest moisture (120kms);
- constructed a feeder road of 0.5 km;
- protected the area using 6 community guards.

- Amount of food given according to specific activities as follows:

(i)	Pits preparation =	105,000 seedlings x 0.03 / 20	= 157.5 Quintals
(ii)	Seedling planting =	105000 seedlings x 0.03 / 67	= 47.02 Quintals
(iii)	Hillside terracing =	120 kms x 4.5 Quintals	= 540.0 Quintals
(iv)	Site guards =	1 PD x 7 years x 12 x 90 Kg	= 7560 kgs.

- Share of costs of the Area enclosure:

(i)	WFP	= 60%
(ii)	FDRE	= 30%
(iii)	Community	= 10%
Total		= 100%

1.2 Other Major Features of WFP Activities

1.2.1 Diagnostic Studies and Socio-economic and Participatory Studies

At the onset of the Project 2488 diagnostic studies focused on identifying sub-catchments suffering from severe degradation and drought rather on understanding the people that lived in these areas. Recently, WFP Project increased use of socio-economic and participatory studies that greatly helped understanding of people's livelihood systems and processes.

1.2.2 The Top-down Approach (1980 –1991)

This approach started in 1980 and has been managed by soil and water conservation experts with enough food to provide a large labour-force. The top-down approach involves dividing an area in sub-catchments of 3,000 – 4,000 ha and a given catchment was treated from top to bottom. Land with over 35% slope was either closed or afforested. Arable land was bunded or terraced, with work starting at the top and proceeding downhill. Also, nurseries for tree seedlings and grasses (for revegetation of bund) were created throughout project areas.

The major activities include:

- stone and soil bunds for erosion control on farmlands;
- hill terracing and microbasin for afforestation;
- gully control (check dams);

- cut-off drains;
- area closer for natural regeneration of vegetation;
- farm ponds for water harvesting (for domestic and livestock).

1.2.3 The LLPPA Methodology

The Local Level Participatory Approach (LLPPA) was initiated in 1992 and aims at a wide scale, pragmatic and participatory effort for conservation-based development (agricultural development including crop and livestock production and rural infrastructure). The LLPPA is implemented in several stages and takes from one month to three months:

Stage I: Selection of a Wereda based on classification requirements of the Disaster Prevention and Preparedness Commission of chronic or severe food deficiency.

Stage II: Identification of peasant associations (PAs) and communities within the Wereda as project sites or beneficiaries based on the following criteria:

- the sites that urgently require soil and water conservation measures to arrest or prevent serious land degradation (using MOA data or based on empirical observations by MOA field staff);
- physically accessible sites;
- sufficient manpower from the community to perform FFW activities.

Stage III: Formation of a Development Committee (DC) with a membership of 6-12 people depending on whom the community feels should be included. The elders/leaders of the community are consulted in this process and the DC comprises of: Development Agent (DA); The Wereda Expert or the Catchment technician (CT); Local Kebele Chairman/other position holders (treasurer, accountant, secretary); Community leaders; Priests; Unemployed high school graduates; Farmers; Demobilized soldiers; Chairperson of local women associations; and Women farmers.

Stage IV: Socio-economic and technical surveys of selected sites by the LLPPA Wereda Coordinator, the CT and the DA in co-ordination with the DC. The surveys collect data on: demographic, land use pattern, agricultural production and seasons, animal husbandry and sources of fodder, water supply, fuel supply, soil quality, type and level of degradation and soil erosion and whether traditional protective measures are being undertaken, community forestry and soil conservation activities through government.

Stage V: Recommendations for FFW and self-help development activities in forestry and soil and water conservation are drawn up and discussed with the community at general assembly meetings. In most Weredas, women do not attend these assemblies. In such cases, separate meetings are held with women's groups to discuss the proposed plans.

Stage VI: Preparation of 3-Year Plan: The plan is prepared with targets and resource requirements budgeted on annual basis and submitted to the Regional agricultural Bureau.

2. Phase IV: Current Phase of Implementing LLPPA

Using Vulnerability Analysis and Mapping (VAM) tool, the WFP selected 66 priority Weredas for project implementation. An additional 21 Weredas are included in local level planning as contingency Weredas. The latter receive capacity building support for technical knowledge and preparation of plans, but cannot implement plans until additional resources are found. Phase 4 aims to improve targeting and efficient use of food by identifying the most vulnerable and addressing the root causes of food security through:

3. Results of the WFP Activities of Phase II & III

Phase II

Objective	Achievement
Employment creation (1987 – 1988)	41.7 million workdays
Reduced soil erosion (over past ten Years of project activities)	- Enclosure of 200,000 – 300,000 ha; - Reforestation on 300,000 – 500,000 ha; - Bunding of 500,000 ha

Phase III

Objective	Achievement
Employment creation annually	374,000 jobs during lean season (60 days)
Reduced soil erosion (Activities during Phase III)	• 120,000 ha treated (bunds, cut-off drains, waterways, gully control) • 800 million tree seedlings planted (70% by individual farmer • 50,000 ha of reforested areas protected; • 120 water ponds and 15 earth dams constructed and 500 springs developed; • 1,000 km of feeder roads maintained and constructed.

4. Lessons Learnt from WFP Activities

- Reducing land degradation should not be confined to structural conservation measures, but should include improvement in the use of land so that farmers can appreciate that it leads to increased agricultural production;
- Action oriented soil conservation programs be integrated with other aspects of rural development (research, extension, credit, inputs, changes in land
- Local participatory planning approach is adopted as an indispensable component compliment to the Ministry of Agriculture;
- The rights of exploitating conservation sites should be transferred to communities;
- The loss of grazing land due to closure was noted as the most resented immediate effect of the project;
- Greater involvement of farmers is therefore important to ensure that their needs are met and to improve the ratio of benefits to costs;

- Given the constraints faced by the Ministry of Agriculture in terms of inadequate qualified staff and other resources, small-scale initiatives and pilot projects should be encouraged and supported to develop a more participatory approach;
- Support for capacity building is essential for effective soil and water conservation;
- Diversion weirs created 5,000 – 50,000 m^3 of water in the catchment areas to serve communities;
- A network of check dams in catchment areas is effective in conserving water and reducing soil erosion;
- WFP has no activities in Southern region, while in Dogda Bora Wereda, 4 sites have been planned and 2-4 more sites might be added;
- Survival rate of seedlings is 60% with polythene bags and much less when seedlings are planted bare roots;
- WFP has supported 680 nurseries of which 66 are in Oromia region – satellite nurseries located near streams support main nurseries in different Weredas.

5. Opinion of the WFP on Watershed Management

The WFP felt that based on its experience in Ethiopia, a network of small check dams in combination with other structures and based on participatory approach could be the best approach for sub-catchment protection. However, it is important for the proponents of soil conservation (e.g. the FDRE and the relevant sectors in the Regional States, Ministry of Water Resources, Environment Protection Authority) should discuss water catchment issues in project areas. This could avert possible future conflicts in trans-regional catchments, especially, where shared water resources are harnessed.

ATTACHMENT 3

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