6. PROJECT PLANNING

6.1 Principles for Planning

The priority project for the Feasibility Study shall be planned within the frame of the Master Plan set forth in PART-I of this report. Therefore, the principles established for the Master Plan shall be observed in this phase, too. However, some principles were reviewed based on the latest findings and discussions made through the study.

Principles discussed for the Master Plan study will not be repeated, but some principal matters are reviewed here.

(1) Flood Mitigation Budget and Project Size

Budgetary situation of HMG/N is outlined as follows on the expenditure basis:

(Budgetary Situation on Expenditure Basis: in million Rs.)

Descriptions	(1996/97)	(1997/98)
National total expenditure	50,724	69,693
DOI total expenditure	2,577.9	3,040.8
Local-level river training program	44.9	120.0
District-wise river training budget Bardiya District	0.8	4.4

The above figures clearly show the severe financial constraints of HMG/N. Given the overall financial constraints, the budgetary allocation per district is small in size. The funding assigned to one river is even more limited, since each district has to distribute the funds among several rivers. This budgetary situation must be kept in mind when planning the operation and maintenance of the project.

As of March 1998, DOI operates six national-level undertakings for river training. Some of the national river training works are stand-along projects, while other are part of DOI's national-level irrigation projects. A summary of these national-level river training works is provided in Table A6.1. Cost of these projects ranges from 28.5 to 370 million Rupees, which gives an idea on project size to be proposed.

(2) Continuous Dike

Continuous dikes constructed on the both banks along river courses are effective

measures to prevent flood inundation. However, the continuous dike has difficulty in maintenance, especially in relation with the sediment control in watershed area. After due consideration and discussions with the competent officials of HMG/N and the Advisory Committee members of JICA, the continuous dike was not finally proposed for the flood mitigation Master Plan up to the target year 2017, mainly for the following reasons:

1) All the rivers in the Terai plain flow into the Ganges river in India. A continuous dike is possible when the plan is coordinated with and agreed to by India.
2) The continuous dike induces a concentration of flood water and sediment in the lower reaches, causing a possible rise of the riverbed and, in consequence, a disastrous breach of the dike when abnormally large flood occurs. The continuous dike, therefore, have to be planned considering the sediment from the watershed area. However, the sediment in the watershed is not controlled. The sediment control in watershed area will take time due to the poor geological conditions in the Siwalik hills and budgetary constrains.
3) A continuous dike generally requires a large amount of maintenance in order to sustain the function properly for the entire length of dike. Considering the present land use of the flood prone area, such costly measures would not be economically viable.
4) Considering the present tight budgetary situation, priority of flood mitigation should be given to bank protection and damage mitigation of villages. Villages can be protected locally instead of the continuous dike. Sheet flood flows in farmlands would not be so disastrous under the present land use.

The flood mitigation Master Plan discussed in PART-I has already been adjusted to this principle of no-continuous dike.

(3) Priority Project as Pilot Project

More than sixty rivers flow through the Nepal Terai plain, and all of these rivers are causing flood and sedimentation. Eight of these rivers were selected from different river classes and various locations throughout the Terai as technical models of flood mitigation for other river basins of a similar nature.

Two river basins, the Lakhandei and Babai rivers, were further selected as a priority

project and are the subject of a Feasibility Study.

Considering the important roles as a model project, the priority work on the Lakhandei and Babai rivers should be intensively implemented as a pilot project. The experience and technical know-how obtained through the priority/pilot project could be applied to other rivers selected for the Master Plan study, and to the more than sixty rivers flowing through the Terai plain as well.

In view of the above considerations, the implementation schedules of the Babai river was rearranged, so that the priority project could be completed by the year 2007 (by the end of 10th national plan).

(4) Classification of Component Measures

In order to carry the project in practical and sustainable manner, it is important to implement the watershed management and river control measures in combination with community development activities. Therefore, the flood mitigation works and activities are discussed dividing into three components, i.e., watershed management, river control and community development components.

The flood mitigation works and activities are classified into respective components as follows:

1) **Criteria:** The beneficiaries should take flood mitigation measures in principle for their own protection, except for those implemented by the central government such as;.
   - Large scale works that local government and community cannot afford;
   - Basic flood mitigation facilities;
   - Works requiring an urgent implementation; and
   - Technical guidance, coordination and political arrangement to be taken from nation-wide viewpoint.

2) **Watershed management component:** Works and activities in the watershed area to be implemented by the central government. The watershed management component includes;
   - Erosion control works,
   - Afforestation/reforestation and land use regulation, and

- Publicity activities.

3) **River control component:** Works and activities in the plain area to be implemented by the central government. The river control component includes;
   - Channel treatment works,
   - Bank protection works,
   - Dike works,
   - Channel excavation works, and
   - Land use regulation.

4) **Community development component:** Works and activities to be implemented by the local community and VDC/DDC as well, for their own protection in the near-by area. The community development component includes;
   - Community mobilization,
   - Local coping strategy, and
   - Local flood mitigation works.

5) **Associate activities:** Aside from the above components of project works, the following activities are necessary to be performed by the central government and other authorities concerned;
   - Research/investigation
   - Technical guidance

6.2 Watershed Management Component

Detailed discussions on the watershed management of the Babai river will not be made, and only the possible measures for watershed management were listed here.

(1) Erosion Control Facilities

Two kinds of measures are necessary depending on the sediment sources as follows:

1) Measures for hill-side erosion in the southern slope of Siwalik hills:
   - Gully erosion control
   - Hill-side works
2) Measures for river-side erosion along the river:

- Consolidation of riverbed
- Protection of riverbank from scoring
- Planting permanent crops along the riverbanks.

Various works applicable to these measures are shown in Fig. A6.1. In the Figure, a combination of structural works and bioengineering is also presented.

(2) Afforestation and Land Use Regulations

1) Management of forests including planting trees and natural regeneration. Community forest management should be encouraged.
2) Designation of steep slopes for planting permanent crops only. Multi-year crops are also encouraged in the watershed areas.
3) Encouragement of planting commercial vegetation such as fruit trees, medicinal herbs, aromatic plant and dye plants. Well-managed cultivation of medical and aromatic plants prevents land erosion in the watersheds and promotes sustainable watershed management activities with income generation. The cultivation of such medicinal and aromatic plants has been one of the main programs of forestry policy of the Nepal. The root crops should not be chosen.
4) Fodder grasses and trees should be planted along the contour and on terraces. Livestock should be restricted within a permissible limit for the sustainable use of pasture and forest.
5) Wild medical herbs should be protected from over-collecting by practicing sustained yield management.
6) In wood deficit areas, firewood use can be decreased through improved cooking devices.
7) Training of local people should be provided in community forest management and the appropriate management of pasture and farmland in watershed areas.

(3) Publicity Activities

Efforts have been made to conserve forests and uplands in the watersheds at various places throughout the country. However, the results of these efforts are not always available to the people who could benefit from them. In order for communities, NGOs, and local/central governments to benefit from this experience, the following activities could be promoted.

1) Produce information on best practices, suitable species and market opportunities.
2) Train trainers from agriculture (both pastoral and arable) and forestry in watershed management techniques. Send trainers to on-going projects to learn from on-the-job training and then into the field to train the people.
3) Conduct study tours to on-going project sites to learn from these efforts.
4) Campaign through the mass media for tree-planting. Have regular radio programs describing success and failures of various initiatives.
5) Introduce or extend education in conservation, management and tree-planting activities in school.
6) Combine forest management and tree planting project with tourism and local development projects using natural resources.
7) Establish a special "tree planting day" as national and/or local level events and conduct campaigns for forest management, conservation, afforestation, reforestation and farm tree planting.
8) Undertake commemorative tree-planting activities for ceremonies and memorial events of residents, and local and national leaders.
9) Enact a commendation system for excellent conservation activities such as afforestation projects, agro-forestry projects, natural forest management, and community development activities executed in watersheds.
10) Organize tree-planting volunteer groups both local/national and international.
11) Establish a foundation and receive contribution to encourage the planting of trees.

6.3 River Control Component

6.3.1 General

Scope of Structural Design: The structural design shall be carried out for all the structures proposed in the River Control Component. The standard design is applied to the design of structures. However, the detailed computations for structural analysis are not made in this phase of the study.

Design Criteria: There are some design criteria for river and drainage channel structures in Nepal. Deliberating over the collected criteria and standards, and through discussions with related organizations, the criteria from the following publications were applied for structural designing.

1) Design Manual for River Training Works in Nepal, prepared by Ministry of Water Resources, Nepal.
2) Technical Standard for River and Sabo Facilities; prepared by the Ministry of Construction, Japan.

In addition to the above criteria, the following basic design concepts were considered:

1) In designing structures, locally based materials are to be used as much as possible in consideration of the cost performance.
2) Structures are to be designed considering previous and ongoing flood control plans.

6.3.2 Preliminary Facility Design

(1) Spur (Groin)

Spur works are the primary bank protection measures. Generally these are constructed in group. They deflect the flow towards the center of channels, so that scouring is transferred away from the banks and sediment deposition is accelerated near banks.

There are two types of spurs, permeable and impermeable ones. Generally permeable spurs are used for river channels with gentle bed slope, while impermeable spurs are adopted for river channels with steep slope. Considering the results of river survey and investigation of riverbed materials, the following combinations are proposed:

River Name	Section (km)	Spur Type
Babai	0.0 ~ 28.0	Permeable
	28.0 ~ 50.0	Impermeable

The length, height and spacing of spurs depend on local conditions, the purpose of the spur, materials to be used, etc. The length of spur is generally less than 20% of the river channel width.

Basically the height of spur depends on the flow depth during floods. In addition, characteristics of each segment such as namely riverbed materials, flow velocity and actual results in Nepal should be taken into account when determining spur height. According to the empirical relation, the spurs with height of 50 % of flow depth are

adopted for segment 2-2, 70 % for segment 2-1 and 100 % for segment 1.

Spacing between spurs is related to the length of the spur. It usually ranges from one to six times the length depending on the degree of channel curvature, flow velocity and structural features of each spur. From the empirical relation the interval-length ratio is set at 2 for segment 2-2, at 3 for segment 2-2 and at 4 for segment 1.

The major dimensions for the proposed spurs are, therefore, as follows:

River Name	Section (km)	Length(m)	Height(m)	Span(m)
Babai	0.0 ~ 28.5	40.0	2.0	80.0
	28.5 ~ 39.8	40.0	2.5	120.0
	39.8 ~ 49.8	40.0	3.0	160.0

A pile spur for the permeable type and a gabion spur for the impermeable type are proposed for this project.

A pile spur consist of four (4) lines of reinforced concrete (RC) piles arranged at intervals of one (1) m each. Considering the local conditions of the Babai river, Type Pb as shown in Fig. A6.2 was adopted. The crown of piles should be inclined toward river center so that the resistance against the flow decreases gradually.

A gabion spur consists of gabion mattress with boulders. They are classified into two (2) types, namely Type-Ic and Id as shown in Fig. A6.3. The slope gradient of both the upstream and downstream sides of spur are set at 1:1.5 (1.0 vertical to 1.5 horizontal) for slope stability. Sufficient gabion apron is provided at the head of spur to cope with local scouring at the spur head. The crown of spur should be also inclined toward river center.

(2) Revetment

Revetment works are proposed along river channel banks where there is a great impact of running water and along dike slopes where slope protection works are inevitable against scouring and wave wash.

To cope with each site condition, the following three types of revetment are proposed as shown in Fig. A6.4.

Type Ra consists of boulder pitching and backfill gravel, supported by a base concrete. The base concrete should be embedded deep enough to cope with the scouring. This type is designed to prevent not only scouring but also seepage. It is employed as a slope protection at both upstream and down stream of a sluice crossing a dike. Adjusting to the dike shape, the slope gradient is set at 1:2 (1.0 vertical to 2.0 horizontal).

Type Rb is widely employed at sections where bank erosion is active and spur works are not applicable due to an insufficient channel width. This type consists of a gabion mattress. Each gabion should be wired together and log anchors are provided at the head of gabions to cope with slippage. Considering the stability of slope and lack of space, 1:1.5 (1.0 vertical to 1.5 horizontal) slope gradient is proposed.

Type Rc is proposed at the sections where there is important structure just behind the bank erosion point and there is no space to adjust the slope for other types of revetment. Gabion boxes are piled up vertically on the land side edge, and in tiers on the river side edge.

Sufficient width of gabion apron is provided at the foot of each revetment to cope with the scouring of the riverbed. Crown elevation of revetment is set at the same level as the design high water level.

(3) Forest and Grass Belts

Forest and grass belts are proposed along the river course to temper flood flow over the land and to trap the sediment. In principle, these belts are aligned on the river boundary line (RBL). Where the river course shifts frequently, grass belts are planned on both banks to stabilize the river course and provide enough sediment transport capacity for the river.

The width of the forest and grass belts is tentatively designed at 50 m. This may be revised, if necessary, after monitoring the functions in the field. Figure A6.5 shows schematically the layout of forest/grass belt and the RBL.

(4) Earth Dike

Closing dikes are proposed as dike structures. Typical dike sections are shown in Fig.

A6.6. Representative dimensions of dikes are designed in accordance with the following criteria:

Freeboard: Considering wave run-up and set-up, floating debris, etc., sufficient freeboard shall be provided above a design high water level to prevent overtopping during flood events, because earth dikes are fragile structure against water overtopping. The table below shows the freeboard to be adopted corresponding to the magnitude of the design discharges. The crest elevation of the dike is determined by adding the freeboard onto a design high water level. In accordance with the table, 1.2 m of freeboard is proposed for the Babai river.

Design Discharge (m^3/s)	Freeboard (m)
Less than 200	0.6
200 to less than 500	0.8
500 to less than 2,000	1.0
2,000 to less than 5,000	1.2
5,000 to less than 10,000	1.5

Crown width: The crown width of the dike is designed to keep sufficient section for stability and seepage protection. The table below shows the crown width to be adopted corresponding to the magnitude of design discharges.

Design Discharge (m^3/s)	Crown width (m)
Less than 500	3.0
500 to less than 2,000	4.0
2,000 to less than 5,000	5.0
5,000 to less than 10,000	6.0

Considering the road supply for daily inspection and flood protection activities, a crown width of five (5) m is recommended.

Side slope: The side slopes of dike shall be designed to resist erosion during normal river flow, rainfall and flood events. Gentle slopes are desirable to prevent seepage through the embankment body or foundation. Side slopes of 1:2 (1.0 vertical to 2.0 horizontal) are generally satisfactory for a well-compacted embankment.

Maintenance road: Roads shall be provided on the dike crown for inspection, maintenance and flood protection activities. The dike crown metaled with gravel of 4.0 m width can be used as a maintenance road and it may be used as public roadway

for inhabitants of villages.

6.3.3 Studies on Alternatives

(1) Severe Meandering of Babai River near Indrapur Bridge

Problem: The Babai river meanders severely just upstream from the Indrapur bridge of Hulaki road. Owing to this meandering, farm land on both side of the riverbanks is being eroded. In addition the approach roads on both sides of the bridge are exposed to the menace of scouring. During large floods, the approach roads are submerged.

Alternative Measures: Two alternative measures are considered to cope with the problems (Fig. A6.7):

1) Alternative-1: Intensive bank protection of the existing river channel
2) Alternative-2: Cut-off channel

These alternative schemes were compared from various aspects as shown in Table A6.2, and evaluated to select an optimum scheme. The costs of these alternative schemes are also shown in Table A6.4.

In conclusion alternative-2 (Cut-off channel) was selected mainly due to the lower net-cost, taking into consideration the value of the reclaimed land.

(2) Sharp Bend of Babai River near Kusumba Bazar

Problem: Active bank erosion at the sharp bend of the Babai river near Kusumba Bazar is threatening the Hulaki road and Shivanagar village on the right bank and settlements located on the left bank downstream.

Alternative measures: Two alternative schemes are considered to mitigate these problems (Fig. A6.8):

1) Alternative-1: Intensive bank protection of existing river channel
2) Alternative-2: Cut-off channel

These alternative schemes were compared from various aspects as shown in Table A6.3, and evaluated to select an optimum scheme. The costs of these alternative schemes are also shown in Table A6.4.

In conclusion alternative-1 (Intensive bank protection of existing channel) is selected mainly due to the advantage of cost. The cutoff channel scheme takes route on the old riverbed, and it will be difficult to maintain the channel on the designated cut-off route.

6.3.4 Construction Plan

The construction plan is worked out taking into consideration the scale of works, hydrological and meteorological conditions in the project area, the results of topographic and geological investigations and other factors related to the implementation of the proposed project.

(1) Conditions for Planning

The essential factors for planning were collected and selected through a number of field reconnaissances, in addition to information from similar projects implemented in and around the study area. The following information is basic to the preparation of a construction schedule.

Number of workable Days: The number of workable days is estimated based on rainfall data recorded in the study area. Sundays, national holidays and religious events are considered as non-workable days. National Holidays are listed in Table A6.5. Allowable workable days estimated are as follows:

Work Items	Workable Days
Concrete Works	240
Embankment Works	220

Workable days are calculated based on the following data and assumptions:

1) **Rainfall Data:** Following rainfall-gauging station within the study area is selected and eight-year daily rainfall records are picked up for analysis. The selected station is shown below:

Rainfall Station No.	Location	Project Site
0416	NEPALGUNJ	Babai River

2) **Number of Rainy Day and Suspended Day:** Daily rainfall of more than 15

mm is counted as a rainy day for both concrete work and earthwork. Suspended days are dependent on the amount of daily rainfall, as shown below.

Daily Rainfall (mm)	Suspended Day	
	Concrete Works	Earthworks
0-4	0	0
5-14	Rainy Day x 1.0	Rainy Day x 1.0
15-29	Rainy Day x 1.0	Rainy Day x 2.0
> 30	Rainy Day x 2.0	Rainy Day x 3.0

Monthly rainy days classified by the amount of daily rainfall of the selected stations are listed in Table A6.6.

3) **Monthly Workable Day:** By using the above data, monthly workable days both for concrete work and earth work are worked out. These are shown in Table A6.7 for concrete work and in Table A6.8 for earthwork.

Daily Working Hours and Work Shift: All construction work will be implemented in a single 8-hour labor.

(2) Work Plan

Construction Method: The work plan must be established considering safety and costs, bearing in mind the scale of the work and site conditions. The standard construction methods for main work items are described as follows.

1) Excavation for on-land works is basically planned to be carried out by a combination of manpower and hauling machines. Additionally backhoe will be adopted for the excavation works in submerged portions.
2) Embankment work including moisture control, spreading and compacting of the materials are planned to be carried out basically by a combination of man power and suitable compaction machines.
3) Other construction work such as gabion work, concrete work, masonry work, afforestation work, etc. generally will be performed by conventional methods. In addition, small-scale temporary work, such as river diversion cofferdams and dewatering work, will be adopted depending on the condition of the sites.

Construction Materials: A large quantity of boulders will be required for the project in the Babai river. Although it is possible to obtain boulders in the upper reaches of the Babai river, the hauling distance is considerable. Therefore, a quarry site in the Karnali river, located next to the Babai river, is used.

Construction Schedule: The target year of completion of the priority project is set for 2007. After completing the preparatory work such as feasibility study, fund arrangements, definite plan/detailed design and preservation of land, the construction phase will start in 2001. After considering the conditions mentioned above, the construction schedule of the priority project is detailed in Fig. A6.9.

6.4 Community Development Component

This section highlights distinct features of the Babai "Community Development" component. The basic framework of the "Community Development" component (explained in the section 4.3 of the Summary Report) will be adjusted accordingly, to meet the particular situations along the Babai river. Table A6.9 gives main features of community development activities along the Babai river. A map showing locations of different VDCs/Municipality Wards is provided in Fig A6.10.

6.4.1 Community Mobilization

(1) Workshops for Local Government Institutions (LGIs)

LGI Workshops for Babai will focus on five topics, as shown in the Table A6.9. The topics will include one special issue on the post-project repair and maintenance. This topic emanates from a workshop which was held during the Feasibility Study, on the 20-21 July 1998, to consider the roles and responsibilities of various local agencies (LGIs, line agencies, and communities). One of the recommendations of the workshop participants was the formation of a separate district-level maintenance fund. The rationale for such an arrangement is that:

1) These activities can not be done without informed participation of local people themselves, who are both risk bearers and beneficiaries;
2) In time of needs, local response can be more quick and effective; and
3) If technical skills are provided to local people, there will be less pressure on government and increased local resources can be mobilized.

The maintenance fund is intended to strengthen the local actors' capabilities in the maintenance of the physical structures, and ultimately to institutionalize this process at the district level, as described as follows.

Suggested Organizational Structure: To manage the maintenance fund, a Committee will be formed under the chairmanship of DDC Chairman, with the District Irrigation Office as the secretariat and District Engineer as member-secretary. All the Chairmen of the affected VDCs and Municipality Wards will serve as ex-officio members of the committee, with the representative of District Administration Office as one member.

Mechanism for District-level Maintenance Fund: Recognizing that the sustainability of the project would depend upon availability of resources and participation of communities, the post-project maintenance fund is partly funded by the central Government and donors, while the concerned LGIs will also share the costs. The local people need to be trained in repair and maintenance. Moreover, major and minor repair/maintenance activities need to be defined in clear terms so that the local authorities and communities can judge which repair activities they should take up.

(2) Creation of Organizational Bases at the Community

Formation of Community Organizations (COs)

Along Babai river, there exist local irrigation systems (with their leaders called "Chaudary"). Chaudary is a traditional system practiced in Bardiya for the maintenance and repair of irrigation canals. Table A6.10 shows the list of the Chaudary groups located in the VDCs affected by Babai floods. Annex 2.9.1 includes some successful flood mitigation cases that built upon the Chaudary traditions.

The beneficiaries of the canals elect one of them as the Chaudary or the chief to look after and mobilize people's participation for maintenance and repair. The contributions from the beneficiaries are based on equity basis or those who have more land contribute more, but each member must contribute. All rules and regulations for these actions are decided by the community. There are provisions to punish the violators of the tradition. Under this system, provisions are made to watch the canals through appointed watchmen by the community. They are also provided compensation for the work. It is said that the Chaudary can mobilize up to 20,000 people in a given day for the repair of the canal.

Chaudary irrigation groups can be tapped, when the river control structures will most immediately save their irrigation systems. In reality, the DIO has been assisting some Chaudary groups in flood mitigation (e.g., Bagnaha VDC).

In other places where primary beneficiaries extend beyond Chaudary members, a separate community organization (CO) can be formed to include all affected households. Even when this is the case, the COs can use the traditions of the Chaudary system (i.e., principles of "equity", and concomitant sharing of costs and benefits by the community members), as evidenced in some of the DIO-supported flood mitigation works in several places (e.g., Padnaha VDC, Baniyabhar VDC).

Not all the localities are endowed with Chaudary organizations. However, even in the absence of Chaudary groups, a number of villages along Babai river have successfully mobilized community members for flood mitigation (e.g., Gulariya Ward 6, Dhadhawar VDC). The Chaudary tradition exerts strong influences over the river basin along Babai river.

Creation of Public Awareness, Knowledge & Skills

Technicalities of Flood Control Measures: Table A6.11 shows the results of the community interviews with different localities along Babai river, concerning a) what they perceive to be the main causes of the flooding, and b) what measures they consider should be taken.

It indicates that the major causes they cited were high rainfall, as well as increased run-off and erosion from the upper watershed areas. CO Training along Babai will inform the people that the forest/grass belts have been designed in such a manner to trap the sediment flows. Moreover, the local residents expressed their hope for embankments and spurs, in most of the cases. However embankments are not proposed for Babai. Another focus of the CO training will therefore be the difference between embankments and spurs/revetments.

Skills in Masonry and Gabion Netting: According to Table A6.12 on the availability of skilled laborers, only a few villages have people with capabilities in masonry and gabion netting. Moreover, almost all the affected villages are interested in receiving skills training for river training. Some representatives from each CO will be given training, who will then be hired for the contraction of flood control works. Their skills

will also be crucial for the COs in maintaining the structures at later stages.

Community Participation in Flood Mitigation: As mentioned already, there is a strong tradition of self-organized activities along Babai, which has been utilized extensively for flood mitigation efforts. The "equity" principle (i.e., the larger benefits one person receives, the larger cost the person bears"), which is integral to the concept of "participation", has been extensively practiced (e.g., participatory bank protection works undertaken in Baniyabhar VDC, Padnaha VDC, and Gulariya Ward 8).

The more crucial issues along Babai are to upgrade the quality of their local efforts, as well as to disseminate traditional practices to other areas. One of the most common local initiatives is to plan one type of shrub (i.e., Behiya) for bank protection (e.g., Bagnaha VDC). For example, this practice can be improved, if the shrub is replaced by other high-value shrubs/grasses, which the local residents are not familiar with. Another major features along Babai are the existence of traditional practices of river watching and evacuations (e.g., Dhadhawar VDC, Mahamadpur VDC, Gulariya Ward 6 & 10).

There are other types of commendable efforts by the local communities (e.g., drainage construction in Sano Shri VDC) that will be used as model sites during the plan implementation. These are described in Annex 2.9.1.

<u>Generation of Financial Resources by COs</u>

There exists a tradition of group savings for the local irrigation systems in the Babai basin. To undertake the irrigation management, each member pays a membership fee. Moreover, there are also provisions to punish the violators of the established rules, which will also go to the group fund. Moreover, such practice is not confined to the farmer-managed irrigation system. For example, in Dadhawar VDC, there exit a community-managed "social emergency fund" which draws upon penalties in the use of common property resources as a whole, e.g., forests and irrigation. This tradition is tapped in initiating groups savings, as part of Babai Flood Mitigation Master Plan.

6.4.2 Local Coping Measures

(1) Flood Proofing

For un-irrigated areas (e.g., Gulariya Ward 5, 6, 8, 10, some parts in Mahamadpur

VDC and Dhadhawar VDC), irrigation provide opportunities to adjust agricultural practices to mitigate against inundation, e.g., switching to rice cultivation, or adjusting the cropping cycles. Once new irrigation facilities are developed in these localities, the farmers will be encouraged to adopt adjustment strategies to cope with flooding.

Moreover, in those areas, where flooding brings infertile sand onto agricultural land, the people will be assisted in adopting the types of crops that can be grown on sand-deposited land. Such recovery strategies (cultivating Bitter Gourd, Pigeon Pea, & Groundnuts etc.) are already observed already in several places along Babai river (e.g., Gulariya Ward 8, Baniyabhar VDC). Table A6.13 shows a list of such "catch crops" that can potentially be adopted in different localities along Babai river.

Another effective strategy for flood proofing is plantation along Babai river. Support will be provided to localities where deforestation is taking place (e.g., Gulariya Ward 2) to replant community woodlands, which will serve to alleviate problems arising from overflow and sedimentation. There is also scope to assist in converting the existing community forests of a single species (i.e., sisoo) into mixed forests (e.g., Gulariya Ward 5, Mahamadpur VDC). This will enable to enhance the forests' functions for soil conservation, as well as to obtain a wider range of tree products that the local communities require.

Other possible strategies for flood proofing along Babai include the provision of drainage systems. In several places along Babai, what accelerates the land cutting in this proposed site is gully erosion of the riverbank (e.g., Gulariya Ward 8, Sano Shri VDC). Often villagers attempt to control the gully erosion by placing earthen drainage systems. The earthen structure is often broken during the most critical time of monsoon, the people can be assisted to convert the drainage into more durable structure through paving stones and rubble, etc.

(2) Forecasting, Warning, & Evacuation

In a few villages (Gulariya Ward 10, and Mahamadpur VDC), the residents have their indigenous ways of safeguarding their properties and to watch the river, etc. These include observing such natural clues as leaves and branches floating, relying upon fishers, herdsmen, and farmers whose "workplaces" are close to the rivers, for river watching during daytime, using cow feed pots as evacuation boats, tying bullock carts

to nearby trees and storing valuables on the floating carts.

On the other hand, a majority of the localities expressed their hope to be accorded with flood forecasting systems, since they find it difficult to notice the warning signs of flooding (especially some parts of Bagnaha VDC, and Dhadwar VDC). In order to deal with this problem, it is recommended that a system be developed to engage those managing the irrigation barrage in Bagnaha VDC, to disseminate information to downstream towns and villages when the water level rises. It is even more desirable, at the junction of the Sharada and Babai rivers, (70 km from the irrigation barrage in Bagnaha VDC, towards the upper watershed areas), to install water level gauge to enable the staff at the Bagnaha irrigation barrage, to obtain information six hours in advance.

At present, all the 6 VDCs and 1 Municipality have the P.C.O.(Public Call Office), except for 1 VDC (Mahamadpur VDC). Forecasting or warning messages can easily be disseminated by using the telephone networks. In case of Mahamadpur VDC located adjacent to Gulariya Municipality, it is possible to convey the message by using the speakers of the District Police Headquarters in the Municipality. In any case, it is important also to be prepared to take alternative measures for information dissemination (e.g., sending messengers), since the telephone system is prone to breakdowns during the rainy season.

Although overflow is not so much a problem in comparison with bank erosion, there are a few settlements that feel the need to improve evacuation (e.g., part of Dahdhawar VDC, Gulariya Ward 10). In such places, since the issue is the accessibility to safe sites, rather than the lack of refuge areas, support should be provided to improve road networks to facilitate the people mobility. The riverbanks where spurs and/or revetments are built will be stabilized. Those areas will be converted to gravel, or earthen roads, which in some places, serve to facilitate people's evacuation to safer grounds at the times of flooding (e.g., Gulariya Ward 10).

(3) Flood Fighting

The DIO in Bardiya delivers bamboo and sandbags, during emergencies, to construct temporary revetments. However, this support is extended only to a limited number of places (e.g., Gulariya Ward 5 & 6), due to the DIO's resource constraints. The local communities will therefore be encouraged to adopt this simple measure with lesser

external support. This will be achieved by planting bamboo as part of the Forest/Gras Belt, and/or purchasing sandbags from the market using Groups Saving. Sandbags are readily available in the markets along Babai river.

6.4.3 Community-based Sustainable River Control Measures

(1) Forest/Grass Belts as Dike Works

Along Babai river, there exist a range of local trees and grass that can be used as fuel, fodder, timber, roofing, etc (Table A6.14). As the community surveys revealed (Table A6.15), different localities exhibit unique variations in their needs and wants of trees, shrubs and grass, the selection of the species should be tailored to a particular situation surrounding each community.

Especially relevant in the context of flood mitigation is the fact that there is a need to promote local production of flood fighting materials, as mentioned above. In such places, the "Forest/ Grass Belt" component can be linked to the "Flood Fighting" component, by planting those trees/bamboo that produce quality materials.

(2) Preventive Bank Protection Works

A certain type of shrub (i.e., Behiya) has been used, in some places, by the residents themselves for bank protection along Babai river, to augment the DOI-provided structures (e.g., Gulariya Ward 8, Bagnaha VDC). This is done mainly by planting the shrubs at the back side of the revetments/spurs, and at the sand deposit areas of the spurs. Most of the localities, where the DIO provided revetments and spurs, have not initiated the bioengineering measures mentioned above. In these places, the communities should be encouraged to plant shrubs/grass to supplement the DIO-provided river training facilities.

In other places, the shrubs are planted by the local communities as stand-alone "protection" work (e.g., Gulariya Ward 6, Mahamadpur VDC, Dhdhawar VDC). Some are successful, while others are not. One major reason for the failure is the shearing force of the water which shrubs alone cannot counteract. In such places, support can be extended to combine shrub planting with other simple measures, such as spurs made of bamboo nets and sandbags.

In areas of both success and failure, support can be extended to change the species from

Bchiya, whose use is rather limited, to other more versatile species of shrubs or grasses. The latter include Amlisso (used for fodder and broom-making, etc.) and Khar (roofing, paper-making etc.)

(3) Access Improvements using Flood Control Facilities

Where spurs and/or revetments are constructed, it is expected that the riverbanks will be stabilized. Therefore, there exist, ample opportunities to develop gravel, or earthen roads along those banks. At some of those planned construction sites (e.g., Gulariya Ward 10, Baniyabhar VDC, Padnaha VDC), new roads along the river banks will improve the people's accessibility to markets. In some places, roads will also facilitate people's movement to safer grounds at the times of flooding (e.g., Gulariya Ward 10), as mentioned in the above section on "Forecasting, Warning, & Evacuation".

Moreover, in places where closing dike works are proposed (e.g., Bagnaha VDC, Gulariya Ward 2, Gulariya Ward 5), the people will be assisted in using the structure as pathways, which otherwise were hardly passable due to water flows. In such places, gravel, or earthen roads will be developed to link the closing dikes with other existing roads.

(4) Bed Material Collection as Channel Excavation Works

Along the Babai river, there are a number of locations where quality bed materials can be collected. In fact, however, the number of the extraction sites is rather limited (e.g., Ward 3/4-Kumaraugau in Dhadhawar VDC, and Ward 5-Jabdi and 8-Belbhar in Dhadwar VDC). This is partly because some parts of the river come under jurisdictions of the Department of Forest (DOF), and the Department of National Park (DONP). DOF manages the river areas of (a) Ward 6-Balapur of Gulariya Municipality to the Bhada bridge, and (b) Ward 3-Shivanagar in Sano Sri VDC where there is a sharp river bend. DONP' jurisdiction lies on the left bank north of Ward 1-Sahipur of Bagnaha VDC.

The full potentialities of bed material collection have not been exploited along Babao, because of the prohibitive provisions in the Forest/National Park Acts, and also due to the lack of clarity as to which agency is responsible for sand/gravel extraction. Support will therefore be extended to engage the DOF/DONP and the DDC also entrusted with the bed material collection under the Local Government Act, to clarify the responsible party, and to initiate action to promote the extraction of sand, gravel, and

boulders in those potential areas.

It is to be noted that tighter control should be exercised over contractors and local communities who tend to limit their extractions to accessible locations (near riverbanks or bridges). Generally speaking, it is necessary to dig in the middle part of the river where the sediments are deposited. This may cause the diversion of the river flow towards the banks. For this purpose, guidelines should be developed and enforced to enable and encourage village and district authorities to monitor and regulate extraction activities.

(5) Operation and Maintenance (O&M) of Flood Control Structures

The proposed flood control structures along Babai are revetments and spurs. The COs will be given the responsibilities to constantly monitor these structures, and undertake minor repairs. The local communities are expected to seek external support for rehabilitation, only when the tasks go beyond local capacity. The local residents will learn the basic technicalities of the river control measure chosen, i.e., why a particular solution has been chosen, and how it will mitigate against possible disasters, as mentioned in the above section. At the same time, to enable the COs to take on regular maintenance activities, they will be trained in the basic maintenance skills as follows.

For revetment works made of G.I. boxes, community will monitor the riverbed, and when it is scoured, place stones and rubbles on the riverbed. When the gabion wire is cut, the local residents should request the DIO, through the DDC/VDC, for additional nets. It is also necessary, on a regular basis, to remove objects which may be hooked to the G.I. boxes.

For both gabion spurs and permeable types of pile spurs, similarly, it is important to monitor the level of the riverbeds. In case the surface of the riverbeds is washed off, it is crucial to stabilize the foundation of the spurs by placing stones and rubbles on the riverbeds. Moreover, the local residents will see to it that any objects hooked to the piles or the gabion will be removed. In case of gabion spurs, it is also desirable to plant grass or shrubs on the sand-deposit areas, which will serve to stabilize the land adjacent to the structures.

(6) Land Use Management

Along Babai river, bank erosion has been accelerated by improper land use. Babai

river is one of the two rivers that have more forest area than agricultural land, among the eight rivers covered by this Flood Mitigation Master Plan. Thus there is substantial vegetation along Babai river.

However, there are a number of places along Babai, where the local residents use the land adjacent to the river for open grazing. To ensure continued stability of the engineering structures, the people residing in the river basins should be encouraged to properly manage soil and vegetation on adjacent lands, through the introduction of rotational grazing, fodder plantation, etc.

Babai River (Terai): 1998

River	Agriculture	Forest	Barren/ Sand	Other	Total
Babai (ha)	12,950	15,540	3,580	230	32,400
%	40.1	48.1	11.1	0.7	100

Although relatively a small portion of the riverside area is use for agricultural purposes, over cultivation is practiced in some places on the riverbanks. In those places, the farmers should be encouraged to stop over cultivating on the riverbanks, and to be provided with alternatives to plant high-yield crops or to start other income-generating activities.

6.4.4 Location-specific Strategies

The "River Control" component envisages additional flood control measures (i.e., mainly bank revetment and spur works) at critical points along Babai river. This section will describer what "Community Development" strategies will be taken in those specific sites, within the overall framework provided in the above section

(1) Bagnaha VDC

Three sets of bank protection work are planned in Bagnaha VDC. At the site close to the East-West Highway, farmers suffer from flooding which carried sediments onto their farmland. To enable the farmers to cope with this issue, it is necessary to introduce the "catch crops" that can be grown on sand-covered land (e.g., pointed gourd, pigeon pea, and sweet potato). The farmers currently do not adopt recovery strategies, at the present.

Located at the place where river enters the Terai plain, it is very difficult for the resident

in the northern site to notice the comings of flooding. In this regard, the local community should strengthen relations with the Babai irrigation office, which operate the irrigation barrage in the same locality. This will enable the local residents to obtain prior information of floods from the irrigation office.

At the other two locations, DIO already provided several spurs. However, the residents have not adopted bioengineering measures to stabilize the soil adjacent to the structures. In another location in the same VDC, there is one exemplary example of the farmers' planting shrubs on the sand deposit areas of the DIO-provided spurs. The residents at the two planned sites should be encouraged to follow this local-initiated plantation, also.

Supporting in community forestry will be crucial for both the two sites. At the upper part of the two locations, there is one government forest near the river bank. It is desirable to assist the local community to prepare an operational plan, and to negotiate with the Department of Forest in obtaining the responsibilities for the forest management. This will enable the local community to take on the responsibility of soil conservation near the proposed bank protection work.

The lower part of the two proposed sites has already a well-managed community forest. However, the community forest covers only a portion of the riverbank, while the remaining land is being used for open grazing. As proposed by some village leaders, it is preferable to expand the forest to cover the remaining open land, to stabilized the riverbank. At the same time, support should also be extended to initiate alternative fodder production, and if feasible, practice of using sheds.

(2) Baniyabhar VDC

Of the two sites are proposed for the revetment construction, thee exist several spurs supported by DIO in the northern site. For this construction, DIO managed, instead of using a contractor, to draw upon the people's participation in boulder collection and transportation, as well as revetment construction. Being one of the few exemplary cases of "participatory" DIO support, this should be applied also for the future river training at both the sites.

Despite this commendable participation, however, there are several issues to be dealt with. One example is that the backside of the spurs is being scoured away, which

could have been avoided through local plantation activities. It will therefore be necessary to examine the past work, to draw out better ways of promoting participation for the revetment construction.

Another activity that should be carried on is the plantation of "catch crops", such as pigeon peas and groundnuts, after farmland is covered by sand. While some farmers in the northern part of the VDC adopt this practice, support should be provided to disseminate to other farmers.

In order to go to markets, residents in Baniyabhar residents usually pass through Padnaha, a neighboring VDC in the south. It is therefore crucial to develop a road linking the two proposed construction sites, which would benefit especially the northern residents. Part of the existing path linking the north and the south is disconnected during the rainy season. It is therefore necessary to strengthen such places of the path, for example, by installing culverts.

In the southern part of the VDC, adjacent to the proposed is mostly farmland. To fight against overflow, the farmers dig trenches to improve drainage of their agricultural land. Support should be provided to improve upon this practice, for example, through the use of such materials as stones and rubble, and also through plantation along ditches.

(3) Sano Shri VDC

In Sano Shri VDC, revetment work of more that 1.5 km proposed, to alleviate the active bank erosion at the sharp bend of the Babai river. What accelerates the land cutting in this proposed site is gully erosion of the riverbank. Villagers have already constructed earthen drainage with a view to controlling gully erosion. However, since the earthen structure is often broken during the most critical time of monsoon, it is desirable to assist the villagers to convert the drainage into more durable structure through paving stones and rubble, etc.

Open grazing on the riverbank exacerbates the gully erosion. It is therefore desirable, if the river bank is to be stabilized, to initiate more organized grassland management, e.g., rotational grazing of pasture lands. Moreover, as part of the pasture management, the local residents should be assisted to plant ground-coverage grass. For this community-based action to take place, it is necessary to accord the community to right to manage the riverbank, which currently comes under the jurisdiction of the Forest

Department.

(4) Padnaha VDC

Two sets of bank protection work are proposed in Padnaha VDC which lies at the opposite side of the sharp bend at Sano Shri VDC. The bank protection in the north is expected to stabilize the river bank thus potentially serving part of a new road linking with the neighboring VDC, i.e., Baniyabhar VDC. This would be of substantial help for people in Baniyabhar VDC to go to a major market in Sano Shri VDC (the opposite side of Padnaha VDC), then onto the district center (Gulariya Municipality). In this connection, additional support should be provided to complete the road, by paving the short-distance pathway linking the revetment site and Baniyabhar.

In the northern site, DIO provided support in installing a small-scale revetment, drawing upon the people's participation in boulder collection and transportation, as well as revetment construction. This is one of the few examples of extensive community mobilization in DIO support; community groups are usually involved as laborers for the contractor hired by DIO. While this precedent should be carried on in the northern site, it should also be followed at the southern site.

Despite the exemplary precedent, the villagers at the DIO-supported site have not undertaken bioengineering measures. Support should therefore be extended, to encourage the farmers to plant shrubs and/or grass to stabilize the physical structures provided by the DOI project office.

In both the sites, a number of people living in the riverside take refuge in north-eastern parts of the VDC, at the times of flooding. However, one main irrigation canal runs through the VDC, which would impede the people's movements towards safer land in the north-east. There is only one wooden crossing, which is far inadequate to serve as evacuation routes.

There exists irrigation drainage at the proposed construction site in the south. In Padnaha VDC, according to some of the farmers, flooding comes not only from the river, but also from irrigation channels. In parallel with the revetment construction, the existing drainage should be upgraded to increase its discharge capacity. At the same time, support should be extended to look into the existing water distribution into the VDC during the rainy season.

(5) Dadhawar VDC

There are two sets of bank protection work proposed in Dhadhawar VDC. In both the sites, there exists a community-managed "social emergency fund" that provides financial support to those individuals with imminent financial needs. The funds are collected from penalties in the use of common property resources (e.g., forests, and irrigation). This tradition of should be tapped, to be evolved into local funding scheme to be used for communal purposes, e.g., local-level flood mitigation measures; the fund is currently used only for individuals.

The western proposed site would benefit the settlement called Jabdi. Jabdi is in lowland, and the village thus suffers severely from endemic disease during rainy season. Support should therefore be extended to address this problem through the installation of tube wells, which would secure sources of drinking water. The residents largely rely on wells which get contaminated during rainy season.

There are no easily accessible pathways to the settlement. During the rainy season, the residents are forced to cross several waterways, even to get to the VDC center (called Belbhar) and to go outside the VDC passing through the VDC center. With this in view, support should be provided to develop more accessible rural road between Jabdi and Belbhar. This will enable the villagers to move to Belbhar both during flooding as well as "normal" times. During the rainy season, the road would be crucial to go to the health post. Throughout the year, it would serve a range of purposes.

In Belbhar, some farmers plant a type of shrub (i.e., Bihiya) on the riverside to alleviate bank erosion. This practice should be encouraged to other localities in the VDC, to supplement the bank protection work. In doing so, several alternative species of shrubs/grasses should be introduced, other than Bihiya which can be used only for fences; there are other types which could be used for a variety of purposes (e.g., Khar, & Amlisso).

(6) Mahamadpur VDC

Three sets of bank protection work are planned in Mahamadpur VDC. In the uppermost site, a few residents have implemented a traditional slope stabilization measure, using some shrubs and branches. This practice should be carried on, and also to be disseminated to other places, in order to stabilized the riverbank adjacent to the

proposed revetment work.

Moreover, there is a irrigation ditch which drains into the river, which runs northward, i.e., against the river flow. While, according to some villagers, there has not been inflow of river water into the ditch, there is no guarantee that the irrigation drainage remains safe. It is therefore necessary to assist the community to divert the irrigation ditch, to run in parallel with the river flow.

The two remaining sites suffer from inundation over farmland where both paddy and maize are planted. With a loan from the World Bank, most of the farmland in the two sites are expected to be irrigated shortly. This will enable the farmers to convert maize to paddy plantation. This crop adjustment should be encouraged, one irrigation schemes are in place, since paddy is flood-prone compared with maize.

At the site located in the middle, there is one community forest of sisoo near the river bank. While sisoo produces quality poles, the tree is not as useful in meeting their immediate needs, such as fodder and fuel wood. The community forest hardly serves to alleviate overflow, since it is of single species. It is therefore desirable to encourage the community group to promote inter-cropping with other species that could provide fodder and fuel wood.

On the other hand at the site in the south, local residents have planted a type of shrub (i.e., Bihiya) on the riverside to alleviate bank erosion. This practice should be also be applied to the proposed bank protection work. In doing so, however, several alternative species of shrubs/grasses should be introduced to the community (other than Bihiya) which can be used only for fences; there are other types which could be used for a variety of purposes (e.g., Khar, & Amlisso).

(7) Gulariya Ward 2

In Ward 2 of Gulariya Municipality, bank protection of about 1 km is proposed, together with closing work. This is intended to prevent the river from reverting to the old course. This Ward is witnessing deforestation of the community forest which lies between the Babai river and the Ward 2 settlements. Support can be provided to localities to promote mixed plantations, which would thereby serve to alleviate problems arising from overflow and sedimentation.

Just like Sano Shri VDC, the grassland adjacent to the river is currently exploited freely by herders. The users should be assisted to replace the current free grazing with more organized management of pastureland. It is necessary to promote the soil conservation, in order to stabilize the revetment work to be install at the grassland. Unlike Sano Shri VDC, however, the land is already part of the community forest, which thus enables the Ward residents to initiate communal management of the grazing area.

(8) Guraliya Ward 5

In Ward 5 of Gulariya Municipality, one closing dike with diversion, and two sets of bank protection work are planned. Adjacent to the proposed construction sites is mostly agricultural land, part of which is almost leveled with the river. In such lowland, the residents dig trenches to improve drainage of their farmland. This practice could be improved upon, through the use of such materials as stones and rubble, and also through plantation along ditches.

Some residents of Ward 5 watch the river carefully during monsoon, to prepare for flooding. At present, however, the river watching is undertaken individually. This practice should be organized into a communal effort, in which the local residents form a group to watch the river by turns.

Like Belbharin Dhadhawar VDC, some farmers plant a type of shrub (i.e., Bihiya) on the riverside to alleviate bank erosion. This practice should be also be applied to the proposed bank protection work. In doing so, however, several alternative species of shrubs/grasses should be introduced to the community (other than Bihiya) which can be used only for fences; there are other types which could be used for a variety of purposes (e.g., Khar, & Amlisso).

(9) Gulariya Ward 6

Revetment work is envisaged to protect the communal land in Ward 6 of Gulariya Municipality. The land adjacent to the river is currently used for open grazing. It is therefore desirable, if the river bank is to be stabilized, to initiate more organized grassland management, e.g., rotational grazing of pasture lands. Moreover, as part of the pasture management, the local residents should be assisted in planting ground-coverage grass.

Next to the open grazing are is a community forest of sisoo. While sisoo produces

quality poles, the tree is not as useful in meeting their immediate needs, such as fodder and fuel wood. The community forest hardly serves to alleviate overflow, since it is of single species. It is therefore desirable to encourage the community group to promote inter-cropping with other species that could provide fodder and fuel wood.

Like Belbhar in Dhadhawar VDC, some farmers plant a type of shrub (i.e., Bihiya) on the riverside to alleviate bank erosion. This practice should be also be applied to the proposed bank protection work. In doing so, however, several alternative species of shrubs/grasses should be introduced to the community (other than Bihiya) which can be used only for fences; there are other types which could be used for a variety of purposes (e.g., Khar, & Amlisso).

(10) Gulariya Ward 8

In Ward 8 of Gulariya Municipality, it is proposed to expand the existing small-scale spurs to revetment works of 600 m. When supported by DIO to install the spurs, the beneficiaries planted Bihiya to stabilize sand deposit areas. In this coonection, the same strategy as those proposed for Ward 5 and 6 should be followed in Ward 8 as well, in introducing alternative species of shrubs/grasses (e.g., Khar, & Amlisso). While Bihiya can be used only for fencing, there are other species that could be used for a wider range of purposes.

In addition to soil stabilization through bioengineering, the current practice of free grazing should be replaced with more organized management of pasture land, e.g., rotational grazing of pasture lands, and plantation of ground-coverage grass.

There are several ponds on the riverside. While these could serve as "retarding basins" at the times of flooding, support could be extended for deepening the ponds, and for planting shrubs and grass to stabilize the ponds.

(11) Gulariya Ward 10

It is proposed, with a view to protecting active bank erosion south of the highway linking Gulariya and Nepalgunj, to construct revetment work of more than 1km. Many residents in Ward 10 hope to have easier access to the highway for various reasons, e.g., to secure an evacuation route at the times of monsoon. Since the proposed revetment work is intended to stabilize the riverbank, support should further be provided to develop earthen roads along the riverbank. The road will also be crucial for the

livelihood, since it will facilitate the vegetable marketing in Gulariya; the main agricultural product in Ward 10 are vegetable.

There is a community forest in Ward 10, for which the residents transplant Babul during the month of July. However, since it is the monsoon season, the young seedlings of Babul are liable to being washed away. The user group should therefore be encouraged to wait until end August.

There is one pond in Ward 10 that was created as a result of flooding. This pond could potentially be used as a fishpond.

6.4.5 Examples of Community-based Actions for Flood Mitigation

(1) Bagnaha VDC

In Ward 1 (Saphipur), DIO provided spurs for bank protection, to safeguard one irrigation channel from land cutting. The local traditional irrigation group (i.e., Chaudary) came forward to plant one type of shrub (i.e., Behiya) at the sand deposit areas of the spurs, to augment the DOI-provided structures.

(2) Baniyabhar VDC

In construction bank protection spurs with DIO support in Ward 3 (Kumaragau), the VDC mobilized ALL the beneficiaries (140 households) to provide voluntary labor contributions (usually only a few beneficiaries are hires as paid laborers). However, since it was difficult to motivate landless to participate voluntarily (i.e., they do not have land to be protected), DIO provide 1 lakh rupees to pay for the landless.

Some of the farmers in Ward 3/4 (Kumaragau/Mainawar) have adopted agricultural recovery strategies to plant "catch crops" after their land is covered by sand. Such crops include Bitter Gourd, Pigeon Pea, & Groundnuts etc.).

(3) Padnaha VDC

In Ward 8 (Barbatta, Ranipur), the beneficiary group was mobilized to contribute voluntary labor for the boulder transportation of boulders and GI boxes (among other activities) which are usually left to contractors in other projects. The total contributions by the beneficiaries, in terms of monetary value, amounted to 2 lakh

rupees, while DIO only paid 1 lakh rupees plus GI boxes.

(4) Dhadhawar VDC

In Ward (Balbhar), some farmers prepare again flooding, by planting summer maize earlier than other farmers. With this adjustment, even when their land is

(5) Mahamadpur VDC

In Ward 9 (Bikri), some residents implement a traditional slope stabilization measure, using some shrubs and tree branches. This practice helps stabilize the river bank adjacent to the proposed site for revetment construction.

In the same Ward, the whole community entrusts fishers, herdsmen, and farmers, whose "workplaces" are close to the rivers, to watch rivers during daytime. These include observing such natural clues as leaves and branches floating

(6) Sano Shri VDC

In Ward 3 (Kusumba Bazar), what accelerates the land cutting in this proposed site is gully erosion of the riverbank. Villagers have already constructed earthen drainage with a view to controlling gully erosion on the riverbank. (Although there is still room to improve drainage "design" with some stone and rubbles).

(7) Gulariya Ward 5&6

Local residents collectively plant one type of shrub (i.e., Beiya), as stand-alone "bank protection" work. This strategy help reduce the extent of land cutting, but it is to be noted it works only in those areas where the velocity of water flow is so low that shrubs alone can counteract.

DIO provided spurs for the bank protection purpose. To strengthen the DIO-provided structures, the community came forward to plant one type of shrub (i.e., Behiya) at the backside of the spurs, to stabilize the land adjacent to the DOI-provided structures. For this purpose, the Ward members started a "campaign" to encourage the residents to provide voluntary labour for a few days. In addition, the school teachers took children also to help plant the shrub.

(8) Gurariya Ward 10

In this Ward of Tharus who are indigenous to the Terai plain, the residents have their traditional ways of safeguarding their properties. These include, using cow feed pots as evacuation boats, and tying bullock carts to nearby trees with a view to storing valuables on the floating carts.

6.5 Proposed Project Works

As a summary of project planning in the previous sections, general location map and general plans of the project works are shown in Figs. A6.11 through A6.13.

The community surveys have revealed unique variations among different localities, in terms of requirements for "Community Development" activities. Instead of formulating straightjackets, therefore, VDC- or ward-wise strategies should be developed based upon the overall framework provided in the following Table A6.16. Moreover, several villages have their own peculiar needs that are not common to other localities. It should be noted that such unique cases are not included in the summary table presented below, but will be presented in the final report. At this stage, the VDC-/ward-wise "Community Development" strategies are briefly presented in the Fig A6.13, which shows some examples of how the "Flood Control Component" and the "Community Development Component" can be combined to work toward "Comprehensive Flood Mitigation".

6.6 Project Implementation Program and Maintenance Plan

6.6.1 Project Implementation Plan

(1) Sequence of Works

The priority project is proposed for implementation by the year of 2007 considering the roles of the project as pilot work. The project works must be carried out effectively in orderly manner, and the people shall enjoy the effect of the project even in the course of project implementation. In view of these, consideration was given to the work sequence.

Preparatory Works: Upon completion of the Feasibility Study, the following activities should be taken immediately:

1) **Fund arrangement**
2) **Definite plan/detail design:** A definite plan of the flood mitigation works, including establishment of river boundary line (RBL), will be drawn up after getting consent of the agencies and communities concerned. A detailed design will be prepared of the project facilities.
3) **Environmental study:** In parallel with the definite plan and detail design, environmental study will be conducted in accordance with the procedures stipulated in the Environmental Conservation Rules to get approval of MOPE for project implementation.
4) **Preservation of Lands:** Population in the Terai is growing rapidly. Because of this, more and more people are living in flood prone areas close to the rivers. Therefore, it is essential to preserve the lands for flood mitigation facilities. This should start immediately after the preparation of definite flood mitigation plan. Appropriate land use should also be encouraged as outlined in the definite plan and detail design.
5) **Coordination among agencies and communities:** Coordination should be started as soon as possible after completion of the Feasibility Study, in order to mobilize agencies and communities concerned toward project implementation.

Community Development:

1) Community development activities should precede the implementation of the river control works.
2) Community mobilization and local coping strategy should go first in parallel with the definite plan study. Community mobilization is a key for the successful project implementation.
3) Local flood mitigation works will be executed in line with the definite plan.

Watershed Management:

1) Afforestation and land use regulation and publicity activities can be started immediately.
2) The erosion control test works in the Lakhandei river will be commenced upon completion of the detailed design.

River Control:

1) Flood hazard map will be prepared refining those prepared in this stage during the definite plan stage.
2) The river control works will be started upon completion of the detailed design.

3) Sequence of implementation among the component works is not important. Any work can be started basically at any places where the inceptive procedures are ready.

Associate Activities: The following associate activities are required to be started soon. These activities will support the effective project implementation.

1) **Research and Investigation:**
   - **Flood and sediment runoff:** Study on flood and sediment runoff especially for class III rivers originating at Siwalik hills. Observations on a designated model basin would serve this purpose.
   - **Bank erosion mechanism:** Characteristics of bank erosion in the Terai have yet to be investigated. Erosion mechanisms, erosion speed and width, etc. should be investigated in relation with the river segment, riverbed and bank materials, river flow condition, etc.
   - **Bank protection works:** Various types of bank protection works should be introduced and investigate the works fit with the conditions of rivers in the Terai. Hydraulic model tests in the laboratory and prototype in field will evaluate the effect of bank protection work.
   - **Bioengineering technology:** In order to introduce bioengineering technology as a component of flood mitigation, research works are necessary mainly for the selection of plant species, type and function of work applicable, cultivation techniques, and contribution to income generation.
   - **Construction materials:** Effective and economic use of local materials such as boulders, sands, bamboo, trees, etc. should be investigated.

2) **Technical Guidance:**
   - **Publicity of existing technical know-how:** Accumulation of experience and know-how related to the flood mitigation, and supply them to the implementing agencies and organizations.
   - **Consultation on technical problems**
   - **Training:** Training of local leaders for basic techniques necessary for the river training and bank protection works, etc.

(2) Time Schedule

1) Implementation of the works for the Lakhandei and Babai rivers are scheduled in advance to the other river basins for M/P study as priority project.
2) Time schedule for the Babai river is outlined as follows (Fig. A6.14):
   - June, 1999-June, 2001: Fund arrangement, definite plan, and other inceptive procedures
   - June, 2000-June, 2001: Definite plan, detailed design, environmental study, and community mobilization
   - June, 2000-June, 2007: Intensive implementation of community development activities, though the activities should be continued ever since.
   - June, 2001-June, 2005: Civil works for river control component
   - June, 2001-June 2007: Intensive implementation of local flood mitigation works, the works should be continued ever since.

(3) Roles of Agencies/Organizations Concerned

Various agencies and organizations are incorporated in implementation of the project works. The following are the proposed roles of concerned agencies/organizations in the project implementation (Fig. A6.15):

1) Overall coordination by DOI.
2) Technical guidance by DOI, DOSCWM, DPTC, and other institutes as required.
3) Works to be implemented, in principle, by the beneficiaries such as local communities and VDC/DDC.
4) Large scale works and basic facilities for flood mitigation to be implemented by DOI or DOSCWM.
5) Urgent works to be implemented by DOI, DOSCWM, and other organizations.

(4) Required External Input

Considering the financial constrains of the MHG/N and necessity of intensive implementation of the work as pilot project, the following external inputs are required for the project implementation:

1) Financial assistance, especially for the river control component

2) Technical assistance for watershed management, river control and community development components. Especially for the community development, it is proposed that a expert group stations in the community and promote the activities collaborating with the community peoples. The expert group should include various field of expert such as community development, forestry, agriculture, and flood mitigation.

6.6.2 Organization for Project Implementation

(1) Coordinating/Implementing Agencies

The flood mitigation program will be managed by the DOI Project Management Office (PMO) to be set up at the district level. The PMO will comprise three divisions, i.e., an Upper Catchment Conservation Division, Flood Control Division, and Community Development Division. As shown in Fig.A6.16, it is expected that DOSCWM will depute its staff to work as the Chief of the Upper Catchment Division, while DOI staff will fill all the other key posts.

The River Control Division will take the lead in the design and construction management of the River Control Component. At the same time, the local government institutions (LGIs) also play an important role to match the DOI's resources with local communities. The LGIs will assist DOI in aggregating local information required for the design of the physical facilities, and also will encourage community organizations (COs) to make in-kind (labor, land, and material)/cash contributions to the construction of the flood control facilities. During the maintenance phase, also, LGIs will assist COs, when necessary, to liaise with DOI and other agencies to provide external skills and resources for the rehabilitation of flood control facilities. The River Control Component will draw largely upon bioengineering measures. The River Control Division will therefore seek, as and when necessary, technical as well as material inputs (e.g., seedlings and samplings) from technical line agencies such as the DOF and DOSCWM.

The Community Development Division will implement the Community Development Component. The Division will maintain close coordination with the LGIs. Under the overall coordination and supervision of the PMO Division, the LGIs will undertake community mobilization to assist communities to organize themselves, and will assist their community organizations (COs) to implement community-based flood mitigation measures. The community development activities envisage a range of activities which

no single agencies can handle on its own. Accordingly, the Community Development Division will mobilize technical line agencies, e.g., DOSCWM, and DOA to provide technical and material inputs for community development activities.

A District-level Coordination Committee (DCC) will also be established, to provide coordination between the PMO and other relevant agencies which will participate as Cooperating Agencies (the details of the Cooperating Agencies' roles are provided in the following section). As shown in the figure on the implementation arrangement, the DCC will draw membership from the District Development Committee (DDC) as well as other line agencies. The latter include the Departments of Soil Conservation and Watershed Management (DOSCWM), Forest (DOF), and Agriculture (DOA). The Chief District Officer (CDO) will also serve as a DCC member.

At present, all the district-level DOI's resources for flood control are channeled through the District River Training Coordination Committee (DRTCC). On the other hand, the master plan will replace DRTCC with DCC, since the latter has the following advantages over DRTCC:

- **All the flood-prone villages will be directly represented in DCC,** to provide an open and transparent forum for interactions between the district and the villages (whereas DRTCC is composed only of district-level representatives, which often is the cause of irrational allocation of funding).
- **DCC will draw members from pertinent line agencies,** i.e., DOSCWM, DOF, and DOA for a more comprehensive approaches to river training (whereas DRTCC does not include any line agencies, which makes it difficult to coordinate river training, with other related developmental activities).

(2) Cooperating Agencies

The DCC member institutions will participate in the program implementation, as the cooperating agencies. The flood mitigation program is a multi-sectored undertaking which no single agencies can handle on its own. Accordingly, DOI will mobilize technical line agencies as well as local government institutions, who will take on the tasks and responsibilities explained below.

<u>Technical Line Agencies</u>

DOSCWM :

1) Initiate programs aimed at soil conservation in the Chure range.

2) Provide seed and seedlings, as well as technical support for soil conservation.
3) Offer technical advice and also provide seedlings to protect infrastructure, soil erosion and flooding.

DOF:

1) Assist in establishing green belts along riverbanks.
2) Provide seed and saplings, as well as technical support.
3) Hand over forest /riverbed management to local communities wherever feasible.
4) In the watershed – hand over management of the forests to the local communities wherever feasible, and assist in their management.

DOA:

1) Provide technical advice on safe cultivation on the riverside.
2) Offer awareness building and seedlings to support in crop production that would minimize river cutting and flood damage.

CDO:

1) Resolve conflicts when DDC/VDCs alone cannot handle.
2) Make available district-level Natural Calamity Fund for community-level flood management.
3) Coordinate relief activities with the overall Flood Mitigation Plan.

Local Government Institutions (LGIs)

DDC:

1) Undertake the "Community Development" component, in collaboration with the VDCs, and communities.
2) Contribute some funding/other resources for "Community Development", in accordance with financial capacity.
3) Promote inter-VDC coordination, and/or coordination between DIO/other line agencies and the VDCs.
4) Shoulder the responsibility of regular monitoring and minor repair in partnership with the VDC/municipality.
5) Resolve conflict among different VDCs.
6) Include the program as a priority sector in district planning.

VDC / Municipality:

1) Collaborate with the DDC and local communities to conduct the "Community Development" component.
2) Contribute some funding/other resources for "Community Development", in accordance with financial capacity.
3) Undertake regular maintenance and minor repair.
4) Mobilize community participation.
5) Set criteria of community/individual contribution on the basis of equity.
6) Control encroachments/inappropriate practices along riverbanks.
7) Take the main role to minimize and resolve conflicts, if any.

In view of upgrading the LGIs' capabilities to undertake these crucial roles for "community development", a series of training workshops will be undertaken at the inception of "community development" activities, as mentioned in the section on "Community Development".component.

6.7 Project Cost

6.7.1 Basic Conditions for Cost Estimates

Price Level: All unit costs are expressed under the economic conditions prevailing in October 1998.

Currency Exchange Rate: Currency exchange rates are assumed as follows:

US$1.00 = NRs.67.93 = ¥115.14 (NRs.1.00 = ¥1.69)

Composition of Project Costs: Project costs are composed of construction base cost, compensation cost, administration cost, engineering service cost, physical contingency, price contingency and value added tax. Calculation is carried out based on the following:

1) Construction base cost: Unit cost basis
2) Compensation cost: Unit cost basis
3) Administration cost: 5% of [(1) + (2)]
4) Engineering service cost: Lump sum basis
5) Physical Contingency = 10% of [(1) + (2) + (3) + (4)]
6) Price contingency (Financial cost only): At annual escalation rate of 3 % for the foreign currency, and 10 % for the local currency portions

Labor Wage: Basic labor wages were obtained from government agencies and the private sector. These rates were carefully examined and the agreed rates are shown in Table A6.17.

Unit Operation Cost of Heavy Equipment: Unit operation costs of heavy equipment are shown in Table A6.17. Operator, fuel and other administrative fees such as insurance, maintenance and so on are not included in the costs.

Unit Prices of Materials: Unit prices of construction materials available at the site and those that have to be delivered from other districts through suppliers or dealers are determined using current market prices. The construction material costs are listed in Table A6.18.

Foreign Currency and Local Currency Portion: Project cost consists of the foreign currency portion (F.C.) and the local currency portion (L.C.). The components of the major work items are given as follows:

Item	F.C. (%)	L.C. (%)
1. Labor wage	0	100
2. Owing cost of heavy equipment	100	0
3. Material unit cost		
- Cement	50	50
- Aggregate	60	40
- Fuel	50	50
- Deformed reinforcing bar	80	20
- Timber	10	90
4. Compensation cost	0	100
5. Administration cost	0	100

Financial Cost and Economic Cost: Financial cost is estimated as an actual expenses of the project owner on the market price basis, whereas economic cost for project evaluation is reckoned in terms of net usage of sources. The transfer cost such as tax and duty, and contractor's profit are, therefore, not considered in the economic costs. Hence, the economic project costs were estimated from the financial project costs deducting 10% for transfer costs and contractor's profit.

6.7.2 Estimation of Project Cost

Project cost is estimated based on the design and construction schedule described in the previous chapters.

(1) Unit Cost of Construction Works

Construction base cost is estimated by multiplying the unit cost and the corresponding work quantity. Preparatory and miscellaneous works are estimated on lump sum basis as 10 % of main works. The unit cost for each work item consists of the cost of materials, labor and equipment. Contractor's indirect cost is also incorporated in the unit cost of each work item.

Unit costs, by work item, are established by analyzing the data of similar works implemented in recent years. The local conditions in study areas are also taken into consideration. In addition, the fittest unit prices of materials estimated through the detail research in study areas are applied to the Babai river. The unit work costs are shown in Table A6.18.

(2) Project Cost of River Control Works

The project costs of the proposed river control works for the Babai river was estimated as shown in Table A6.19 respectively and summarized below:

Item	Babai river (million NRs)
1. Construction Base Cost	338.7
2. Compensation Cost	26.6
3. Administration Cost	18.3
4. Engineering Cost	67.7
5. Physical Contingency	45.1
6. Value Added Tax	49.6
7. Grand Total	546.1

Note: Price Contingency is not included.

(3) Operation and Maintenance Cost

The annual operation and maintenance costs include the salaries of project administrative and operation staff, the material and labor costs for project facilities.

The annual O&M costs were estimated to be 0.5 % of the total construction base cost.

6.7.3 Annual Disbursement Schedule and Fund Required

Annual disbursement of investment costs was estimated on the basis of the implementation schedule. The disbursement schedule of financial costs for the Babai river is shown in Table A6.20 respectively. The funds required for the project implementation are estimated at Rs.744.7 million for the Babai river as summarized below.

Items	Babai river (million NRs)
Project cost	546.1
Price contingency	198.6
Fund required	744.7

6.8 Evaluation

6.8.1 Economic Evaluation

Economic viability was examined for the flood mitigation projects proposed for the Feasibility Study for the Babai river basin. Flood damage reduction benefit, bank protection benefit and indirect benefit were considered for the evaluation.

Flood Damage Reduction Benefit: At the beginning of the Feasibility Study stage, topographic mapping and river survey were conducted for the Babai river. Therefore, the flood damage reduction benefit was estimated based on the simulation results of flood flows in this river. The flood reduction benefit is defined as a balance of flood damages under the conditions without and with project.

Bank Protection Benefit: The bank protection benefit was estimated as a loss of land and properties on it.

Evaluation: Cash flows of the project cost, maintenance cost and benefit were prepared according to the proposed implementation schedule. Annual disbursement schedule was prepared according to the implementation schedule proposed for the Babai river, i.e., detail design in 2000 and construction works 4 years from 2001 to 2005.

Cash flows of the project cost, maintenance cost and benefit are shown in Table A6.21.

As indexes of the economic viability, the EIRR, B/C and NPV-values were worked out in the table. The results are summarized below.

River	Existing basin			Future basin		
	EIRR (%)	B/C	NPV (10^6Rs)	EIRR (%)	B/C	NPV (10^6Rs)
Babai	9.7	0.98	-8.7	15.2	1.54	188.7

Note: B/C and NPV were calculated under the discount rate of 10 %.

Methodology and procedures of economic evaluation of the project are compiled in SUPPORTING REPORT-C.

6.8.2 Environmental Screening

(1) General

An environmental screening was undertaken following the JICA environmental screening process, since there is no statement for environmental screening in Environmental Conservation Rules (ECR) of Nepal. The screening is termed an "initial environmental examination" by JICA. However, it should not be confused with the IEE as specified in Environmental Conservation Rules of Nepal. This latter is a detailed and prolonged environmental assessment, where as the former is an environmental screening to determine which specific projects or areas within a project require detailed environmental studies. Thus in order to avoid confusion the JICA "initial environmental examination" will be termed as "Environmental Screening (ES)".

(2) Results of Environmental Screening

The flood mitigation plan for the Babai river is to align and demarcate the two river banks below the Royal Bardiya Wildlife Reserve in the Terai so as to minimize flood damage. These banks will then be stabilized by vegetative means (trees and grasses etc.) in the upper reaches of the river and with dykes and vegetation in the lower reaches. Occasionally, some river channels will have to be blocked, a few banks reinforced and perhaps one or two bends straightened. Where houses are in danger of being eroded and washed away, they will be relocated to safer ground. Access roads will be built along the dykes and embankments. There are 12,812 hectares of listed wetlands along this river, mainly within the reserve. There is also a buffer zone round the reserve, some of which will be along the river in the Terai. The relevant wetlands and buffer zones will be mapped, their use tabulated and a plan formulated to protect them, where feasible.

Screening forms filled as a result of environmental screening evaluation are shown in Tables A6.22 through A6.24 for social environment assessment, natural environment assessment and pollution assessment, respectively.

(3) Overall Evaluation

The flood mitigation interventions on the Babai river basin are environmentally positive. Flood mitigation interventions will only occur along those parts of the river outside the Royal Bardiya Wildlife Reserve. Thus the interventions will be confines to about 52 km. of river in the Terai, below where it emerges from the reserve. In these areas, the two river banks will be realigned and demarcated so as to minimize flood damage. These new alignments will be reinforced by physical and/or vegetative means, namely dykes, embankment support, river training, and the planting of trees and grasses. These interventions will minimize flooding, decrease soil erosion from river banks and farmer's fields, minimize river course changes, reduce the deposition of coarse gravel, sand and soil particles on farmland and curtail house flooding and subsidence. It should also decrease the incidence of raw human sewage spilling into rivers, thus reducing infections.

Some houses may have to be relocated and some farmland taken if they are on the new alignment or on the river side of the new alignment: these measures cannot be undertaken without the consent of and compensation for the affected people. However, by stabilizing the river course and minimizing flood damage, existing land (and houses) near to the river will be protected from degradation and previously degraded land can be reclaimed. So there should be a considerable net benefit. Also, the land on the riverside of the embankment may still be farmed during the "dry" season.

These interventions cannot be successful without the approval and active participation of the people living along or in the vicinity of the rivers. Flood mitigation measures, including repair and maintenance of the existing and proposed structure are ongoing activities. If the people are not involved in and approve of these activities from the outset, then the chances of successful flood mitigation measures will be minimal. Village Development Committees, Municipalities and District Development Committees must be a party to the plans and play an active role in their formulation, amendment and approval. The plans should also be dynamic and subject to alteration, addition and improvement as a result of learning from interventions in this and other river systems. However, the overall plan should not be subject to a rigorous

environmental examination. This should be reserved for "fragile" areas that may be adversely affected.

There is need to undertake IEE's in areas where large-scale structural riverbank protection is required, (one kilometer or more) and perhaps where people are displaced. There are significant wetlands and buffer zones along the river. Where wetlands occur outside the national park (and buffer zone) they will be mapped. However, according to IUCN/Nepal, there is no identified wetland within 1 km. of the Babai river in the Terai. Therefore, no EIA study should be necessary, but if any wetlands are found along the river, and flood mitigation interventions are proposed, then an EIA's will be undertaken in these areas, to ensure that they are afforded protection. No EIA should be required in the buffer zones, if the flood mitigation interventions are in accordance with the buffer zone management plans. Otherwise an EIA will have to be carried out.

(4) Environmental Inventory along Babai River in Terai

The Babai river was chosen as a priority river to demonstrate various flood mitigation initiatives. Detailed investigations were carried out along this river, two of which were environmental studies. One of the studies was an environmental inventory along the river and the other was an assessment at four specific sites along the river. The results of these surveys are summarized below. A summary of the principal findings is given here.

Over 4,000 hectares of land in a strip of about 410 meters on either side of the Babai river was surveyed. The following table gives a breakdown of the land use in 1998 in this strip.

(Babai River Belt: Land Use and Land Ownership)

Land Use	Land Ownership (ha)				
	Private	Public- state	Public - community	Total	%
Cultivated land	1,525	110	0	1,635	40.1
Barren land	0	455	0	455	11.1
Forest land	6	1,148	806	1,960	48.1
Building area	21	0	0	21	0.5
Road/canal area	0	8	0	8	0.2
Total area	**1,552**	**1,721**	**806**	**4,079**	**100.0**
percentage	38.0	42.2	19.8	100.0	

An estimated 48% of the land in the riverside strip is forested, 40% is cultivated (including pasture), 11% is barren and buildings and infrastructure occupy the

remaining 1%. Most of the cultivated land is privately farmed (93%), whereas practically all the forestland is public. Of the forestland, communities manage over 40%: these are mainly plantation areas of *Dalbergia sissoo*. Thus 62% of the land is public and only 38% are in private hands. This should help when fixing the River Boundary Line (RBL).

The survey estimated that 5,295 meters of riverbank were eroded this monsoon period: this amounts to 5.3% of the bank length. Over half the erosion occurred on public land, and some riverside trees were washed away, including mature sal (*Shorea robusta*), a protected tree species. One village of 20 houses was completely destroyed and the families are now living in temporary shelters in a government plantation.

The table below gives the number of buildings counted in both riverside strips, the number of houses in danger, destroyed or moved because of flooding, with an estimate of the population. The lengths of erosion and road damage are also given.

(Babai: Population, Buildings and Flood Damage in the Riverside Strips)

Babai river: left and right river strips	
Length of river in the Terai (m)	49,480
Average width of strip (m)	409.2
Number of houses in the area	1,980
Houses destroyed or moved in 1998	50
Houses in danger from flood damage	66
Number of other building in the area	29
Number of people living along the river bank strips	9,820
Population density: people per hectare (ha/person)	2.4 (0.42)
Length of river bank erosion (m)	5,295
Length of road damage (m)	0

Nearly 10,000 people live in 1,900 houses along the narrow strip of land next to the Babai river, with on average a building every 50 meters. Thus, this area is fairly densely inhabited and severe flooding would seriously affect many people. In 1998, fifty houses were destroyed or had to be salvaged and moved because of flood damage. A further 66 houses are in danger of being destroyed in future flood periods.

If and when a flood mitigation project is undertaken along this river, an Initial Environmental Evaluation (IEE) is required regarding the 66 houses that may have to be moved or protected with ring dykes. Again, if the mitigation measures will affect the "Black Buck Conservation Area," then an Environmental Impact Assessment is

required.

This Environmental Inventory highlighted the great contrast between the Lakhandei and the Babai river areas. There are nearly five times more people living along the Lakhandei compared to the Babai. Hence, twice as much land is farmed along the Lakhandei compared to the Babai. There are seven times more forest areas along the Babai than the Lakhandei. This could account for more than twice as much riverbank being eroded along the Lakhandei. In general, the environmental conditions are much better along the Babai compared to the Lakhandei. There is a greater number and variety of flora and fauna and most people burn fuel wood as opposed to residues and dung along the Lakhandei. However, if nothing is done to improve agricultural productivity, then in about 20 years time, the Babai may resemble the present conditions along the Lakhandei. This is why flood mitigation interventions are so important.

(5) Environmental Study for River Training along Babai.

For the Master Plan, much river training work was proposed along the Babai. Four of these proposals would require an IEE at the project proposal stage. Therefore, it was decided to undertake a detailed environmental assessment at these four sites to test the Environmental Conservation Rules and to seek the views of the people at or near these particular sites. Alternative proposals at two sites considered river channeling as opposed to bank protection. Both these alternatives were examined in the Environmental Study.

During the Feasibility Study stage, a more detailed study has been undertaken. As a result of this study, about 25 river training interventions are being contemplated, of which 10 are more than 1 km. in length and, therefore, require IEE's at the project proposal stage.

The first river training proposal is in the Buffer Zone near the National Park. This is about 5 km below the E-W highway on the west bank. This bank protection measure would protect two irrigation canals, supplying water to nearly 5,300 hectares. The local Buffer Zone User's Committee and the National Park personnel were very receptive to this riverbank strengthening proposal and the User's Committee promised support in terms of labor inputs. No negative environmental impacts were envisaged at this site, except perhaps at the building stage when water turbulence may increase temporarily.

The second site is about 20 km. downstream at a sharp bend. At this point the river changes direction from flowing south to flowing east. The river is eroding the southern bank and trees from an old sal forest are being washed away. There is a main road near this bend as well as a temple on the riverbank; this is in danger of being destroyed. In 1998, a village of 20 houses was washed away on the northern bank and the people are living in temporary accommodation. Two alternative proposals were considered – bank strengthening and river channeling. The latter is more expensive, but there is little difference between the two when a cost/benefit analysis is undertaken. From an environmental perspective, the river channeling is more beneficial, for it will afford greater protection to the sal forest, the temple and the road. The local people are also in favor of the river channeling work.

The third site is 4 km. further downstream from the second site, just before the river changes direction and turns southwards. At this site it is proposed to strengthen the south bank to prevent the river from taking an old course. If this occurs, it will threaten the Black Buck Conservation Area, about 1,000 ha. of farm land and parts of Gulariya municipality. Again the environmental benefits of such an intervention are very positive.

The final site is near Indrapur bridge close to the Indian border. At this site the river meanders considerably. Two options were considered – bank strengthening and river channeling. The latter option would cost Yen 20 million more, but would provide over Yen 100 million more in benefits, principally because about a net 85 ha. would be reclaimed. The environmental benefits from the river channeling are also more beneficial, because there would be an increased tree and grass cover and erosion should decrease.

The overall conclusion of these four environmental studies along the Babai river is that the environmental benefits of the proposed interventions are very positive and the people are overwhelmingly in favor of these interventions. These investigations followed the Environmental Conservation Rules. It showed that although the rules were designed for discrete projects, they can be applied to river training proposals. Therefore, the methodology in this study can be used as a model when actual projects are proposed.

6.8.3 Technical Evaluation

The flood mitigation activities must be undertaken in a sustainable way. Therefore, the plan must fit well with the local situation, the technical capability and financial solvency of the central and local government agencies, non-governmental organizations and local communities concerned.

In planning the flood mitigation plan of the rivers in the Terai plain, efforts were made for the plan to meet these requirements as presented below.

1) **Consideration on Local Situation:**
   - Bottom up procedures by community development activities are proposed for planning and implementation of the project.
   - Maximum use of local materials is proposed, and the works proposed are labor intensive.
   - Considering the potential disastrous situation of the Study Area, stage-wise approaches are proposed so that the residents could enjoy the benefits soon after they have been finished the component works invested.
   - The proposed works are selective for their sizes and able to enhance their function depending on the requirements and solvency of the local communities.

2) **Consideration on Technical Capability:**
   - The proposed works are mostly simple for their construction and maintenance as far as the appropriate instructions are given timely by the DOI/DIO engineer.
   - Participation of local communities in flood mitigation work is proposed. Through the experience of participation, local community will also learn the technique for flood mitigation and improve their awareness. This would contribute much to the sustainability of the project operation.
   - The proposed river control measures will be improved through on-site experience so that the measures will be more effective, practical and economic.

3) **Consideration on Financial Solvency:**
   - Taking into consideration the financial strictures of the country, low cost

and labor intensive project is proposed with full use of local materials.

- In addition to the procurement of fund from central and local government, in-come generation measures are proposed as a part of community development activities.

6.8.4 Summary and Conclusion

1) **Economic Viability:** Implementation of the Master Plan will bring about various tangible and intangible benefits, to the communities in the Study Area. Though the economic viability is not high under the existing basin conditions, it shows higher viability in future basin. The proposed works can be started from any place and at any size. Project works can be implemented from those of higher cost-performance, keeping pace with basin's development.
2) **Environmental Impacts:** From environmental conservation viewpoint, the proposed project will exert favorable effects on social and natural environment and no pollution problems are envisaged. Only problems found so far are conservation of wetlands most of which have already been developed as farmlands or are in protected areas of national parks and wildlife reserves.
3) **Technical Aspect:** The technology proposed for the Master Plan is appropriate, since the plan took due consideration of the local situation, the technical capability of the people and financial solvency of the country, etc.
4) **Conclusion:** In conclusion, the proposed master plan is economically and technically feasible and exerts little adverse effect to the environment. The implementation of plan is recommended in order to promote and support people's livelihood and the sound development of the Terai plain.

PROFILE OF DOI'S NATIONAL-LEVEL RIVER TRAINING PROJECTS

Project Name	Fiscal Year	Description	Total Budget (Rs.)	Source of Funding
Rajapur Irrigation	1991/92 - 97/98	A irrigation project (15,800 ha. of land in 11 VDCs), with a component for flood control works	204,502,000*	HMG, & Asian Development Bank
East Rapti Irrigation	1992/93 -	A irrigation project (5,200 ha. of land), which includes 18 km long embankment, with some additional river control works	291,888,000*	HMG, & Asian Development Bank
Bagmati River Training	1994/95 - 99/00	Construction of 10 km embankment as well as spurs (also when require, emergency protection works)	79,765,000	HMG
Banganga River Training	1996/97 - 98/99	Construction of 1.5 km length of boulder/earthen bund, with river diversion and channelization work.	28,5000,000	HMG
Extension of Right Embankment along Lalbankeya	1996/97 - 97/98	Extension of embankment (by 9.5 km) along Lanlbankeya river	52,146,000	HMG, & Govt. of India
Bakra River Flood Protection	1997/98 - 99/00	River control covering from foothill to Indian border, with main construction works of 66.5km embankment, 104 spurs, and 14.6 km revetments.	370,000,000	HMG, & OPEC Fund

source: Dept. of Irrigation

* only budget for river training component

SEVERE MEANDERING OF BABAI RIVER AT INDRAPUR BRIDGE

Descriptions	Alternative-1 (Existing route)	Alternative-2 (Cut-off channel)
SCHEME DESCRIPTION	Intensive bank protection of existing river channel	Cut-off channel
TECHNICAL ASPECT		
- Quantity of work	- New channel: None Excavation: None - Spur: 38 pcs. - Revetment: 2,750 m - Closing dike: None	- New channel: 1.4 km Excavation: 390,000 m^3 - Spur: 7 pcs. - Revetment: 1,450 m - Closing dike: 44,880 m^3 - Reclamation of land: 100 ha
- Difficulty in work	Not difficult	New channel
- Ranking (Wt=0.15)	1	2
FINANCIAL ASPECT		
- Project cost	Rs 52.0 million	Rs 48.7 million
- Maintenance cost	High	High
- Ranking (Wt=0.40)	2	1
ECONOMIC ASPECT		
- Project effects	- Same as other scheme	- Same as other scheme
- Other positive/negative effects	- Though the bank protection will be achieved, flood flows in meandering channel still attack the bridge approaches.	- A part of existing river area can be reclaimed
- Ranking (Wt=0.15)	2	1
SOCIAL ASPECT		
- Relocation of houses	None	None
- Land acquisition	None	11 ha of land on opposite side bank of beneficiaries 100 ha of reclaimed land on Glaria side
- Ranking (Wt=0.15)	1	2
ENVIRONMENTAL ASPECT		
- Negative impact	Not identified	Small portion of forest on right bank must be cut.
- Positive impact	Not identified	Not identified
- Ranking (Wt=0.15)	1	2
OVERALL EVALUATION		
- Summary of ranking	**1.53**	**1.44**
- Special remarks	None	None
- Evaluation	Not selected	**SELECTED**

(REMARKS) Wt: Weight for overall evaluation

SHARP BEND OF BABAI RIVER NEAR KUSUMBA BAZAR

Descriptions	Alternative-1 (Existing route)	Alternative-2 (Cut-off channel)
SCHEME DESCRIPTION	Intensive bank protection of existing river channel	Cut-off channel
TECHNICAL ASPECT		
- Quantity of work	New channel: None Excavation: None - Spur: 62 pcs. - Revetment(Type-Rb): None Revetment(Type-Rc): 1,450 m - Closing dike: None	New channel: 1.3 km Excavation: 825,000 m^3 - Spur: 24 pcs. - Revetment(Type-Rb): 2,950 m Revetment(Type-Rc): None - Closing dike: 44,880 m^3
- Difficulty in work	Not difficult	New channel
- Ranking (Wt=0.15)	1	2
FINANCIAL ASPECT		
- Project cost	Rs 88.9 million	Rs 109.5 million
- Maintenance cost	High	High
- Ranking (Wt=0.40)	1	2
ECONOMIC ASPECT		
- Project effects	- Same as other scheme	- Same as other scheme
- Other positive/negative effects	- Though the bank protection will be achieved, flood flows still attack the bridge approaches.	- Flood attack to downstream left bank can be alleviated
- Ranking (Wt=0.15)	2	1
SOCIAL ASPECT		
- Relocation of houses	None	None
- Land acquisition	None	25 ha Forest land
- Ranking (Wt=0.15)	1	2
ENVIRONMENTAL ASPECT		
- Negative impact	Not identified	Forest on the left bank must be cut.
- Positive impact	Not identified	Not identified
- Ranking (Wt=0.15)	1	2
OVERALL EVALUATION		
- Summary of ranking	**1.13**	**1.84**
- Special remarks	None	None
- Evaluation	**SELECTED**	Not selected

(REMARKS) Wt: Weight for overall evaluation

COSTS ESTIMATED FOR ALTERNATIVE SCHEMES

ALTERNATIVES AT SEVERE MEANDERING OF BABAI RIVER AT INDRAPUR BRIDGE

(unit: NRs1,000)

Item	Unit	Alt.1 (Existing Route)			Alt.2 (Cut-off-channel)		
		Quantity	Unit Price	Amount	Quantity	Unit Price	Amount
Spur	pc	38	580.80	22,288	13	580.80	7,696
Revetment	m	2,750	10.79	29,673	1,850	10.79	19,962
Closing Dike	m3	0	0.11	0	11,440	0.11	1,258
Excavation	m3	0	0.09	0	390,000	0.09	35,100
Land Acquisition	ha	0	240.00	0	11	240.00	2,640
House Evacuation	pc	0	0.00	0	0	0.00	0
Land Development	ha	0	0.00	0	100	180.00	-18,000
Total				51,961			48,656

ALTERNATIVES AT SHARP BEND OF BABAI RIVER NEAR KUSUMBA BAZAR

(unit: NRs1,000)

Item	Unit	Alt.1 (Existing Route)			Alt.2 (Cut-off-channel)		
		Quantity	Unit Price	Amount	Quantity	Unit Price	Amount
Spur	pc	62	580.80	36,191	24	580.80	14,121
Revetment(Type-Rb)	m	0	10.79	0	2,950	10.79	31,831
Revetment(Type-Rc)	m	1,450	36.32	52,664	0	36.32	0
Closing Dike	m3	0	0.11	0	11,440	0.11	1,258
Excavation	m3	0	0.09	0	825,000	0.09	74,250
Land Acquisition	ha	0	240.00	0	25	240.00	6,000
House Evacuation	pc	0	0	0	0	0	0
Land Development	ha	0	0	0	80	180	-18,000
Total				88,855			109,460

NATIONAL HOLIDAYS

NO.	DATE	NAME OF HOLIDAY
1	11-Jan	Birthday of Prithvi Narayan Sha & Unity Day
2	29-Jan	Shahid Divas
3	1-Feb	Basanta Panchami
4	19-Feb	National Democracy Day
5	25-Feb	Mahashivaratri
6	8-Mar	Women's Day (Only for Women)
7	12-Mar	Fagu Purnima
8	13-Mar	Fagu Purnima (Only in Terai)
9	27-Mar	Ghode Jatra Kathmandu Vally Only)
10	5-Apr	Shree Ram Nawami
11	14-Apr	New Year's Day
12	9-May	Law Day (Courts Only)
13	11-May	Buddha Jayanti
14	8-Aug	Janai Purnima
15	9-Aug	Gai Jatra (Kathmandu Vally Only)
16	14-Aug	Krishnasthami
17	22-Aug	Solar Eclipse
18	25-Aug	Tij (Women Only)
19	27-Aug	Rishi Panchami (Women Only)
20	30-Aug	Gaura Parva (in far-westren development region where the festival is obesrved)
21	5-Sep	Indra Jatra (Kathmandu Only)
22	21-Sep	Ghatasthapana
23	28-Sep to 5-Oct	Dashain*
24	19-Oct	Laxmi Puja
25	20-Oct	Gai Puja
26	21-Oct	Govardhan Puja
27	22-Oct	Tihar (Bhai -Tika)
28	26-Oct	Chhat (in districts where the festival is obse-rved
29	9-Nov	Constitution Day
30	25-Dec	Christmas Day (Christian employees only)
31	29-Dec	His Majesty's Birthday

(As of 1998)

MONTHLY RAINY DAY IN BABAI RIVER (STATION No.0416)

Unit : day

Year	Rainfall	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
	0-4 mm	30	25	31	27	27	28	14	24	22	29	30	30	317
	5-9 mm	1	2	0	1	1	0	4	2	3	1	0	1	16
1987	10-14 mm	0	1	0	1	1	0	2	2	1	0	0	0	8
	15-29 mm	0	0	0	1	1	1	3	2	2	1	0	0	11
	>30 mm	0	0	0	0	1	1	8	1	2	0	0	0	13
	0-4 mm	29	27	29	28	26	24	16	17	23	29	30	29	307
	5-9 mm	1	2	2	2	2	2	1	2	2	1	0	1	18
1988	10-14 mm	1	0	0	0	1	1	2	1	2	1	0	0	9
	15-29 mm	0	0	0	0	2	1	3	2	2	0	0	1	11
	>30 mm	0	0	0	0	0	2	9	9	1	0	0	0	21
	0-4 mm	29	26	29	30	29	20	20	20	16	30	29	30	308
	5-9 mm	1	1	1	0	1	3	0	4	5	0	1	0	17
1989	10-14 mm	0	1	1	0	0	2	2	2	2	0	0	1	11
	15-29 mm	1	0	0	0	1	4	2	3	4	0	0	0	15
	>30 mm	0	0	0	0	0	1	7	2	3	1	0	0	14
	0-4 mm	31	24	27	30	25	22	18	25	21	29	30	29	311
	5-9 mm	0	1	1	0	3	1	2	1	3	1	0	0	13
1990	10-14 mm	0	1	1	0	1	1	2	2	2	1	0	1	12
	15-29 mm	0	1	1	0	2	2	3	1	2	0	0	1	13
	>30 mm	0	1	1	0		4	6	2	2	0	0	0	16
	0-4 mm	30	26	30	28	29	26	24	19	22	31	30	29	324
	5-9 mm	0	1	1	1	1	1	1	3	3	0	0	0	12
1991	10-14 mm	1	1	0	1	1	1	2	2	2	0	0	1	12
	15-29 mm	0	0	0	0	0	1	2	2	2	0	0	1	8
	>30 mm	0	0	0	0	0	1	2	5	1	0	0	0	9
	0-4 mm	30	28	31	29	29	24	21	23	22	29	29	31	326
	5-9 mm	1	0	0	1	2	2	1	2	1	0	1	0	11
1992	10-14 mm	0	1	0	0	0	1	2	1	2	0	0	0	7
	15-29 mm	0	0	0	0	0	2	4	1	3	1	0	0	11
	>30 mm	0	0	0	0	0	1	3	4	2	1	0	0	11
	0-4 mm	30	27	28	28	28	21	18	17	21	31	30	31	310
	5-9 mm	1	1	2	0	1	2	4	2	3	0	0	0	16
1993	10-14 mm	0	0	1	1	1	1	2	1	1	0	0	0	8
	15-29 mm	0	0	0	1	0	1	3	3	2	0	0	0	10
	>30 mm	0	0	0	0	1	5	4	8	3	0	0	0	21
	0-4 mm	28	26	31	30	28	23	21	19	28	31	30	31	326
	5-9 mm	1	1	0	0	2	4	2	3	1	0	0	0	14
1994	10-14 mm	1	0	0	0	1	1	2	3	0	0	0	0	8
	15-29 mm	1	0	0	0	0	1	4	3	1	0	0	0	10
	>30 mm	0	1	0	0	0	1	2	3	0	0	0	0	7
	0-4 mm	30	26	29	29	28	24	19	21	22	30	30	30	318
	5-9 mm	1	1	1	1	2	2	2	2	3	0	0	0	15
Ave	10-14 mm	0	1	0	0	1	1	2	2	2	0	0	0	9
	15-29 mm	0	0	0	0	1	2	3	2	2	0	0	0	10
	>30 mm	0	0	0	0	0	2	5	4	2	0	0	0	13

MONTHLY WORKABLE DAY FOR CONCRETE WORKS IN BABAI RIVER (STATION No. 0416)

Unit : day

Item	Month												Total
	Jan	Feb	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
(1) Rainy Day & Suspended Day													
Calendar Day	31	28	31	30	31	30	31	31	30	31	30	31	365
5-9 mm : Rainy day	1.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	3.0	0.0	0.0	0.0	15.0
: Suspended Day (Rainy Day x 0.0)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10-14 mm : Rainy Day	0.0	1.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	0.0	0.0	0.0	9.0
: Suspended Day (Rainy Day x 1.0)	0.0	1.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	0.0	0.0	0.0	9.0
15-29 mm : Rainy Day	0.0	0.0	0.0	0.0	1.0	2.0	3.0	2.0	2.0	0.0	0.0	0.0	10.0
: Suspended Day (Rainy Day x 1.0)	0.0	0.0	0.0	0.0	1.0	2.0	3.0	2.0	2.0	0.0	0.0	0.0	10.0
>30 mm : Rainy Day	0.0	0.0	0.0	0.0	0.0	2.0	5.0	4.0	2.0	0.0	0.0	0.0	13.0
: Suspended Day (Rainy Day x 2.0)	0.0	0.0	0.0	0.0	0.0	4.0	10.0	8.0	4.0	0.0	0.0	0.0	26.0
(2) Total of Rainy Day	1.0	2.0	1.0	1.0	4.0	7.0	12.0	10.0	9.0	0.0	0.0	0.0	47.0
(3) Total of Suspended Day	0.0	1.0	0.0	0.0	2.0	7.0	15.0	12.0	8.0	0.0	0.0	0.0	45.0
(4) Suspended Rate :(3)/(1)%	0.0	3.6	0.0	0.0	6.5	23.3	48.4	38.7	26.7	0.0	0.0	0.0	12.3
(5) Sunday and National Holiday	6.0	7.0	9.0	6.0	7.0	4.0	4.0	12.0	9.0	14.0	6.0	6.0	90.0
(6) Rainy Day in Sunday & National Holiday (5)x(4)	0.0	0.3	0.0	0.0	0.5	0.9	1.9	4.6	2.4	0.0	0.0	0.0	10.6
(7) Non Workable Day : (3)+(5)-(6)	6.0	7.8	9.0	6.0	8.5	10.1	17.1	19.4	14.6	14.0	6.0	6.0	124.4
(8) Workable Day : (1) (7)	25.0	20.3	22.0	24.0	22.5	19.9	13.9	11.6	15.4	17.0	24.0	25.0	240.6
(9) Workable Rate : (8)/(1)%	80.6	72.3	71.0	80.0	72.4	66.4	45.0	37.6	51.3	54.8	80.0	80.6	65.9
(10) Applied Workable Day	25	20	22	24	22	20	14	12	15	17	24	25	240

Note : Data of average rainy day is given from 1987 to 1994 at station No. 0416

MONTHLY WORKABLE DAY FOR EARTHWORKS IN BABAI RIVER (STATION No. 0416)

Unit : day

Item	Month												Total
	Jan	Feb	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
(1) Rainy Day & Suspended Day													
Calendar Day	31	28	31	30	31	30	31	31	30	31	30	31	365
5-9 mm : Rainy day	1.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	3.0	0.0	0.0	0.0	15.0
: Suspended Day (Rainy Day x 0.0)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10-14 mm : Rainy Day	0.0	1.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	0.0	0.0	0.0	9.0
: Suspended Day (Rainy Day x 1.0)	0.0	1.0	0.0	0.0	1.0	1.0	2.0	2.0	2.0	0.0	0.0	0.0	9.0
15-29 mm : Rainy Day	0.0	0.0	0.0	0.0	1.0	2.0	3.0	2.0	2.0	0.0	0.0	0.0	10.0
: Suspended Day (Rainy Day x 2.0)	0.0	0.0	0.0	0.0	2.0	4.0	6.0	4.0	4.0	0.0	0.0	0.0	20.0
>30 mm : Rainy Day	0.0	0.0	0.0	0.0	0.0	2.0	5.0	4.0	2.0	0.0	0.0	0.0	13.0
: Suspended Day (Rainy Day x 3.0)	0.0	0.0	0.0	0.0	0.0	6.0	15.0	12.0	6.0	0.0	0.0	0.0	39.0
(2) Total of Rainy Day	1.0	2.0	1.0	1.0	4.0	7.0	12.0	10.0	9.0	0.0	0.0	0.0	47.0
(3) Total of Suspended Day	0.0	1.0	0.0	0.0	3.0	11.0	23.0	18.0	12.0	0.0	0.0	0.0	68.0
(4) Suspended Rate :(3)/(1)%	0.0	3.6	0.0	0.0	9.7	36.7	74.2	58.1	40.0	0.0	0.0	0.0	18.6
(5) Sunday and National Holiday	6.0	7.0	9.0	6.0	7.0	4.0	4.0	12.0	9.0	14.0	6.0	6.0	90.0
(6) Rainy Day in Sunday & National Holiday (5)x(4)	0.0	0.3	0.0	0.0	0.7	1.5	3.0	7.0	3.6	0.0	0.0	0.0	15.9
(7) Non Workable Day : (3)+(5)-(6)	6.0	7.8	9.0	6.0	9.3	13.5	24.0	23.0	17.4	14.0	6.0	6.0	142.1
(8) Workable Day : (1)-(7)	25.0	20.3	22.0	24.0	21.7	16.5	7.0	8.0	12.6	17.0	24.0	25.0	222.9
(9) Workable Rate : (8)/(1)%	80.6	72.3	71.0	80.0	69.9	54.9	22.5	25.7	42.0	54.8	80.0	80.6	61.1
(10) Applied Workable Day	25	20	22	24	22	16	7	8	13	17	24	25	223

Note : Data of average rainy day is given from 1987 to 1994 at station No. 0416

COMMUNITY DEVELOPMENT COMPONENT

MAIN FEATURES OF "COMMUNITY MOBILIZATION" ALONG BABAI

(1)Workshops for Local Government Institutions (LGIs)
- Technicalities of flood control measures
- Local initiatives for flood mitigation
- Community mobilization processes
- Facilitative roles by LGIs
- **District-level maintenance fund** (special subject for Babai)

(2) Creation of Organizational Bases

① **Formation of Community Groups**
- Building upon tradition of people-managed irrigation system

② **Promotion of Public Awareness, Knowledge, & Skills**
- Learning difference between spurs/revetments, and dikes
- Understanding how increased run-off and erosion from the upper areas is to be contained
- Skills training on gabion netting and masonry
- Revisiting traditional ways of participation

③ **Generation of Financial Resources**
- Utilization of traditions of group saving in the management of common property resources (e.g., irrigation, forests)

MAIN FEATURES OF "LOCAL COPING MEASURES" ALONG BABAI

(1) Flood Proofing
- Agricultural adjustments (esp. through irrigation & adoption of catch crops)
- Plantation along riverbanks
- Installation of drainage systems

(2) Forecasting, Warning, & Evacuation
- Forecasting & warning utilizing existing facilities (e.g., irrigation barrage, P.C.O)
- Installation of water gauge in the upper side of the river
- Enhanced evacuation through pathway improvements

(3) Flood Fighting
- Local production & procurement of flood fighting materials (e.g. bamboo, sandbags)
- Dissemination of flood fighting activities to wider areas

MAIN FEATURES OF "COMMUNITY-BASED SUSTAINABLE STRATEGIES" ALONG BABAI

(1) Forest/Grass Belts
- Utilization of forest/grass products for livelihood improvements
- Linkage with flood fighting etc

(2) Preventive Bank Protection Works
- Planting shrubs/grass to augment engineering measures for flood control
- Protection works using locally available materials (e.g., sandbags, bamboo, shrubs)
- Introduction of higher-value shrubs/grass

(3) Access Improvements
- Development of gravel/earthen roads where bank protection works are installed
- Linkage between closing dikes and road networks

(4) Bed Material Collection
- Clarification of responsible parties for bed material collection
- Guidelines for LGIs to monitor and regulate bed material collection

(5) O&M of Flood Control Structures
- Regular maintenance and minor repair of revetments and spurs

(6) Land Use Management
- Management of grazing areas.
- Stop over cultivation along the river, while pursuing other income opportunities

LIST OF TRADITIONAL IRRIGATION GROUPS (CHAUDARY) IN FLOOD-AFFECTED VDCs

Bargadaha System

Bagnaha VDC

Ward	No. 2	Bargadaha
	No. 3	Mrchaiya
	No. 4	Mainubar
	No. 6	Govindpur
	No. 7	Bagnaha
	No. 8	Bawanpur
	No. 8	Sainubar
	No. 9	Manpur
	No.	Sutapur

Dhodhari System

Bagnaha VDC

Ward	No. 1	Shaipur
	No. 1	Dugrahawa
	No. 5	Banbir
	No. 6 (A)	Takiwaha
	No. 6 (B)	Bankari
	No. 7	Bagnaha

Sano Shri VDC

Ward	No. 1 (A)	Shreekaida
	No. 1 (B)	Bada gau
	No. 2 (A)	Indrapur
	No. 2 (B)	Kashipur
	No. 3 (A)	Shivanagar
	No. 3 (B)	Durgapur
	No. 4	Ganeshpur
	No. 5 (A)	Shreenagar
	No. 5 (B)	Shreenagar
	No. 6	Buddhanagar
	No. 7 (A)	Santinagar
	No. 7 (B)	Saktipur
	No. 8	Krishnapur
	No. 9	Ramnagar

Buddahan System

Padhanaha VDC

Ward	No. 1.	Padanaha
	No. 2.	Bairia, Jagtiya
	No. 3.	Banghusri
	No. 4.	Bardiya
	No. 5.	Sorhabigha, Borfardiya
	No. 6.	Padanaha
	No. 7.	Ghorpitta
	No. 8.	Ranipur, Barbatta, Shreepur
	No. 9.	Guruwagaon, Phatterpur, Rajapur

Bhaniyabhar VDC

Ward	No. 1	Bhaniyabhar, Jamuniya
	No. 6/7	Bellabajha
	No. 9	Mudba

Manjhara System

Baniyabhar VDC

Ward	No. 2	Jodhipur, Baniyabhar, Pahadipur, Kusumdemda
	No. 3	Kumrahwa Gaon, Pachgharawa
	No. 4	Dhongarahi, Naryanpur, Gauripara, Patuwaripur
	No. 5	Jongigau,, Ghidharpur, Lathuwa, Bepptapur, Jitpur, Hasnapur, Gonghipur, Namidashara, Bethunidanda
	No. 6	Rampur, Laxmanpur

Dhadhawar VDC

Ward	No. 1	Dhadhawar
	No. 2	Bakalbhar
	No. 3	Katarniya
	No. 4	Baida, Gumsta
	No. 5	Jabdi, Khumtipur
	No. 6	Akalgharaia, Phakchawa
	No. 7	Dhudha, Thanagfna
	No. 8	Bakalbhar

Source: Note Prepared by Chaudary (Leader) of Bargadaha System

Note:

1: Along Babai there are five chaudary system , and four of them cover flood – affected VDC.

2: Gulariya municipality and Mahamadpur VDC have no chaudary systems.

RESULTS OF COMMUNITY INTERVIEWS ON CAUSES OF FLOODS & PROPOSED MEASURES

	What the people perceive to be the main causes of the flooding ?	What measures the people consider should be taken ?
Bagnaha Ward 1	• In hill area, the river flows between narrow gorges, and when it comes in Terai plain area spread out to become disaster.	• To make spur between 40 – 50 meters and plantation.
Bagnaha Ward 2	• More water catchment area deforestation in Dang and Surkhet valley. • Poor management of irrigation program.	• Embankment construction and plantation at backside and downstream.
Sano Shri Ward 3	• High rainfall	• Spur construction, but technically it must be well.
Baniyabhar Ward 3/4	• If continuous rainfall more than two days	• Revetment.
Baniyabhar Ward 9	• High rainfall at mountain (Dang Valley)	• Revetment and embankment.
Padnaha Ward 8	• Deforestation (No forest area)	• Embankments
Dhadwar Ward 5	• High rainfall. • Ploughing on riverbanks • Drainage • Irrigation more intake	• Irrigation cannel system • Spur construction • Revetment at slope at same level on land.
Dhadwar Ward 8	• High rainfall • Deforestation • Loose soil due to plough and other activities • No forest	• Revetment at both side & both side plantation is necessary.
Mahamdpur Ward 7	• High rainfall at mountain.	• Embankment and revetment at low level.
Mahamdpur Ward 9	• High rainfall at mountain and hill area.	• Settlement must be upland area • Identify areas of new deforested areas, and intensively ploughed areas to prevent land cutting.
Gulariaya Ward 2	• High rainfall at mountain, • Level of settlement areas is very low.	• Land level is low so need long embankment at south part.
Gulariya Ward 5	• High rainfall deforestation.	• Straighten river, spur & check dam. to protect land cutting from Bagaha VDC (Jamtinala) • Better management of irrigation facilities • Continuous river embankment.

(continued to next page)

Gulariya Ward 6	• Soil erosion in hill area, carrying soil, sand, plants and deposit, causing river bed rising	• Irrigation canal system to divide water. • Channelization by dossier to straighten river.
Gulariya Ward 8	• Before 1950 wide was very narrow and very deep but now deposit of soil at riverbed and cutting embankment and become big river. • About 30 km from Nepal-India boarder there is irrigation and when it is closed it affects the Nepal side.	• At direct cutting parts (area) need check dam • Channelization so that river water goes smoothly.
Gulariya Ward 10	• High rainfall • Looses soil	• Spur construction is necessary.
Gulariya Ward 13	• High rainfall is in mountain area.	• Month of irrigation cannel at India should be broad. • Embankment at bank erosion sites.
Guraliya Ward 14	• High rainfall in mountain area.	• Embankment it's protect land cutting.

source: JICA Study Team

Table A6.12

AVAILABILITY OF SKILLED LABOURERS (GABION NETTING & MASONRY) IN FLOOD-PRONE AREAS

VDCs/Municipality Wards	Availability	Whether People Would be Interested in Taking Masonry & Gabion-netting Training
Baghana VDC	O	Yes, some skilled people are available but only in Barghadaha. Other part, no skilled people.
Sano Shree	X	Yes, if trained, can work as skilled laborers.
Baniyabhar VDC	X	Yes, can go other areas.
Padanaha VDC	X	Yes, interested to take training for income generation.
Dhadhawar	O	Some train people are available in Belbhar (Ward 8) of the village, and if get 1/3 hour training can do easily. Yes, if we have skill manpower can maintenance later also.
Mahamadpur VDC	X	In the southern part of the VDC, it is difficult to available people who are interested. But the northern parts, people are interested.
Gulariya Munacipality-2	X	Yes, because people they want skills for opportunity to work outside.
Gulariya Munacipality-5	X	Yes, if they have opportunity interested.
Gulariya Munacipality-6	X	Yes, can get opportunity to work outside village if they got skills.
Gulariya Munacipality-8	X	Local people can net gabion for erosion mainly. If the people get training there are many opportunity.
Gulariya Munacipality-10	X	Yes, they can go outside village.
Gulariya Munacipality-13,14	X	If they have directly profit they are interest, otherwise they would not be interested. Yes, interested but they can't go to outside from village because they are busy in farming.

source: JICA Study Team

POSSIBLE CATCH CROPS AT FLOOD AFFECTED AREA (BABAI R.)

NAME OF THE VDC/MUNACIPALITY	WARD NO. - VILLAGES	CROPS/VEGETABLES
Baghna VDC	1. Shahipur, Khunpur, Chandanpur	Pigeon Pea
	2. Bargadaha	Sugarcane, Sweetpotato Pigionpea
	6. Bankatti	
	9. Manpur	-
Sano Shree VDC	3. Shivnagar	-
Baniyabhar VDC	3,4. Kumargau Dhungtigu	Sweetpotato, Groundnut Pigionpea, Gourd, Bitter Gourd, Pointedgourd, Tomato
	9. Jhakipur	Pigionpea, Tomato
Padanaha VDC	8, 9. Sarjipur, Rajpur, Ranipur	Groundnut, Sweetpotato Pigionpea
Dhadhawar VDC	5. Jabdi, Khumtipur	Pigionpea, Tomato, Bittergourd, Gourd
	8. Belbhar	Pigionpea, Sweetpotatato Groundnut
Mohmadpur VDC	7. Indrapur	Pointedgourd, Sweetpotato Bittergourd, Gourd, Pigionpea
	8, 9. Bhaisai, Bikri	Sugarcane, Groundnut, Pigionpea, Pointedgourd Bittergourd, Gourd, Sweetpotato
Guleriya Municipality	2. Panditpur	Pigionpea, Groundnut Tomato, Bittergourd
	5. Tulsipur	Pigionpea
	6. Shuhelwa	Pigionpea
	8. Kothiya	Bittergourd, Pigionpea Sugarcane, Groundnut
	10. Thapuwa	Bittergourd, Pointedgourd Cuccurbits, Watermelon Tomato, Ladyfinger
	13. Ratanpur	Pointedgourd, Bittergourd Watermelon, Gourd (Lauka) Pigionpea, Cuccurbits
	14. Parsiya	Pointedgourd, Bittergourd Watermelon, Gourd, Pigionpea, Cuccurbits

TREES/SHRUBS/GRASS ALONG BABAI RIVER

Name of Plants	Uses
1. Sisso (tree)	Fuel , Furniture , Timber
2. Khayer (tree)	Fuel , Katha , Piller
3. Simal (tree)	Timber for house construction, Fuel
4. Sal (tree)	Timber
5. Khar (Grass)	Thatch/Roofing
6. Peruwa	-
7. Babul (tree)	Fuel , Make for cart , Live Fence
8. Tik (tree)	Furniture
9. Dhumre (Grass)	Fodder
10. Behiya (shrub)	Live fence , River Training (Bio-Engineering)
11. Bamboo (tree)	Local Furniture, House Construction
12. Kusum (tree)	Fodder, Furniture, Fruit, fuel
13. Ashrey (Bushy types) (shrub)	Fuel
14. Kharse (tree)	Fodder
15. Khori (tree)	Fodder
16. Tote (tree)	Fodder
17. Rohini (tree)	Fodder, Use as dam at irrigation cannel
18. Asna (tree)	Timber (Can use for house construction where water does not hit direct)
19. Jamun (tree)	Timber, fuel
20. Paya (shrub)	Fuel
21. Dhouti (tree)	Fuel
22. Bell (tree)	Fuel, Fruit
23. Tenu (tree)	Fodder
24. Saj (tree)	Timber, Furniture

Table A6.15

TREES/SHRUBS/GRASS
AVAILABI/ NEEDS IN VARIOUS LOCALITEIS (BABAI)

	What Trees/Shrubs/Grass Are Available Locally ?	What Trees/Shrubs/Grass Are Needed Most by People ?
Gulariya Ward 6	Sissoo, Khair	Sisso, Khair
Gulariya Ward 5	Khair, Simal	Khair, Simal
Gulariya Ward 13	Sal, Khar and Peruwa	Sal, Khar, Peruwa
Gulariya Ward 14	Babul, Mango, Sissoo and Sagum (Tik)	Babul, Mango, Sissoo and Sagum
Gulariya Ward 8	Sissoo, Sal, Khayer, Mango, Simal, Dhunre and Bheu	Sissoo, Sal, Khayer, Mango, Simal, Dhumre, and Bheu
Gulariya Ward 10	Babul, Bamboo, Guava	Babul, Bamboo, Guava
Gulariya Ward 2	Kusum, Simal, Sissoo, Khayer, Ashre, Khari Tote, Rohini, and Khasse	Kusum, Simal, Sissoo, Khayer Asna, Khari Tote and Rohini
Sano Shri Ward 3		Sissoo, Sal, Asna
Bagnaha Ward 1	Sal, Sissoo, Khayer, Asna, Kusum, Janum, Rohini, Payr, and Dhoti Simal	Sal. Sissoo, Asna, Kusum
Bagnaha Ward 2	Sisso, Babul	Sal, Sissoo, Asna, Kusum
Mahamadpur Ward 7	Babul, Sissoo, Simal	Baboor, Sissoo, Simal
Mahamadpur Ward 9	Sal, Khayer	Baboor, Sissoo, Simal
Padanaha Ward 8	Khayer, Sissoo, Simal, Babul	Khayer, Sissoo, Simal, Baboor
Baniyabhar Ward 3/4	Simal, Khayer, Sisoo, Sal Eculyptus, Mango, Guava, Bheu, Janum, Khar, Sentha, Bayer, Khaniya, Rohini, Neeu, and Nigot	Simal, Baboor, Rohini, Sal
Baniyabhar Ward 9	Babul, Simal, Sal, Sissoo, Neem, Khar and Churki	Simal. Baboor, Rohini, Sal
Dhadhawar Ward 8	Simal, Sal, Soj, Khair, Bel, Dhanti, Khusum, Janum, Kachari, Bakino, Pipal, Ficus and Neem	Sissoo, Babul, Bamboo
Dhadhawar Ward 5	Sissoo, Babul ,Bamboo	Sissoo, Babul, Bamboo

OVERALL FRAMEWORK OF COMMUNITY DEVELOPMENT

Lakahndei River

Community Mobilization

1) Formation of Community Groups
- Learning from a limited # of outstanding cases of community mobilization

2) Creation of Awareness, Knowledge & Skills
- Education on technical measures for flood control (spurs, dikes etc.)
- Skills training on gabion netting and masonry
- Promotion of proper land use practices

3) Groups Savings for Disaster Management
- Resource mobilization for regular maintenance of river training facilities
- Local contributions for community-based actions
- More emphasis on women's participation

Local Coping Strategy

1) Flood Proofing
- Agricultural adjustments (esp. through flood-proof varieties, & storage of rice saplings)
- Housing structure through plantation of trees for durable construction materials

2) Forecasting, Warning, & Evacuation
- Warning utilizing existing facilities (e.g., PCO, & mosques)
- Accessibility enhancement for evacuation

3) Flood Fighting
- Supply of materials not available locally (e.g., boulders, gabion)
- Dissemination of flood fighting activities

Multi-purpose Facility

1) Collection of Bed Materials
- Clear-cut rules for sand/gravel extraction
- Enforcement of guidelines for proper extractions

2) Forest/Grass Belts
- Use of trees/grass for livelihood improvements (fuel, fruits etc.)
- Plantation of trees for evacuation & housing

3) Preventive Bank Protection
- Introduction of high-value grass /shrubs
- Simple protection works using local materials
- Dissemination of bio-engineering

4) Road Network Development
- Access improvement using river control facilities (esp. dikes)
- Road improvements for flood mitigation & to meet other local needs

Babai River

Community Mobilization

1) Formation of Community Groups
- Working through, or building upon, traditional irrigation groups

2) Creation of Awareness, Knowledge & Skills
- Education on technical measures for flood control (spurs, revetments etc.)
- Skills training on gabion netting and masonry
- Promotion of proper land use practices

3) Groups Savings for Disaster Management
- Resource mobilization for regular maintenance of river training facilities
- Local contributions to undertake community-based disaster management actions

Local Coping Strategy

1) Flood Proofing
- Agricultural adjustments (esp. through irrigation, & flood-proof varieties)
- Reforestation/aforestation
- Installation of drainage

2) Forecasting, Warning, & Evacuation
- Forecasting & warning utilizing existing facilities (e.g., irrigation barrage)
- Organized strategy for river watching

3) Flood Fighting
- Local production and procurement of flood fighting materials (e.g., bamboo, sandbags)
- Dissemination of flood fighting activities

Multi-purpose Facility

1) Collection of Bed Materials
- Exemption of prohibitive rules
- Enforcement of guidelines for proper extractions

2) Forest/Grass Belts
- Use of trees/grass for livelihood improvements (fuel, fodder, roofing, etc.)
- Plantation of trees for flood fighting

3) Preventive Bank Protection
- Introduction of high-value grass /shrubs
- Simple protection works using local materials
- Dissemination of bio-engineering

4) Road Network Development
- Access improvement using river control facilities (esp. bank protection)

LABOR WAGE & CONSTRUCTION EQUIPMENT COST

BASIC LABOUR WEGES (NRs)

Item	Unit	F.C.	L.C.	Total
Foreman	md	0	150	150
Welder	md	0	140	140
Operator	md	0	120	120
Electrician	md	0	140	140
Mechanic	md	0	120	120
Mason	md	0	140	140
Painter	md	0	140	140
Driver	md	0	100	100
Concrete Worker	md	0	140	140
Steel Worker	md	0	140	140
Carpenter	md	0	140	140
Skilled Labour	md	0	100	100
As.Operator	md	0	100	100
As.Driver	md	0	80	80
Common Labour	md	0	60	60

(REMARKS) F.C:Foreign currency portion, L.C:Local currency portion

UNIT OPERATION COST OF MAJOR CONSTRUCTION EQUIPMENT (NRs)

Item	Capacity	Unit	F.C.	L.C.	Total
Backhoe	0.7 m^3	hour	1,440	360	1,800
Backhoe	1.2 m^3	hour	2,560	640	3,200
Bulldozer	21 ton	hour	3,200	800	4,000
Bulldozer	11 ton	hour	1,440	360	1,800
Tractor Shavel	2 m^3	hour	1,440	360	1,800
Dump Truck	8 ton	hour	640	160	800
Air Compressor	11 m^3/min	day	3,360	840	4,200
Leg Hammer		day	800	200	1,000
Tire Roller	8 ton	hour	960	240	1,200
Vibratory Roller	3 ton	hour	560	140	700
Vibratory Roller	8 ton	hour	1,120	280	1,400
Truck Crane		hour	2,080	520	2,600
Aggregate Plant		hour	7,200	1,800	9,000
Batcher Plant	25 m^3/h	hour	4,320	1,080	5,400
Concrete Mixer		day	240	60	300
Crawle Crane	30 t	hour	3,200	800	4,000
Concrete Vibrator		day	400	100	500

Table A6.18

MATERIAL PRICE AND WORK COST IN BABAI RIVER FOR FEASIBILITY STUDY

UNIT PRICES OF CONSTRUCTION MATERIALS (NRs)

Item	Unit	F.C.	L.C.	Total
Portland Cement	ton	3,100	3,100	6,200
Concrete Aggregate; Coarse	m^3	474	316	790
Concrete Aggregate; Fine	m^3	240	160	400
Boulder Stone	m^3	462	308	770
Crushed Stone	m^3	474	316	790
Formwork Timber	m^3	2,000	18,000	20,000
Plywood (t=1.2 cm)	m^2	168	112	280
Bamboo; (L=5m)	pc	10	90	100
Deformed Bar	t	25,520	6,380	31,900
Gabion Wire	kg	36	9	45
Asphalt	kg	13	13	25
Gasoline	ltr	15	15	30
Light Oil	ltr	5	5	10
Hydraulic Oil	ltr	40	40	80
Grease	kg	35	35	70
Drain Pipe; PVC(D=40mm)	m	36	144	180
Hume Pipe (D=0.9m)	m	700	2,800	3,500
Hume Pipe (D=1.2m)	m	1,080	4,320	5,400
Water Stop; t=250mm	m	200	200	400
Log Pile (ϕ 0.15m)	m	35	318	353
RC Pile (□ 0.2m x 0.2m)	m	185	185	370

(REMARKS) F.C:Foreign currency portion, L.C:Local currency portion

UNIT COSTS OF CONSTRUCTION WORKS (NRs)

Work Item	Unit	F.C.	L.C.	Total
Stripping of Top Soil	m^2	0	5	5
Excavation(soft soil)	m^3	0	45	45
Excavation(boulder mixed soil)	m^3	0	90	90
Excavation(weathered rock)	m^3	252	28	280
Excavation(rock)	m^3	324	36	360
Embankment	m^3	51	34	85
Back Filling	m^3	24	16	40
Plain Concrete(1:3), inc.formwork	m^3	2,024	3,036	5,060
Reinforced Con.(1:3.), inc.form&steel	m^3	4,630	4,630	9,260
Wet Masonry	m^3	924	1,386	2,310
Rubble Concrete	m^3	1,324	1,986	3,310
Boulder Pitching	m^3	604	906	1,510
Gabion	m^3	804	1,206	2,010
Boulder Riprap	m^3	364	546	910
Gravel Work	m^3	444	666	1,110
Turfing	m^2	3	12	15
Log Pile Piling (ϕ 0.15m)	m	42	398	440
RC Pile Piling (□ 0.2m x 0.2m)	m	223	277	500
Tree Planting	ha	17,420	50,700	68,120
Grass Planting	ha	24,900	101,000	125,900

SUMMARY OF PROJECT COST FOR BABAI RIVER (FINANCIAL) FEASIBILITY STUDY

(NRs1,000)

Item	Unit	Quantity	Amount		
			F.C.	L.C.	Total
I . Construction Base Cost			138,837	199,821	338,658
1. Preparatory Works	L.S.	1.00	12,622	18,166	30,787
2. Bank Protection			87,178	120,310	207,488
2-1 Pile Spur	km	13.19	46,627	57,917	104,544
2-2 Gabion Spur	km	5.21	11,873	18,460	30,333
2-3 Revetment	km	3.30	28,678	43,934	72,611
3. Dike Embankment			12,743	23,381	36,125
3-1 Forest and Grass Belt	ha	284.00	2,509	10,612	13,120
3-2 Closing Dike	place	8.00	10,234	12,770	23,004
4. Cut-off Channel	km	1.40	14,820	21,450	36,270
5. Miscellaneous Works	L.S.	1.00	11,474	16,514	27,988
II . Compensation Cost	L.S.	1.00	0	26,640	26,640
III. Addministration Cost	L.S.	1.00	0	18,265	18,265
IV. Engineering Cost	L.S.	1.00	40,639	27,093	67,732
V . Physical Contingency	L.S.	1.00	17,948	27,182	45,130
VI. Total			197,424	299,001	496,425
VII. Value Added Tax	L.S.	1.00	0	49,642	49,642
VIII. Grand Total			197,424	348,643	546,067

Note: 1: Price Level in October 1998
2: Convertion Rate US$ 1.00 = NRs 67.93, 1.00 Yen = NRs 0.59
3: Cost does not include price contingency
4: Figures may not add up to totals due to rounding
F.C:Foreign currency portion
L.C:Local currency portion

ANNUAL DISBURSEMENT SCHEDULE OF BABAI RIVER PROJECT (FINANCIAL)

(NRs1,000)

Discription	Amount			1999/2000		2000/2001		2001/2002		2002/2003		2003/2004		2004/2005		2005/2006		2006/2007	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
I . Construction Base Cost	138,837	199,821	338,658	0	0	0	0	44,175	63,580	31,554	45,414	31,554	45,414	31,554	45,414	0	0	0	0
1. Preparatory Works	12,622	18,166	30,787	0	0	0	0	12,622	18,166	0	0	0	0	0	0	0	0	0	0
2. Bank Protection	87,178	120,310	207,488	0	0	0	0	21,795	30,078	21,795	30,078	21,795	30,078	21,795	30,078				
3. Dike Embankment	12,743	23,381	36,125	0	0	0	0	3,186	5,845	3,186	5,845	3,186	5,845	3,186	5,845				
4. Cut-off Channel	14,820	21,450	36,270	0	0	0	0	3,705	5,363	3,705	5,363	3,705	5,363	3,705	5,363				
5. Miscellaneous Works	11,474	16,514	27,988	0	0	0	0	2,869	4,129	2,869	4,129	2,869	4,129	2,869	4,129	0	0	0	0
Sub-total	138,837	199,821	338,658	0	0	0	0	44,175	63,580	31,554	45,414	31,554	45,414	31,554	45,414	0	0	0	0
II . Compensation Cost	0	26,640	26,640	0	0	0	6,660	0	6,660	0	6,660	0	6,660	0	0	0	0	0	0
1. Compensation	0	26,640	26,640		0	0	6,660	0	6,660	0	6,660	0	6,660	0	0	0	0	0	0
III. Addministration Cost	0	18,265	18,265	0	0	0	333	0	5,721	0	4,181	0	4,181	0	3,848	0	0	0	0
1. Administration	0	18,265	18,265	0	0	0	333	0	5,721	0	4,181	0	4,181	0	3,848	0	0	0	0
IV. Engineering Cost	40,639	27,093	67,732	0	0	20,320	13,546	6,465	4,310	4,618	3,079	4,618	3,079	4,618	3,079	0	0	0	0
1. Detail Design	20,320	13,546	33,866	0	0	20,320	13,546	0	0	0	0	0	0	0	0	0	0	0	0
2. Construction Supervision	20,320	13,546	33,866	0	0	0	0	6,465	4,310	4,618	3,079	4,618	3,079	4,618	3,079				
V. Physical Contingency	17,948	27,182	45,130	0	0	2,032	2,054	5,064	8,027	3,617	5,933	3,617	5,933	3,617	5,234	0	0	0	0
VI. Value Added Tax	0	49,642	49,642	0	0	0	4,494	0	14,400	0	10,506	0	10,506	0	9,736	0	0	0	0
VII. Total	197,424	348,643	546,067	0	0	22,351	27,088	55,705	102,698	39,789	75,773	39,789	75,773	39,789	67,312	0	0	0	0
VIII. Price Contingency	25,579	173,043	198,622	0	0	1,361	5,688	5,165	33,993	4,994	35,166	6,337	46,260	7,721	51,935	0	0	0	0
IX. Grand Total	223,003	521,686	744,689	0	0	23,713	32,776	60,870	136,691	44,783	110,939	46,126	122,033	47,510	119,247	0	0	0	0

Note: *1 Price Level in October 1998
*2 Convertion Rate US$ 1.00 = NRs 67.93, 1.00 Yen = NRs 0.59
*3 Figures may not add up to totals due to rounding

COST BENEFIT FLOW
(Existing Basin)

River: Babai (Unit: NRs. 1,000)

Year	Economic cost/benefit				Discounted (10%)	
	Project cost	Maintenance cost	Total cost	Benefit	(C) Cost	(B) Benefit
1 1999	0	0	0	0	0	0
2 2000	40,450	0	40,450	0	36,773	0
3 2001	129,602	0	129,602	0	107,109	0
4 2002	94,551	0	94,551	0	71,038	0
5 2003	94,551	763	95,314	17,168	65,101	11,726
6 2004	87,628	1,527	89,155	34,335	55,358	21,320
7 2005	0	2,234	2,234	50,246	1,261	28,363
8 2006	0	2,234	2,234	50,246	1,146	25,784
9 2007		2,234	2,234	50,246	1,042	23,440
10 2008		2,234	2,234	50,246	947	21,309
11 2009		2,234	2,234	50,246	861	19,372
12 2010		2,234	2,234	50,246	783	17,611
13 2011		2,234	2,234	50,246	712	16,010
14 2012		2,234	2,234	50,246	647	14,554
15 2013		2,234	2,234	50,246	588	13,231
16 2014		2,234	2,234	50,246	535	12,028
17 2015		2,234	2,234	50,246	486	10,935
18 2016		2,234	2,234	50,246	442	9,941
19 2017		2,234	2,234	50,246	402	9,037
20 2018		2,234	2,234	50,246	365	8,216
21 2019		2,234	2,234	50,246	332	7,469
22 2020		2,234	2,234	50,246	302	6,790
23 2021		2,234	2,234	50,246	274	6,173
24 2022		2,234	2,234	50,246	249	5,611
25 2023		2,234	2,234	50,246	227	5,101
26 2024		2,234	2,234	50,246	206	4,638
27 2025		2,234	2,234	50,246	187	4,216
28 2026		2,234	2,234	50,246	170	3,833
29 2027		2,234	2,234	50,246	155	3,484
30 2028		2,234	2,234	50,246	141	3,167
31 2029		2,234	2,234	50,246	128	2,880
32 2030		2,234	2,234	50,246	116	2,618
33 2031		2,234	2,234	50,246	106	2,380
34 2032		2,234	2,234	50,246	96	2,163
35 2033		2,234	2,234	50,246	87	1,967
36 2034		2,234	2,234	50,246	79	1,788
37 2035		2,234	2,234	50,246	72	1,625
38 2036		2,234	2,234	50,246	66	1,478
39 2037		2,234	2,234	50,246	60	1,343
40 2038		2,234	2,234	50,246	54	1,221
41 2039		2,234	2,234	50,246	49	1,110
42 2040		2,234	2,234	50,246	45	1,009
43 2041		2,234	2,234	50,246	41	918
44 2042		2,234	2,234	50,246	37	834
45 2043		2,234	2,234	50,246	34	758
46 2044		2,234	2,234	50,246	31	689
47 2045		2,234	2,234	50,246	28	627
48 2046		2,234	2,234	50,246	25	570
49 2047		2,234	2,234	50,246	23	518
50 2048		2,234	2,234	50,246	21	471
Total	446,782	100,582	547,364	2,262,327	349,040	340,325

EIRR: 9.7%
B/C: 0.98
NPV(B-C): -8,715 (NRs.1,000)

COST BENEFIT FLOW
(Future Basin)

River: Babai (Unit: NRs. 1,000)

Year	Economic cost/benefit				Discounted (10%)	
	Project cost	Maintenance cost	Total cost	Benefit	(C) Cost	(B) Benefit
1 1999	0	0	0	0	0	0
2 2000	40,450	0	40,450	0	36,773	0
3 2001	129,602	0	129,602	0	107,109	0
4 2002	94,551	0	94,551	0	71,038	0
5 2003	94,551	763	95,314	27,125	65,101	18,527
6 2004	87,628	1,527	89,155	54,250	55,358	33,685
7 2005	0	2,234	2,234	79,389	1,261	44,813
8 2006	0	2,234	2,234	79,389	1,146	40,739
9 2007		2,234	2,234	79,389	1,042	37,035
10 2008		2,234	2,234	79,389	947	33,669
11 2009		2,234	2,234	79,389	861	30,608
12 2010		2,234	2,234	79,389	783	27,825
13 2011		2,234	2,234	79,389	712	25,296
14 2012		2,234	2,234	79,389	647	22,996
15 2013		2,234	2,234	79,389	588	20,906
16 2014		2,234	2,234	79,389	535	19,005
17 2015		2,234	2,234	79,389	486	17,277
18 2016		2,234	2,234	79,389	442	15,707
19 2017		2,234	2,234	79,389	402	14,279
20 2018		2,234	2,234	79,389	365	12,981
21 2019		2,234	2,234	79,389	332	11,801
22 2020		2,234	2,234	79,389	302	10,728
23 2021		2,234	2,234	79,389	274	9,753
24 2022		2,234	2,234	79,389	249	8,866
25 2023		2,234	2,234	79,389	227	8,060
26 2024		2,234	2,234	79,389	206	7,327
27 2025		2,234	2,234	79,389	187	6,661
28 2026		2,234	2,234	79,389	170	6,056
29 2027		2,234	2,234	79,389	155	5,505
30 2028		2,234	2,234	79,389	141	5,005
31 2029		2,234	2,234	79,389	128	4,550
32 2030		2,234	2,234	79,389	116	4,136
33 2031		2,234	2,234	79,389	106	3,760
34 2032		2,234	2,234	79,389	96	3,418
35 2033		2,234	2,234	79,389	87	3,107
36 2034		2,234	2,234	79,389	79	2,825
37 2035		2,234	2,234	79,389	72	2,568
38 2036		2,234	2,234	79,389	66	2,335
39 2037		2,234	2,234	79,389	60	2,122
40 2038		2,234	2,234	79,389	54	1,929
41 2039		2,234	2,234	79,389	49	1,754
42 2040		2,234	2,234	79,389	45	1,595
43 2041		2,234	2,234	79,389	41	1,450
44 2042		2,234	2,234	79,389	37	1,318
45 2043		2,234	2,234	79,389	34	1,198
46 2044		2,234	2,234	79,389	31	1,089
47 2045		2,234	2,234	79,389	28	990
48 2046		2,234	2,234	79,389	25	900
49 2047		2,234	2,234	79,389	23	818
50 2048		2,234	2,234	79,389	21	744
Total	446,782	100,582	547,364	3,574,477	349,040	537,714

EIRR: 15.2%
B/C: 1.54
NPV(B-C): 188,674 (NRs.1,000)

SOCIAL ENVIRONMENT ASSESSMENT: BABAI RIVER.

No.	Environmental Item	Type of Impact	Evaluation	Remarks
a	Resettlement	Resettlement by land occupation (Transfer of residence/land ownership rights)	B	Some people along the river will have to be resettled
b	Economic Activities	GAIN in production base (land etc.) and change of economic structure.	A	Stabilization of river banks and prevention of erosion and land degradation should lead to increase of productive land base.
c	Traffic and Public Facilities	Positive impact on existing traffic, schools, hospital etc. (e.g., Traffic congestion, accident rate)	A	New roads should improve access to facilities and markets
d	Split of Communities	Separation of communities by interference of regional traffic.	D	No regional traffic
e	Cultural Property	Loss or deterioration of cultural properties such as temples, shrines, historic assets.	D	No loss envisaged. List to be made of historic assets, if any.
f	Water Rights and Rights of Common	IMPROVED access to water, irrigation or fishing rights.	B	By stabilizing river, there should be improved access to irrigation water and well water will have less chance of contamination.
g	Public Health Condition	IMPROVEMENT of health or sanitary conditions due to more secure latrines. There may be increased risk of pollution due additional use of agricultural chemicals.	B	Improved sanitary conditions may reduce the risk of water born diseases such as cholera. Over time farmers will use more fertilizers; these may contaminate the water supply
h	Waste	Eroded gravel, sand and soil trapped by the vegetation planted along the river banks. Domestic waste secured from polluting the river.	A	Vegetation used to build up river banks. Houses moved to prevent subsidence and thus effluent pollution
i	Hazards (Risks)	DECREASED risk of subsidence, building collapse and accidents.	A	By stabilizing the river banks, it will reduce risk of subsidence to buildings near the river.
j	Other (specify)			

Note. The column entitle "Type of Impact" describes the possible outcomes as a result of the project.
The marking system under "Evaluation" refers to the degree of environmental impact.
It is as follows: **A**, Important; **B**, Some; **C**, Unknown; **D**, No.
The "Remarks" column lists major environmental costs and benefits.

NATURAL ENVIRONMENT ASSESSMENT: BABAI RIVER.

No.	Environmental Item	Type of Impact	Evaluation	Remarks
a	Topography And Geology	Change of important topography and geology DECREASED due to REDUCTION of natural excavation and earth-fill.	B	Flood mitigation measures help prevent natural excavation and earth-fill.
b	Soil And Land	DECREASE of topsoil erosion by flood mitigation initiatives including reforestation. IMPROVEMENT to soil fertility, through decrease deposition of coarse gravel etc.	A	Flood mitigation measures will decrease topsoil erosion and the deposition of coarse sand and gravel onto fields close to the river.
c	Groundwater	Lowering of groundwater table due to overdraft and turbid water caused by construction work.	D	Flood mitigation measures will not affect water table during construction work.
d	Hydrological Situation	Change of discharge and water quality due to reclamation and/or drainage.	B	Successful flood mitigation interventions will lead to land reclamation of land previously degraded by past flooding.
e	River Basin	River basin erosion DECREASED and POSITIVE vegetation changes due to land reclamation and river training.	A	As a result of flood mitigation measures, soil erosion should decrease in the river basin, and land reclamation will increase due to river training. These measures should have a positive impact on the flora and fauna.
f	Fauna And Flora	Interruption of reproduction or extinction of species due to habitat changes.	D	There should be no effect on species due to habitat changes. But see Wetlands under (i) below.
g	Meteorology	Changes in microclimate, such as temperature, wind etc. due to large-scale reclamation and construction.	D	No large-scale construction or reclamation considered. However, the proposed planting of a belt of trees along both river banks may improve the local microclimate.
h	Landscape	IMPROVEMENT of aesthetic beauty by structural and topographical changes due to reclamation.	B	Flood mitigation measures, especially the planting of trees and grasses should improve the habitat and encourage an increased fauna.
i	Other (specify)	Buffer zone (along the river, bordering the wildlife reserve)	B	The published management plans for the buffer zones along the river will be examined to see what interventions, if any can be made.
j	Other (specify)	Wetland stability, (in the Terai, below the W.R.).	A	The listed wetlands in the river basin will be identified and measures taken to stabilize or improve their habitat.

Note. The column entitle "Type of Impact" describes the possible outcomes as a result of the project.
The marking system under "Evaluation" refers to the degree of environmental impact.
It is as follows: **A**, Important; **B**, Some; **C**, Unknown; **D**, No.
The "Remarks" column lists major environmental costs and benefits.

POLLUTION ASSESSMENT: BABAI RIVER.

No.	Environmental Item	Type of Impact	Evaluation	Remarks
a	Air Pollution	Change in air quality caused by exhaust gases or toxic gases from vehicles and/or factories.	D	Not applicable
b	Water Pollution	Water pollution of rivers and groundwater caused by drilling mud and oil.	D	Not applicable
c	Soil Contamination	Contamination caused by discharge or diffusion of sewage or toxic substances.	D	Sewage from houses contaminating the soil should be negligible.
d	Noise and Vibration	Generation of noise and vibrations due to drilling and operation of pumping machines.	D	Not applicable
e	Land Subsidence	Deformation of the land and land subsidence due to lowering of groundwater table.	D	Increased population may use more groundwater, but the flood mitigation project should have no negative effect on the groundwater table.
f	Offensive Odour	Generation of offensive odours and exhaust gases.	D	These will be negligible or non-existant.
g	Other (specify)			

Note. The column entitle "Type of Impact" describes the possible outcomes as a result of the project.
The marking system under "Evaluation" refers to the degree of environmental impact.
It is as follows: **A**, Important; **B**, Some; **C**, Unknown; **D**, No.
The "Remarks" column lists major environmental costs and benefits