



INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Study On Operation And Maintenance Of Water Resources In Bangladesh

Engineer Sheikh Mohammad Nurul Islam

ABSTRACT

In Bangladesh, effective water resources schemes were mostly small-scale and locally constructed and managed. The government of the people's republic of Bangladesh has taken many projects and sub projects for water resources management. Through these projects and sub projects Bangladesh government has achieved many positive things. However the present study has conducted to explore challenges of operations and maintenance of Small Scale water resource management in Bangladesh. The study was documentary analysis type. Information and data were collected from secondary sources. Information and data were collected from books, research reports, journals, different annual reports, different government and non government websites and different websites. A literature review was conducted by using the internet search, Google databases with the operation and maintenance of water resources in Bangladesh. A hand search was also undertaken to relevant journals identified by the electronic search and additional articles identified from the reference list of the key articles. A number of articles have been found on virtual classroom. From the study it was found that there were low irrigation service collection which is inadequate to support system O&M. There were no systematic procedure for asset management and to identify O&M needs so there should have systematic procedure for asset management. There were limited participation and consultation with beneficiaries on O&M requirements so participation should be increased. There were lacks of asset inventory and condition survey on which to develop maintenance budget so asset inventory and condition survey should be increased. Proposed annual budgets for O&M are curtailed due to insufficient funds which should be increased. Funds released for O&M do not reflect requirements for annual, periodic or emergency maintenance of a system. There are lacking of enforcement of cost recovery or contribution to O&M costs in particular for annual maintenance the lacking should remove. So, from the study it was recommended that in Upazila and district LGED office, WMCA monitoring, operations and maintenances issues needs to be more emphasized and included as one of the reporting agenda in monthly meeting. This will increase experiences and understand on SSWRD by concerned engineers in the field in terms of better water resource management. LGED can take necessary step to include WMCA in Upazila Level Water Management Committee and Union level water resources Management committee formed as per Water Rule-2018. It is urgent to continue these Union and Upazila level meeting regular monthly basis. Member Education Programme (MEP) of all members should be continuing at least twice a year. Members should be aware about Operation and Maintenance and Service Charges. More motivational work at WMCA member level should necessary. More Good Governance should practice in WMCA and record keeping, and more transparency should practice in WMCA. Operation and Maintenance Plan Book preparation (following Joint Visit) should be mandatory to each WMCA which already included in grading data.

Key words: Water resource, Monitoring, Operation, Maintenance, Evaluation, Irrigation, Drainage, Infrastructure, Flood, Embankment, Canal, Water control structures, Projects.

INTRODUCTION

There were two levels of institutional responsibility for water resources schemes. The first type of schemes that covered more than 1000 ha area of water resources is the responsibility of the Bangladesh Water Development Board. The second type, consisting covering area less than 1000 ha, is under the Local Government Engineering Department (LGED) of the Ministry of Local Government Rural Development and Cooperatives. Efforts to improve the small-scale water resources infrastructure have started in the mid-1990s with the Small-Scale Water Resources Development Project. The project's results provided an impetus for further investment in 2001. Approved in 2009, the Participatory Small-Scale Water Resources Project was the third project aimed at strengthening water users' participation in helping improve the sustainability of small-scale water resources schemes. For better water resources management, a project was designed to finance a range of small-scale subprojects for flood management, drainage, water conservation, surface irrigation, and command area development. Initially, the project was to develop 230 new subprojects in 43 of 64 districts throughout the country. This was expanded to 270 new subprojects in 61 districts after the approval of additional co financing from the International Fund for Agricultural Development (IFAD) in 2010. In addition, the project was to cover the improvement of 150 subprojects already developed under the first two projects. Since a large number of subprojects were to be financed, a sector modality was chosen to implement the project. Three subprojects two for drainage and flood control and one for irrigation command area development were presented as sample subprojects during project preparation. Subsequent subprojects were subjected to due diligence during the implementation period. The project was financed by funds from the Government of Bangladesh, a loan from the Asian Development Bank (ADB), and two loans from IFAD with a grant from Government of Netherlands.

OBJECTIVE OF THE STUDY

The objective of the study is as follows:

1. To explore challenges of operations and maintenance of water resource management in Bangladesh.

METHODOLOGY OF THE STUDY

The study was documentary analysis type. Information and data were collected from secondary sources. Information and data were collected from books, research reports, journals, different annual reports, different government and non government websites and different websites. A literature review was conducted by using the internet search, google databases with the virtual classroom. A hand search was also undertaken to relevant journals identified by the electronic search and additional articles identified from the reference list of the key articles. A number of articles have been found on virtual class room.

RESULTS AND DISCUSSION

FLOOD CONTROL EMBANKMENT

1. Full Flood Embankment

The embankment which is constructed at the required height to keep the sub project area flood free is known as flood control embankment or bundh. Sluice gate or regulator is constructed to control water within and outside the embankment. The height of flood control embankment is generally higher than that of normal road. The embankment is designed (height, width etc.) and implemented in accordance with the flood data. In SSWRS the embankment is designed with a 20 years flood frequency.



Figure-1 Flood Management Embankment

2. Submersible Flood Embankment

Submersible flood embankment is generally constructed in Haor Area. This embankment goes under water throughout the monsoon period. The embankment is designed with water level of Mid-may with flood frequency of 10 years. This embankment saves boro crop. To control water level of in and out sluice/regulator.

3. Khals: Drainage, Water Conservation, Tidal Water Supply

Khal (channel) is an existing, mostly natural but may also be excavated, water course for drainage of runoff. These khals may be re-excavated according to required design to drain out an area when water logging damages crop during pre-monsoon and/or monsoon seasons. The re-excavated khals will also conserve water during post monsoon season for irrigation use. Sometimes, tidal khals are re-excavated to increase both volume and propagation of tidal water more inside the subproject area for use in irrigation.



Figure-2 Drainage/Conservation Khal

HYDRAULIC STRUCTURES

Different types of hydraulic structures are required to construct in the water resources subprojects. Each structure has different function. A brief description of each type of structure is given below.

1. Regulator

Regulator is used both for flood control and drainage of water. Arrangements are made to operate regulator gate vertically. The operator can operate the gate easily and control water i.e., gate can be opened or closed, as a result required water level can be maintained with the control of water flow within and outside the subproject. Occasionally, operation of the gate is not required when water level remains the same within and outside the subproject area due to the local or regional hydrological system, flooding characteristics and location of the subproject. However, this situation continues for a short period. With reduction of the river water level the gate is opened for the drainage of flood water from within the subproject area.



Figure-3 Regulator

2. Sluice

Sluice is constructed to give tidal flood protection in tidal areas and normal flood protection in non-tidal areas. Usually, flap gate is attached with the sluice gate which is operated automatically. The gate closes automatically when water level in the riverside is higher than in the subproject side. On the other hand, when the water level at subproject is higher the gate opens automatically with the water pressure. Generally the number of vent is single or multiple for each type of sluice gate. Gates are fixed with the sluice head wall.



Figure-4 Sluice

3. Flushing sluice

The sluice or regulator with which arrangement is made to bring in water from outside is known as flushing sluice. In general, the flushing sluice is constructed in relatively higher part of the subproject area. Usually, the flushing sluice is useful to conserve tidal water for irrigation in the subproject area in tidal flooding zone.

4. Water Retention Structure

Generally, this type of structure is constructed in relatively higher and tidal flood free zone. Water retention structure is useful for the conservation of monsoon water, supplementary irrigation in aman rice crop fields and after that for the conservation of water in the post-monsoon season to irrigation-rice and boro rice crops in the winter season. Gate of this structure can be raised vertically and manually operated (open and close) with ease.



Figure-5 Water Conservation Structure

5. Culvert

If any road obstructs flow of water from the subproject area, culvert is constructed at appropriate location to protect land from water logging. Culvert is also constructed on the excavated or re-excavated khal for the local people for their movements across the both banks.



Figure-6 Culvert

IRRIGATION STRUCTURE

The project implements another type of subproject to increase water availability for irrigation. It is categorized as command area development (CAD) subproject. The components of this subproject are different. The descriptions of the components are as follows.

1. Irrigation Canal

Water distribution canals of the irrigation subprojects are categorized into two types. The canal which is constructed from the main source of water (generally river) to the field is called as main canal and which are constructed from the main canal to carry water to the fields considered as a branch canals. Both types of canals are pucca (lined). Besides, there are some earthen canals which are considered as field canals.



Figure-7 Irrigation Canal

2. Aqueduct

Aqueduct is constructed over a drainage channel when it obstructs water distribution through irrigation canal. The aqueduct conveys water over the drainage channel to irrigation area. This can be called as bridge for the conveyance of irrigation water. This type of structure is should be pucca.



Figure-8 Aqueduct

3. Syphon

Generally, if any road or embankment obstructs the irrigation canal, pipe of box culvert type structure is constructed under the road or embankment for the conveyance of water. Syphon and aqueduct can be considered as opposite to each other, but their functions are different. Syphon can be also used for drainage.



Figure-9 Syphon

BURIED IRRIGATION PIPE SYSTEM

In this system with the help of pump water is lifted in the header tank and is distributed to area through the underground pipe system. In this system for supply of irrigation water no land is lost. Though implementation cost is high but considering long term application this system is less costly. During water supply as there is little loss of water during irrigation water can be supplied to larger area. Although irrigation cost with PVC pipe is high but there is advantage in using PVC pipe. For manufacturing of pipe there is no loss of time in field for which there will be less time required for laying pipes. Easy to maintain quality control and there is no chance of constructing low quality pipe. As weight of PVC pipe is less compare to concrete it is easy for transportation of pipe and easy to make joint. If implemented correctly there is little chance of leakage of pipe through pipe joint.

1. Header Tank

Header Tank is a concrete structure. There may be more than one chamber depending on off taking pipe lines. There is provision of steel ladder and gate in the chamber. In the header tank primarily silt can be deposited and arrangement is kept for flushing. Water level of Header tank should be such that it can command the whole area. There will be arrangement for gate regulation so that water can flow through all the pipelines.

2. Standpipe (Air Vents)

Standpipe is to be raised from top of PVC pipeline. Standpipe is to be provided in between two outlets due to air vent air inside the pipeline can be able to come out and pressure of pipeline can be kept as predesigned. Height of standpipe should be 60 meter above the energy line. There is no need to operate air vents.



Figure-10 Air vents & Riser

3. Outlet (Riser)

Riser pipe starts from PVC pipeline. Alfalfa valve is located here. Over the riser pipe distribution box is set and flow of water is controlled. Water is distributed from pipeline through the outlet. Outlet is set at an Average distant of 200 to 500m. Alfalfa valve is regulating so that each irrigation unit can get water as per requirement.

4. Overflow Standpipe

At the place of pipe layout from PVC pipeline straight pipe is added. With the help of outflow standpipe additional water can be released without any damage. Adding Piezometric Pipe in escape pressure can be measured. After monitoring of pressure in pipe line operator can be instructed to increase or decrease the flow and arrangement of drainage can be made. Height of standpipe is kept 0.30m above pressure line.

5. Washout

Washout is control valve with PVC pipe off take or concrete access box which is placed at low pocket of pipeline. Washout is added for flushing, repair or silt cleaning.

RUBBER DAM

At the bed of medium or Small River Rubber Bag is attached with concrete structure and is inflated by air or water to form Rubber Dam. When deflated it sits in the river bed and can be inflated again if required. Rubber Dam is a flexible Dam. Rubber Dams Air Vents Riser can be up to 100m in single units and units can be added one after another separated by concrete piers. However, height of Rubber Dams is presently limited to about 5 m. In our country, Rubber Dams are used to conserve water in small to medium rivers for dry season irrigation and to protect Haor area crops from inundation damage by preventing premonsoon floods entering through khals/rivers up to about the third week of May.



Figure-11 Rubber Dam

Operation of Infrastructure

Infrastructure of FMD and WC subprojects are operated – meaning that gates of the hydraulic structures are opened or closed - to ensure judicious control of water level and/or quantity of water in the subprojects to achieve maximum benefit. Drainage and Tidal Irrigation subprojects do not involve operation activities. Operation of gates differs with type of structures and also with tidal and non-tidal zones. Operation of infrastructure of FMD and WC subprojects are discussed in sections below. For CAD (irrigation) subprojects, operation activities are characteristically different –involves distribution and management of irrigation water over the whole subproject area requiring fulltime involvement of system operators. Operation (and also maintenance) of irrigation systems of CAD subprojects are discussed separately in Appendix G8-A: *O&M of Buried Pipe Irrigation (CAD) Subprojects* appended to this document.

GATE OF WATER CONTROL STRUCTURE

Flood is controlled or water is conserved with the help of gate. Gate has an important role to achieve the subproject objective and expected benefit is not achieved without the proper its operation. Two types of gates are used for regulators and sluices in LGED water resources development project. These are vertical gate and flap gate. Vertical gate is opened or closed with the help of handle and flap gate automatically.

1) Vertical gate: Operation of this gate requires an operator. Flood can be controlled and water can be conserved during the pre-monsoon, monsoon and post monsoon seasons with the operation of this gate. Moreover, in tidal flooding zone this gate is useful to bring river water into the subproject area for conservation. Seal is affixed with the gate on the downstream side during the water conservation.



Figure-12 Vertical Gate

2) Vertical gate lifting system: With the support of mechanical system and use of handle vertical gate is opened or closed manually to control flood, conserve water i.e., maintain water level within the subproject area.



Figure-13 Raising of Vertical Gate

3) Flap gate: This gate is designed so that it is opened automatically with the water pressure developed due to higher water level within the subproject area than in the riverside initiating drainage of water. The rise of water level downstream closes the gate protecting the subproject area from flooding. This gate at the ending part is hanged across the upper part of the barrel. Rubber seal is affixed with the flap gate on the subproject side. The flap gate does not function automatically to bring water from the riverside to the subproject area. It can be opened manually by fixing a chain with the hook attached with the gate frame



Figure -14 Flap gate

4) Flap gate lifting system: Although the flap gate is operated automatically, manual operation is required to lift for flushing of water from the riverside to the subproject area. This can be done by fixing a chain with the hook of the gate frame.



Figure-15 Flap gate lifting system

FLOOD CONTROL AND WATER DRAINAGE STRUCTURE

This type of structure has flap gates on the riverside. As the operation of this gate depends on the water level upstream and downstream, it opens and closes automatically without employment of fulltime operator. However, the WMCA sub-committee should give overall responsibility for the gate operation to a WMCA member. The member will instantaneously inform the sub-committee if there arises any trouble related to the operation of the gate and take necessary step for immediate solution.

1) Flood control, water drainage and water conservation structure

This type of structure has a vertical gate as well as a flap gate. The water level within the subproject area is maintained with the operation of vertical gate. Following information are required for the operation of this structure:

- Description of land related to extent and elevation within the subproject area;
 - Decision on the level of water to be retained after the rainy season;
 - Decision on the level of water to be maintained for water conservation if required during the rainy season;
- and
- Arrangement for the operation of gate during the rainy season.

2) Water retention structure

This type of structure has vertical gates. Water is conserved in the subproject area with the operation of the vertical gate. But, care should be taken so that water retention does not impede drainage. Following information are required for the preparation of gate operation guidelines:

- Description of land related to extent and elevation within the subproject area;
- Decision on the level of water to be retained; and
- As water is retained at the beginning of the rainy season, during the rainy season and at the end of the rainy season with this structure, decision should be taken about when the gate should be closed.

3) Flushing Sluice/Regulator

These types of structures may have flap or vertical gates. The main purpose of water flushing is conservation of water within the subproject area for irrigation. Following information are required for the operation of these structures.

- Description of land related to extent and elevation within the subproject area;
- Decision on the time of flushing; and

□ Specific decision regarding the water conservation level.

GENERAL RULES FOR THE OPERATION OF WATER CONTROL STRUCTURE

When and at what level of water should be retained in the subproject area cannot be decided in a single operation. It is an iterative process and requires several years of operation to decide required water level and timetable. For this purpose, gate operation data should be recorded in a registrar for each gate. The general rules for the operation of water control structure are as follows:

- Before operation of the structure, condition of gate hoisting system should be checked to ensure that it functions properly and the gate moves easily;
- Close the gate and check any leakage of water through the gate;
- Vertical gate should be opened slowly to prevent excess water flow through the structure;
- During the flow of water the difference between upstream and downstream water levels should not be more than 30 cm;
- At the beginning, gate should be opened slowly to increase water level downstream;
- During the opening of gate attention should be given to the velocity of water flow so that it cannot damage the khal downstream or protective blocks;
- The gate opening speed can be increased with the rise of water level downstream. But care should be taken so that there is no damage of khal downstream;
- Flushing sluice gate is operated on the basis of water demand and availability.
- Care should be taken so that the water level difference between subproject side and riverside is not more than 30 cm and less difference is better;
- If the number of vent is more than two, middle gate has to be opened first.
- Sudden opening of gate from any side could cause sharp and oblique water flow which may damage protective blocks downstream. Similarly sudden opening of all gates may damage the protective blocks due to excessive flow of water;
- Gate has to be closed slowly when water level reaches at the required level within the subproject area, sudden closing of the gate may damage the structure;
- In the coastal area gate has to be operated with integration between shrimp farming and crop production;
- During the operation of structure attention should be given to the fish production.

For example opening of gate in the beginning of the rainy season will allow fish and fingerlings migration and floodwater carry spawn into the subproject area;

- WMCA/sub-committee will decide about the operation of gate in consultation with all beneficiary farmers and in consideration with crop patterns and land elevation;
- If required gate operation guidelines should be changed from the experience in preceding year; and
- Certainly gates should be operated according to the decision by the WMCA/sub-committee.

Water level gauge: Gauge is set up with cement plaster pointing to measure water level in the subproject area and riverside when gate remains closed or opened. Adjusting with floor level of the infrastructure the scale of gauge should be set with respect to PWD meter and written in Bengali. Proper attention should be given to set up the gauge accurately, since water level after the implementation of the subproject could not be determined without it. The gauge should be painted for the clear and easy visibility.



Figure-15 Water Level Gauge

Measurement of water level and operation of structure: Preparation of comprehensive operation plan is essential to achieve subproject objectives properly and ensure maximum benefit. Water retention time and level should be decided in line with the beneficiaries demand and occupational interests so that no conflict

arises between them. Information should be collected on the area of land at different elevations and how different occupational use the water resources to decide water level desired in the water conservation subprojects. The collection of the same information is required for structure constructed only for water conservation. In sluice there are vertical gates at the downstream of the flap gate for water conservation. Flap gate is elevated to bring in water from the river for conservation into the subproject area with the help of vertical gate. This process is slightly complicated. If there is rain during the water conservation, the gate may be opened for the drainage of water. Gate should be operated in consideration with water demand and availability. Conservation of water may be required during the premonsoon, monsoon and post-monsoon seasons. The level of conserved water should be decided according to the subproject area elevation curve to so there is no adverse impact within the subproject area. For conservation of water at the end of the rainy season it should be checked that drainage has been ensured up to the required level for subproject benefit. Gate operation calendar and determination of water level depends on the requirement of subproject and diversity of climate. An operation calendar should be prepared before the rainy season starts in consideration of the existing crop pattern and fisheries activities. This should be finalized with the field level examination. At least after three years operation a realistic operation policy could be prepared. It can be mentioned that, from the general policy a written operation index has to be prepared separately for each structure within a subproject area. When there are several structures within a subproject, the operation index of each structure should be coordinated with others so that there is no adverse impact within the subproject.

BENEFICIARY PARTICIPATION IN OPERATION OF SUBPROJECT STRUCTURES

1) Agreed Optimum WL in Subproject Basin: Water management in subprojects having FMD and WC functions amounts to maintaining an optimum water level in the subproject basin by operating gates of hydraulic structures such that farmers of the basin area have a general agreement to that water level. As crop lands have different elevations, this optimum water level is difficult to define in a straight forward way. It is to be arrived at by considering crops in the field and opinion and understanding of the crop owners. Nevertheless, the desirable water levels in sub projects are to be evolved during a few years of subproject operation through crop practice planning (planning different crops in different land elevations based on achievable subproject water level) and experiences gathered over the years. That is to say, continuous participatory efforts will be necessary for having an effective water management established in a subproject.

2) Operation Calendar of Subproject: An initial operation calendar of a subproject is usually provided for the WMCA during design of the subproject. Two such operation calendars – one for subprojects with purposes of flood control and water retention and the other for subprojects of water retention purpose only are given in Exhibit G8-6 and Exhibit G8-7 respectively for reference. The initial operation calendars will be used in operation of the structures during first year joint O&M of the subproject and noting carefully the results and experiences thereof. These will be discussed in the WMCA, particularly by the O&M subcommittee with participation of the Village Representatives and beneficiary farmers and necessary modifications if considered necessary in timing of gate operation and/or in water levels maintained for use in next season. At the same time, crop practice planning should also be considered based on experience learned. It is expected that a reasonably stable water management practice would be established in the subproject in 2-3 years.

3) Record Keeping of Subproject Operation: For each hydraulic structure of a subproject, a register for Operation Records will be maintained. All records like (i) Date and Time, (ii) Opening of gate below the gate bottom by Gate No (for a closed gate opening will be zero), (iii) WL at upstream, (iv) WL at downstream, (v) Reason for increasing or decreasing opening or closing gate, (vi) comment on condition of crops in the field at the time of gate operation, (vii) Person giving instruction to operate the gate, etc will be recorded. The records will be used in subsequent review of operation Calendar and other purposes.

4) O&M Subcommittee and Village Representatives Co-ordinate on Gate Operation: As can be understood from section 5.7.1 above, there may always be people who will have feeling that the operational WL decided and maintained by the subproject management is not favourable for them. Accordingly, there remains the apprehension that someone or a group may try to tamper gate operation in their favour. To avoid such mischievous activity, O&M Subcommittee should remain in alert and maintain close co-ordination with Village Representatives of different villages which will enhance co-operation, understanding and vigilance to avoid such unwanted happenings.

Subproject Maintenance: Activities involved in maintenance of CAD (buried pipe irrigation) subprojects are not similar to the maintenance activities of other subprojects because the structures are not similar. The maintenance works help to keep subproject infrastructure functional. If in any case maintenance works are delayed, the overall damage increases in future. For that reason arrangement for the maintenance is essential immediate after the construction of infrastructure is complete. Usually, the maintenance at the beginning involves minor work to keep the subproject operational, nevertheless if it is not initiated in time the structure may require huge maintenance works afterwards. Maintenance is a regular work throughout the year. It should be carried out in coordination with the operation of infrastructure. Maintenance work is generally divided into three types: (i) regular, (ii) seasonal, and (iii) emergency.

REGULAR MAINTENANCE

Regular maintenance is also known as routine work. If this work is completed regularly, volume of seasonal maintenance reduces. Preventive maintenance continues throughout the year and is implemented when required. Infrastructure should be inspected regularly to check maintenance requirements and accordingly maintenance work is to be undertaken. The following activities are carried out under the routine maintenance.

1) Regular maintenance of khal: The routine or regular khal maintenance works include: (1) weeding and cleaning of hyacinths in khal, and (2) repair of any damage due to raining. Regular maintenance works for khal are shown in Figure 18 and Figure 19.

2) Regular maintenance of embankment: Routine or regular maintenance works of embankment are: (1) repair of rain cuts, (2) repair of rodent dens, (3) repair of ghogs, (4) turfing on the embankment side slopes. Routine maintenance works of embankments are shown in Figure 21 and Figure 22.

3) Regular maintenance of structure: Routine maintenance works of structure are: (1) painting of gates, (2) preventing of leakage of water through gate and fall boards, (3) Earth filling and compaction at wing wall and return wall on subproject side for the erosion or displacement of soil, (4) replacement and repairing of protective works in upstream and downstream side of structure. Regular maintenance works of structure are shown in Figure 37 and Figure 38.

PERIODIC MAINTENANCE

In the end of rainy season, embankment, khal and structure should be visited to undertake maintenance works. After the rainy season visit is very important because major damage occurs during this time. Thus, maintenance works should be undertaken immediately after the rainy season. The seasonal maintenance works include the following.

1) Periodic maintenance of khal: The periodic maintenance works of khal include: (1) clearing of silt from khal, and (2) repairing of khal slopes. Khal maintenance works undertaken seasonally are shown in Figure 17 and Figure 18.

2) Periodic maintenance of embankment: Periodic maintenance works of embankment include: (1) reconstruction of eroded slope, (2) repair of embankment's side slope due to soil slide; (3) repair of crack of embankment, and (4) repair of erosion on embankment side slopes. Seasonal maintenance works of embankment are shown in Figure 31 to Figure 35.

3) Periodic maintenance of structure: Periodic maintenance works of structure include: (1) repairing of damaged protecting works of structure including filter, (2) repairing of gate and hoisting system and replacement of rubber seal, (3) greasing, (4) painting of gate and (5) repairing of damaged concrete works. Seasonal maintenance activities on structure are shown in Figure 30.

4) Emergency maintenance (including major seasonal maintenance): Rehabilitation of embankment or structure when caused by sudden tidal surge and flooding is identified as urgent maintenance work. Generally, embankments are designed for 20-year highest flood level. Flooding above this level can damage embankment and structure which if not repaired on an emergency basis may cause huge damage to the subproject structure. Usually, emergency maintenance works are completed from the technical point of view. For this reason, WMCA should carry out the emergency maintenance work with the support of LGED.

Plantation and nursing: The main objective of plantation along the embankment in subproject is the conservation of environment. Moreover, plantation program is undertaken along the banks of the excavated or re-excavated khal. Initially, plantation is supported by the Project fund. However, beneficiaries and landowners should ensure the plantation, nursing and conservation through the WMCA.



Figure-16 Plantation

MAINTENANCE OF DRAINAGE KHAL

1) Growth of aquatic plants and siltation in khal: Description of the damage: Excess growth of weeds and aquatic plants and siltation decrease khal section, reduces water flow and impedes drainage. Water flow reduces with the increase of density of weeds. Weeds create barricade at the downstream of structure's gate. This also changes direction of water flow. As a result water hit khal's slope. In general, excess growth of plants restricts water flow which impedes drainage system (Figure 17). Cause of the damage: Low flow of water or reduction of depth of khal.57. Inspection: Step should be taken for the maintenance of khal through regular inspections. Two types of maintenance works should be carried out. These are regular and seasonal maintenance. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist. The maintenance work should be completed according to the plan before the rainy season.58. Maintenance system: (a) cleaning of aquatic plan and other debris, (b) regular cleaning of khal and weeding, and cleaning of silt.

2) Slide of side slope

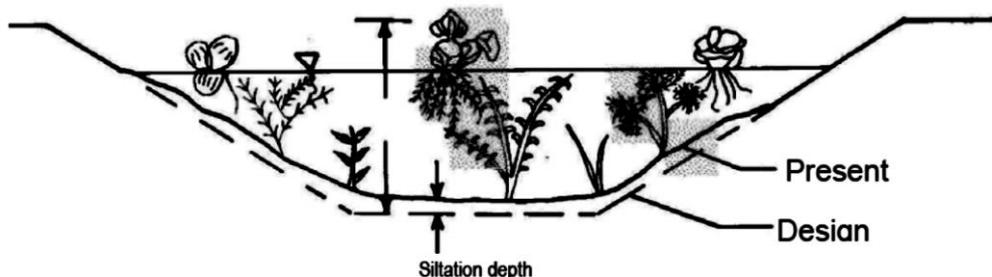


Fig.18: Aquatic plants and siltation

Description of the damage: Excessive erosion of khal slope and slide after ward (Figure 2).

Cause of the damage: Khal slide slope is not according to the soil type, actual slope is steep than the designed.

Inspection: Action should be taken for the maintenance of khal through regular visit and inspection. Maintenance works should be completed in two phases of regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

Maintenance system: (a) re-excavation of khal with side slope, and, (b) rebuilding of banks by reducing side slope.

MAINTENANCE OF FLOOD CONTROL EMBANKMENT

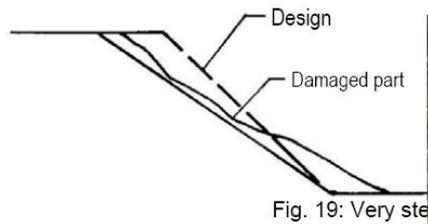


Figure-20 Settlement of Crest and side slope

Maintenance of flood control embankment

1) Excessive settlement of crest and side.

Description of the damage: In many cases there could be settlement of crest and side slope resulting in partial failure embankment to control flooding. Communication along the embankment is disrupted (Figure 20).

Cause of the damage: Inadequate compaction of soil during the construction of the embankment or weak soils used for the construction of the embankment.

Inspection: Actions should be taken for the maintenance of the embankment through regular inspection. Maintenance works should be carried out in two phases of regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

Maintenance system: Embankment should be rehabilitated with the increase of height. During the rehabilitation works settlement of the existing embankment should be taken into account, and the following rehabilitation works should be undertaken:

- a) Uprooting of existing grasses to preserve for re-plantation (1).
- b) Benching of the side slopes in 30 cm height (2).
- c) Earth filling in 15 cm layers and compaction of each layer separately (3).
- d) Dressing of the top of the embankment and grass turfing. Bamboo stick should be used to fix the grass turf with the slope (4).
- e) Planting of new grass seedlings and nursing and watering until the grasses grow up to 10 cm high.

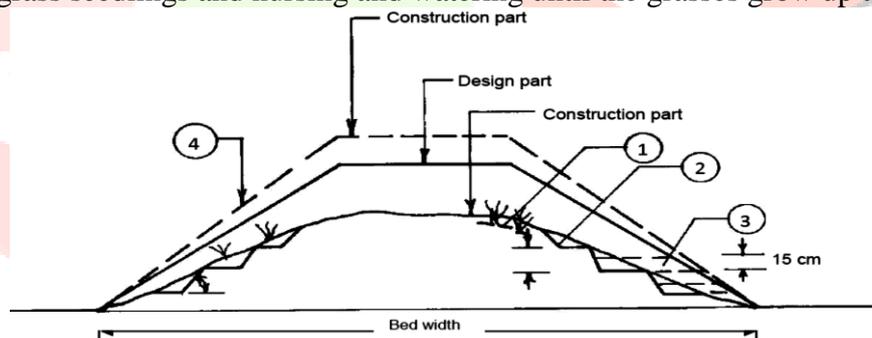


Fig. 21: Excessive subsidence of embankment crest and slope

2) Embankment's side slope cut

Description of the damage: In many cases cut at the adjacent of toe of the embankment's slope is observed. The extent of cut in many cases is found to be wide (Figure 22).

Cause of the damage: Embankments slope cut by farmer to increase size of the plot for dwelling or cultivation.

Inspection: Action should be taken for the maintenance of the embankment through regular inspection. Regular and seasonal maintenance works should be undertaken. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season starts.

Maintenance system: Plantation or installation of concrete pillars at the toe of the embankment, and discouraging of farmers in cutting slopes and undertaking of following rehabilitation works.

- a) Initially, cutting of the toe at an angle of 60° (1).
- b) Earth filling with 15 cm layer and compaction of each layer separately (2).
- c) Dressing and grass turfing on rehabilitated part of the embankment and use of bamboo stick to fix the grass turf with the slope to protect from dislocation (3).
- d) Planting of new grass seedlings and nursing and watering until the grasses grow up to 10 cm high (4)

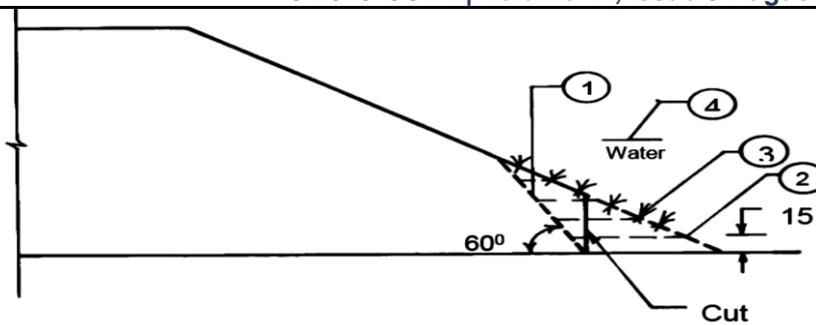


Fig.23: Cutting at side slope of embankment

3) Erosion of side slope by water flow

Description of the damage: In many cases erosion is observed on the side slopes of the embankment due to water flow (Figure 24).

Cause of damage: Water flow with high velocity.

Inspection: Appropriate measure should be taken for the maintenance of the embankment through regular inspection. Regular and seasonal maintenance works should be undertaken. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season starts.

Maintenance system: If flow is not high, embankment should be rehabilitated with bamboo mat pillars. Tree and weeds should be grown on embankment slopes. If flow is high, temporary protection measure can be taken with brick pitching and setting sand bags. Brick or CC blocks can be placed for long-term protection. The embankment rehabilitation activities include the following.

- Initially, the eroded vertical edge should be cut at an angle of 60° with the horizontal line (1).
- Bamboo mat fence (torja) should be constructed vertically along the horizontal line of the eroded embankments (2).
- Filling of eroded part with 15 cm earth layer and compaction of each layer separately (3).
- Dressing of the rehabilitated part of the embankment and grass turfing, use of bamboo stick to fix the grass turf with the slope (4).
- Regular nursing and watering until the grasses grow up to 10 cm high.

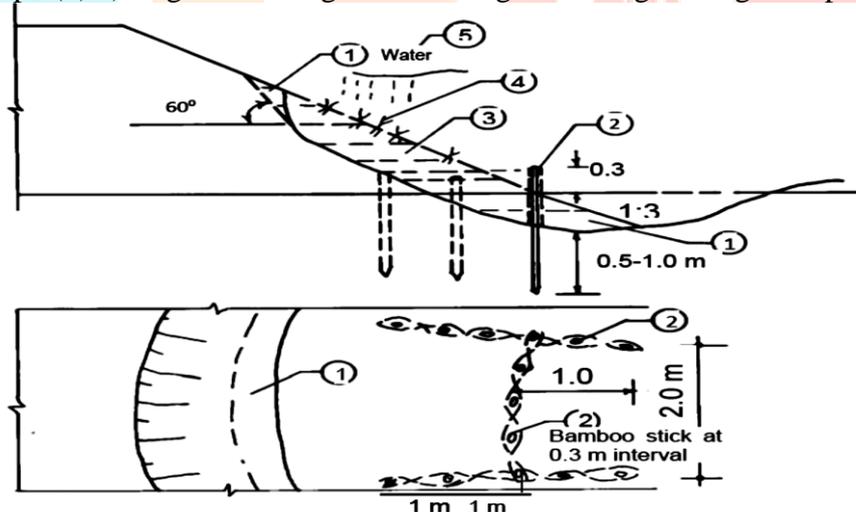


Fig. 24: Erosion of side slope for water flow

4) Erosion of side slope by wave action

Description of the damage: Flood control embankment can be eroded by wave action. This erosion ultimately damages the embankment (Figure 25).

Cause of damage: Generation of strong wave for wind.

Inspection: Appropriate measure should be taken for the maintenance of the embankment through regular inspection. Maintenance works should be undertaken in two phases: regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season starts.

Maintenance system: Embankment should be rehabilitated. Brick or CC blocks should be placed to protect from strong wave action. The embankment rehabilitation activities include the following.

- Initially, the eroded steep should be cut at an angle of 60° with the horizontal line (1).
- Filling of eroded part with 15 cm earth layers and compaction of each layer separately (2).
- Dressing of the rehabilitated part of the embankment and grass turfing, use of bamboo stick to fix the grass turf with the slope (3).
- Construction of bamboo mat fencing (torja) along the toe (4).

e) Development of 1 m wide cover planted with dhaincha (*Sesbania*) to reduce erosion of slope on the riverside.

Note: Generally, the sandy soils piled at the bottom of embankment are not suitable to reuse.

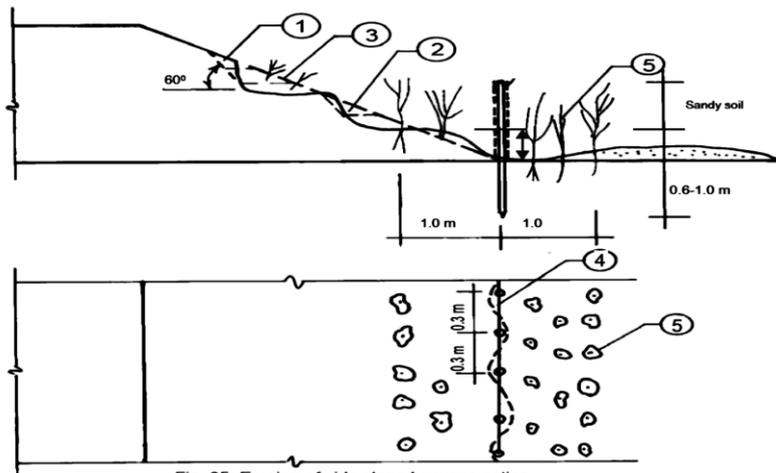


Fig. 25: Erosion of side slope by wave action

5) Slide of side slope

Description of the damage: Generally, slide of side slope of embankment is observed. Excessive rainfall or faulty construction is the root of subsidence which weakens embedment (Figure 26).

Cause of damage: Use of weak and wet soils in the construction of embankment. Improper compaction of soil can cause the subsidence during the rainy season. Too steep side slope can be also the cause of slide.81.

Inspection: Appropriate measure should be taken for the maintenance works through regular inspection. Maintenance works should be carried out in two phases: regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

Maintenance system: Embankment should be rehabilitated with less steep slope. The roots of slope erosion should be identified. Care should be taken that sufficient time is allowed to dry wet soils before filling. The embankment rehabilitation activities are as follow.

- Eroded soil should be removed (1).
- Initially, the vertical part should be cut at an angle of 60° with the horizontal line (2).
- Reconstruction of eroded part based on the original design with 15 cm layer and compaction of each layer separately, i.e., recasting of side slope at proper height(3).
- Dressing of the new slope and grass turfing, use of bamboo stick to fix the grass turf with the slope (4 and 5).
- Regular nursing and watering until the grasses grow up to 10 cm high.

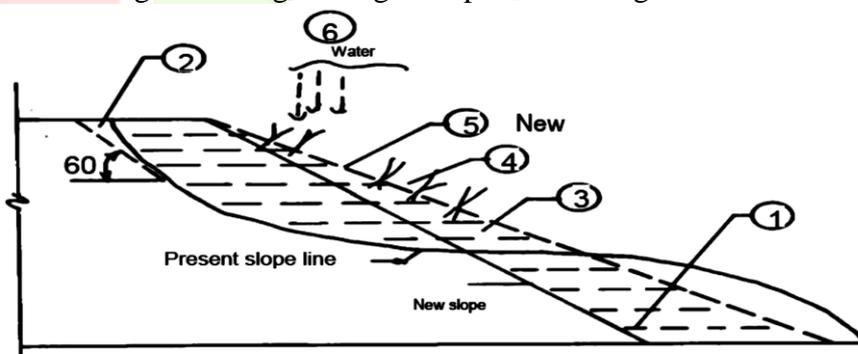


Fig.26: Subsidence of side slope

6) Rain cut

Description of the damage: In many cases soil at the slope of embankment could be displaced. This may weaken the embankment. The embankment can be damaged if it is not rehabilitated properly (Figure 27).

Cause of damage: Heavy rainfall or water flow with high velocity toward lowland can cause the cut

Inspection: Appropriate measure should be taken for the maintenance works through regular inspection of the embankment.

Maintenance works should be undertaken in two phases: regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

Maintenance system: Embankment rehabilitation activities are as follow.

- Benching of the damaged part of the embankment and removal of total loose and sandy soils (1).

b) Reconstruction of eroded part based on the original design with 15 cm layer and compaction of each layer separately.

c) Dressing of the rehabilitated slope and grass turfing, use of bamboo stick to fix the grass turf with the slope (3).

d) Regular nursing and watering until the grasses grow up to 10 cm high (4).

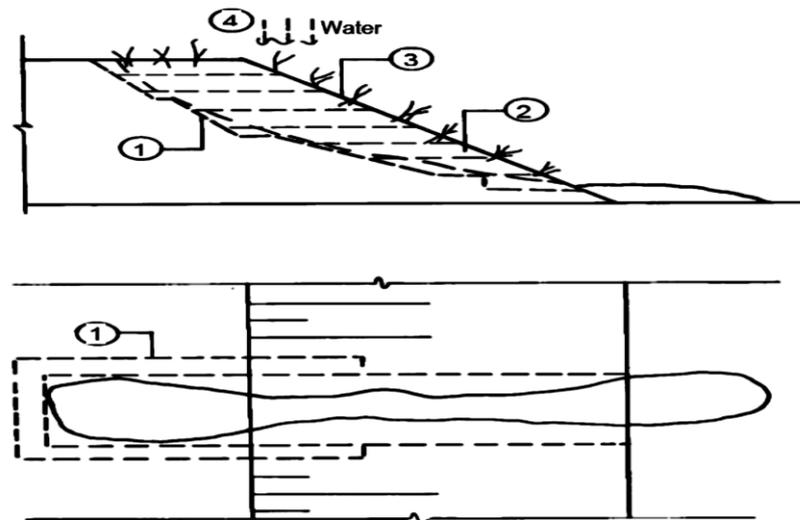


Fig. 28: Rain cut on embankment

7) Rutting and whole due to soil displacement

Description of the damage:

Creation of whole for rutting on embankment, soil displacement or for any other reasons. Water accumulates in the hole and the hole expands due to the traffic damaging the embankment (Figure 29).

Cause of damage: Motor vehicle or any animal can create hole on the embankment or its slope if the compaction works are not done properly.

Inspection: Appropriate measure should be taken to carry out the maintenance works through regular inspection of the embankment. Maintenance works should be carried out in two phases: regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

Maintenance system: The embankment rehabilitation activities are as follow. a) Displacement of loose soils completely (1)

b) Regular nursing and watering until the grasses grow up to 10 cm high (2 and 3)

c) Filling of the holes with 15 cm layer with required soils and compaction of each layer separately, watering if required (2 and 3)

d) Dressing and grass turfing.



Figure-29 Rut Holes

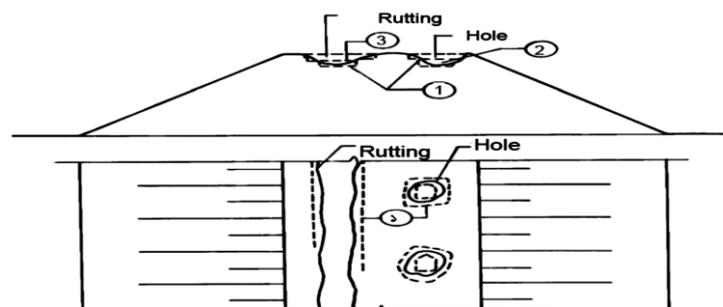


Fig. 30: Rutting and hole

8) Ghogs (hole through the embankment)

Description of the damage: Rats or any other animal can make hole into the slope extending from the subproject side to the riverside. If ghogs are not repaired timely embankment could be breached due to seepage through it (Figure 31).

Cause of damage: Rat or any other animal or inadequate compaction is responsible for it. Moreover, if soil clods are not broken during the construction of embankment may also make ghogs.

Inspection: Appropriate measure should be taken to carry out the maintenance works through regular inspection of the embankment. Maintenance works should be carried out in two phases: regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

Maintenance system: The embankment rehabilitation activities are as follow.

- a) Re-excavation of the ghogs towards river side at a depth of 1m (1).
- b) Filling of the ghogs with mud soils at a depth as much as possible (if possible on both source sides) (2).
- c) Filling of the re-excavated part with appropriate soils with compaction by 15 cm layers (3).
- d) Dressing of the rehabilitated part of the embankment and grass turving, bamboo sticks should be used to fix the grass turf with the slope.
- e) Regular nursing and watering until the grasses grow up to 10 cm high.



Figure-31 Ghogs

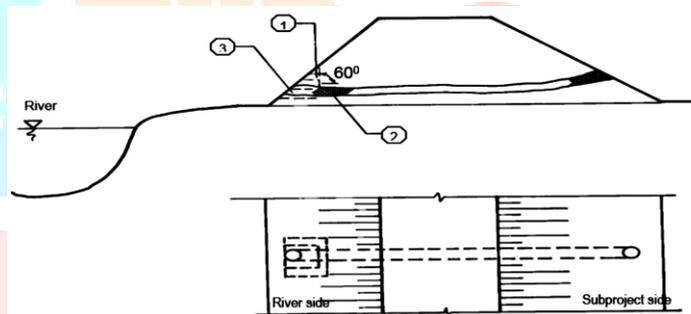


Fig. 32: Ghogs on embankment

9) Embankment breaching

Description of the damage: Flood control embankment can be breached suddenly for high water pressure or if ghogs are not repaired timely. The size of the breaching gradually enlarges from smaller to bigger. The breaching can cause serious damage to the embankment if it is not repaired immediately (Figure 33).

Cause of damage: Sudden floods, flow of floodwater with high velocity, rainfall-runoff, flash floods, rapid rise in flood levels or if embankment is not rehabilitated for long time can cause the breaching.

Inspection: Appropriate measure should be taken for the maintenance works through regular inspection of the embankment. If the embankment is repaired during the flow of water, the level of water (high or low) should be determined and accordingly necessary step should be taken. Regular and seasonal maintenance works can reduce the risk of breaching.

Maintenance system: Maintenance work of the breached embankment can be three types- (a) repair in dry condition, (b) repair during low flow condition, and (c) repair during high flow condition. The embankment rehabilitation activities are as follow.

a) Repair in dry condition (Figure 34).

- Benching at 30 cm depth and at an angle of 60° at the breaching part of the embankment (1).
- Re-sectioned part should be filled with appropriate type of soils with 15 layers and compaction of each layer separately (2).
- Leveling of slope on the river side with additional soils (3).
- Dressing of the upper part and grass turving on the slope, bamboo sticks should be used to fix the grass turf with the slope.
- Regular nursing and watering until the new seedlings grow up to 10 cm high.



Figure-33 Embankment Breaching

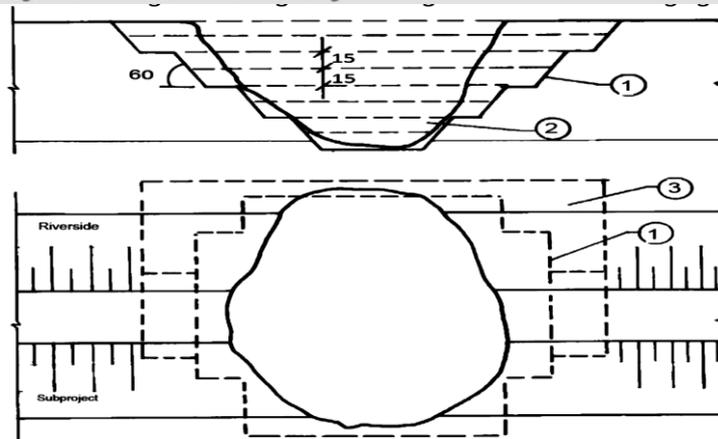
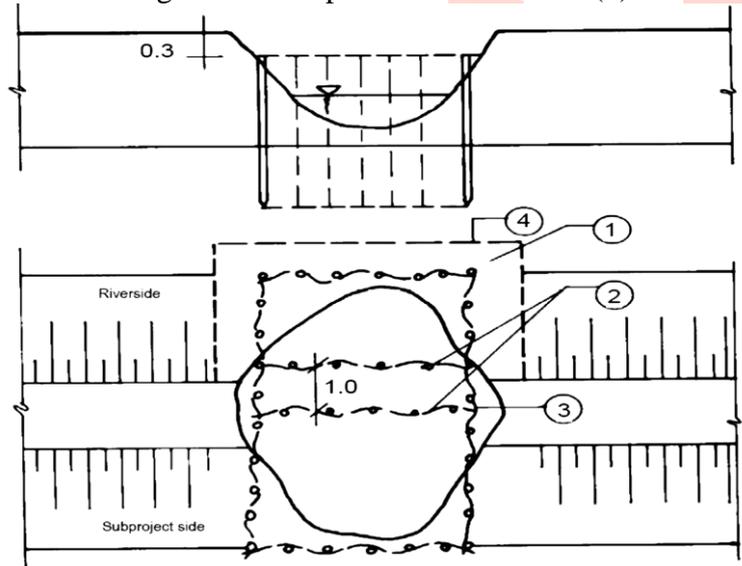


Fig.34: Breaching of embankment: repair in dry condition

b) Repair during water low flow condition (water level difference of < 10 cm) (Figure 35).

- Ring embankment at the breached part with bamboo and torja (1).
- Two rows of bamboo pillars 1 m apart at a height lower than the embankment crest level tied with bamboo mat (torja) (2).
- Water flow should be stopped placing sacks filled with soil and plant residues inside the chamber (3).
- Construction of embankment reducing the side slopes on the river side (4).

Fig. 35: Repair during low flow condition (water level differences of < 10 cm)

c) Repair during high flow condition (water level difference of > 10 cm) (Figure 36).

- 2-3 rows of ring embankments on the subproject side with bamboo and bamboo mat (torja) (1).
- Dumping of sacks filled with soil and brush wood (2).
- Re-construction of new embankment on dry condition (3).
- Filling with 15 cm layer and compaction of each layer separately.
- Dressing of the upper part and grass turfing on the slope, fixing of the grass turf with the slope using bamboo sticks.

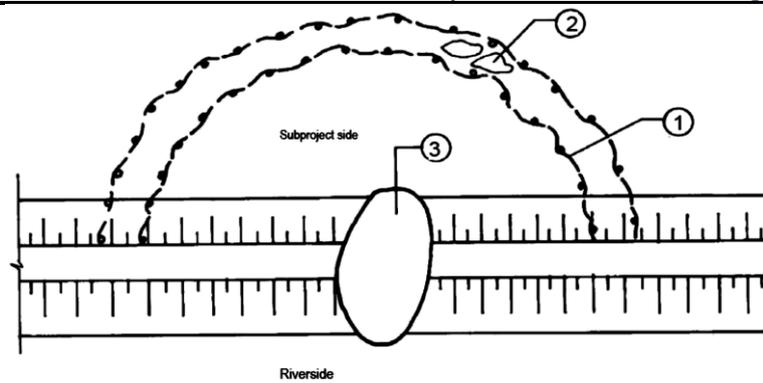


Fig. 36: Breaching of embankment: temporary protection during water flow condition and repair after the rainy season

MAINTENANCE OF WATER CONTROL STRUCTURES & RUBBER DAMS

1) Poor drainage for the aquatic weeds

Description of the damage: Usually, drainage is impeded for the aquatic plants. Inadequate drainage of rainwater causes adverse impacts in the subproject area.

Cause of the damage: Growth of aquatic plants, particularly hyacinth at the gate downstream. Thickness and density increase for not eradicating in time. Water flow is impeded during the operation of the gate and drainage period prolongs. Consequently, depth of water increases on subproject side.

Inspection: Appropriate measure should be taken for the maintenance works through regular inspection of the embankment. Maintenance works should be carried out in two phases: regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

Maintenance system: (a) Preventive and seasonal maintenance works should be undertaken so that aquatic plants cannot grow at the downstream of the gate, (b) Weeds and other residues should be removed in the rainy season.

2) Leakage through the gate

Description of the damage: Leakage of water through the gate is commonly observed. If the leakage increases volume of conserved water decreases.

Cause of the damage: Alignment of the gate is not correct. Partial close of gate for debris at gate groove and breaking of rubber seal.

Inspection: Appropriate measure should be taken for the maintenance works through regular inspection of structure. Maintenance works should be carried out in two phases:

Preventive and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

Maintenance system: Repairing and greasing of gate hoisting system, (b) replacement of rubber season, and (c) cleaning of gate groove.

3) Partial damage of protective works at the downstream of structure.

Description of the damage:

Protective blocks at downstream of structure can be displaced, which ultimately may cause adverse impacts on structure.

Cause of the damage: There can be many reasons. For example, size of the structure is smaller than the requirement, for which velocity of water flow is higher and blocks can be dislocated. In addition, if invert level is kept at higher level than that required, gate is not operated properly and opening of gate rapidly during the period when water level is high can also cause damage of protective blocks.

Inspection: Appropriate measure should be taken for the maintenance works through regular inspection of structure. Maintenance works should be carried out in two phases: routine and seasonal. According to the check list prepared during the inspection after the rainy season, a work plan and budget for maintenance should be prepared and implemented before the rainy season.

Maintenance system:

(a) No rehabilitation will require when only launching apron is dislocated;

(b) Compaction with soil and re-construct of the slope will be required when protective blocks are dislocated. Thereafter filter should be placed and put back the blocks on it;

(c) If protective blocks are dislocated, concrete apron is under threat and quick erosion is observed in downstream of khal. Then causes should immediately be identified to take rectification measure and arrangement should be made for implementation.



Figure-38 Damage of Protective Works in River Side

4) Displacement of soil at the wing wall and return wall of structure

Description of the damage: In many cases soil from the wing wall and return wall of structure is displaced. Excess displacement can cause damage of structure.

Cause of the damage: Inadequate compaction of soil at the back of wall and subsidence due to leakage of water during flooding.

Inspection: Appropriate measure should be taken for the maintenance works through regular inspection of structure. Maintenance works should be carried out in two phases:

Routine and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

Maintenance system: Compaction at the back of wall with 15 thick layer using required soil, and (b) placement of filter at the connecting point of wing and return walls.

PREPARATION AND IMPLEMENTATION OF MAINTENANCE PLAN

1) Preparation of Priority List: To consider annual maintenance program, a priority list of subprojects to be prepared based on importance. A priority list of district to be prepared following prescribed Grading Formats (Exhibit G8-1, Format A, B & C) and based on the marks scored. For getting maximum utilization of the Fund the list should be finalized. Executive Engineer will prepare priority list in his district and will send to regional SE by 30, June. Regional SE after getting the priority list will review the list in monthly meeting and prepare a priority list under his jurisdiction and will send to IWRM by 15, July with recommendation. IWRM will review the priority lists from all the Zonal SE's and will prepare a tentative list of maintenance works for execution and preliminary allotment of fund and will send to Zonal SE and Executive Engineer by 10, August. It is to be noted that maintenance of structure to be given priority but for earthwork clear justification for its implementation should be given.

2) Grading: Grading can be considered as success of implementation and indicator of future investment. As request for government fund is much higher than fund available, the selection should be done based on grading. Those subprojects will secure Excellent (A) and Good (B) will get priority for the fund. Grade consideration will secure the distribution of fund to achieve optimum benefit. Decision for allotment of fund for subprojects will be taken based on the results of Grading. Those subprojects which will receive 'Excellent' and 'Good' grading will be considered eligible to receive GoB fund. Those subprojects which will receive 'Medium' or 'Bad' Grading will try to rectify their defects and involve themselves in O&M activities. Less priority will be given to weak subprojects as application for fund will increase if fund is provided to weak WMCAs. Grading criteria are given below:

To estimate the quantity of works following steps are to be taken:

- After monsoon the O&M sub-committee will visit khal, embankment and structure. This committee will identify the damages in infrastructures during monsoon.
- Following the Exhibit G8-2, Format A, Format B, Format C, Format D, Format E and Format F the committee will assess the damage and prepare possible estimate for rectification of damages as identified
- Following Exhibit G8-2 the committee will estimate quantity of works and prepare budget
- After preparing budget they will prepare time frame (Exhibit G8-4) of implementation of works.

FIELD LEVEL JOINT INSPECTION OF INFRASTRUCTURE

Field level inspection is important to know the overall condition of the subproject for the preparation of subproject maintenance plan. LGED officials and WMCA operation and maintenance committee members jointly conduct this inspection twice annually, before and after the rainy season. LGED Assistant Engineer,

SSWRDSP-2 and Sub-Assistant Engineer, SSWRDSP, or two Sub-Assistant Engineers from Upazila LGED office and four WMCAO&M sub-committee members will participate in the joint inspection.

1) Inspection of infrastructure after the rainy season: Objectives–(a) Identification of the damages of various infrastructure and maintenance activities, (b) preparation of estimate and budget, (c) arrangement for fund collection, and (d) preparation of implementation schedule.

2) Inspection of structure before the rainy season: Objective – (a) Check that the maintenance works which were identified according to the plan are implemented, (b) identification of faults which can make the sub project vulnerable in the rainy season and take appropriate measure for repairing immediately if necessary, and (c) check that gate of the structure function properly and repairing of the gate if there is any fault.

OPERATION & MAINTENANCE SUBCOMMITTEE

A sub-committee should be formed under WMCA for the implementation of operation and maintenance works in time and properly. This sub-committee will be known as the operation and maintenance committee. The committee should be formed before the completion of infrastructure completes. This committee will be accountable to the WMCA for the operation and maintenance of subproject infrastructure. The sub-committee shall be formed consisting of 9 to 12 members including president, general secretary, treasurer and 6 to 9 members. This committee should include three members from the WMCA management committee and three members among the women. The other members should be among the subproject beneficiary members particularly from the landowners and fishers. However, priority should be given to the personnel who are experienced and interested on supervision and construction works. Priority should be given to include members from "monitoring of construction committee" because they have already gained some experience during the subproject construction. The remaining members should be selected according to the guidelines provided in this chapter. This committee will use the WMCA operation and maintenance fund as require with the approval by the management committee and submit detailed report to the management committee at the end of the year. Matters related the subcommittee formation for the operation and maintenance and fund collection should be included in the bye-laws of every WMCA. If there is any change in WMCA management committee through the election, the operation and maintenance committee can also be reorganized. However, new operation and maintenance committee should include three members including treasurer among the members of the old committee. The treasurer will be able to provide information about the fund. WMCA will carefully form the operation and maintenance committee according to the following considerations.

- Water users from the major villages should be represented;
- Priority should be given to those who are interested in operation and maintenance works and experienced in motivating.
- Representation of all types of farmers and occupational;
- Maximum number of members should be 12 and should include three members among the WMCA management committee and three members among the women.
- Members of supervision and construction committee can be included in the committee as convenient.

WMCA will take initiative for the formation of operation and maintenance committee.

The WMCA shall call a general meeting to form the committee according to the considerations as described above. The WMCA Chairman will chair the meeting. The steps involved in the process of committee formation are as follow.

- WMCA will inform chairman/members of the relevant union parishad (council) about the formation of the committee;
- At least two weeks before the place, date and time of the meeting should be decided according to discussion with the local people. The meeting should be held at a convenient place within the subproject area.
- Facilitator and Community Organizer will support WMCA in organizing the meeting.
- WMCA will inform Upazila Engineer about this and Socio-economist and Assistant Engineer at district level will present in the meeting.
- WMCA will distribute a leaflet containing brief description of the subproject and operation and maintenance needs in the meeting supported by the Facilitator and Socio-economist.
- WMCA will arrange to publicize place, date and time of the meeting at a nearest market/bazaar by beating tom-tom or if possible by miking.
- The committee should be formed before the construction of structure completes.

- At least 70 percent of the subproject beneficiaries should be present at the meeting to be organized for the formation of the operation and maintenance committee. If the attendance is found to be less than 70 percent the second meeting should be organized and committee can be formed whatever the attendance is.
- The duration of the sub-committee shall be two years and new committee should be formed when the tenure ends.
- The committee should be formed with common understanding, unanimously and based on democratic principles. The following discussion should be held at the meeting.
- Subproject infrastructure and function
- Importance of operation and maintenance.
- Responsibility of the committee related to operation and maintenance.
- Role of Government/LGED/WMCA on operation and maintenance.
- Government/LGED/Project's guideline on the collection of fund for operation and maintenance.
- Detailed clarification about the transfer of users' ownership of the infrastructure to the WMCA and matters related to handover.

The operation and maintenance sub-committee should be formed according the rules as specified above. Community Organizer, Facilitator and Socio-economist will fully support the WMCA in the whole process. The committee will be announced formally at the meeting.

Signature of the participants of the meeting should be collected. The proceeding of the meeting including the list of the elected members should be sent to the Upazila in the following format.

Subproject name and number	Upazila	Date of O&M sub-committee formation	Name of O&M sub-committee members	Occupation (agriculture, fisheries, teaching, etc.)	Designation (President/ secretary/ treasure/ member)

Sub-committee activities: The sub-committee will implement all the activities related to the operation and maintenance through the WMCA. The specific responsibilities and functions of the committee will be as follow.

- Updating of beneficiaries list;
- Preparation of beneficiary map;
- Regular inspection of subproject infrastructure and identification of problem;
- Assessment of the volume of the required maintenance works before and after the rainy season and accordingly preparation of budget every year;
- Involvement with all works related to operation and maintenance including planning, implementation and supervision of infrastructure;
- Preparation of work plan for the collection of operation and maintenance fund and support to WMCA for its implementation;
- Implementation of plantation program on the subproject embankment;
- Recommendation for the appointment of operator for the operation of structure;
- Regular submission of report on all activities (progress/problem/proposal) related to subproject operation and maintenance to the WMCA and at the general meeting or at special meeting;
- Communication with WMCA or relevant supporting organization (Project/LGED/NGO/Union parishad/upazila parishad) for technical or any other support;
- Support WMCA in organizing special meeting on maintenance with the inspection of subproject after the rainy season every year and related matter;
- Inform WMCA and Union Parishad for the resolution of conflict if there arises in case of operation.

SUBPROJECT BENEFICIARY MAP

Preparation of subproject beneficiary map and listing of beneficiaries are interrelated. Beneficiary map is the first step of the process to determine appropriate number of beneficiaries of the area and size of lands according to the types. This map will be useful to easily determine the number of plots owned by beneficiaries and area of the plots. This will help to clearly determine the number of beneficiaries and ownership of land per household. As a result, fund for operation and maintenance can be collected accurately and timely. The map will be new addition of the mauza map of that area (subproject) showing new homesteads and other infrastructure. The map will provide a clear perception about subproject lands and other infrastructure through this type of technical and educational activities. At the beginning all the mauzas in the area should be identified. The subproject may cover one or more mauzas or part of the

mauzas. Again, there can more than one sheet for each mauza. This indicates all the sheets of identified mauzas will be required to collect. The collected sheets should be put together. The size of the map will be bigger. Now the subproject index map (showing subproject boundary and other infrastructure) should be placed on this new map. After that, boundary and important infrastructure from the subproject map including main road, khal, water bodies (which are not shown in the new map) should be shown in the new map. Now, the additional or unnecessary part (beyond the subproject boundary) of the map can be ripped. The size of this map will depend on the subproject size. However, by any means the size of the mauza map should not be reduced. Because, the plots shown on the map are small in size and any reduction will make the plots further smaller. Accordingly, it will be difficult to work with the reduced map.

SUBPROJECT BENEFICIARY LIST

Each subproject should have separate beneficiary list so that beneficiaries can be involved with the operation and maintenance works along with other activities. This will help to collect operation and maintenance fund easily on the basis of the size of the land owned by the individual beneficiaries. Without the accurate beneficiaries' list land ownership cannot be determined. This may originate conflict among the beneficiaries and obstruct collection of contribution. Therefore, beneficiary list should be prepared according to the specific procedures. The subproject beneficiary's map can be divided as convenient into several parts. Beneficiaries list should be prepared for each part with visit and in consultation with the local people. The local people should be informed before the visit so that they can be presents and express their opinions. The preparation of the list should be started from a particular plot and information from the owner of the adjacent plot should be recorded in the attached format (Exhibit G8-5). Date and time should be fixed for each part of the map. Generally, rural people are acquainted about the area of their neighboring plots. Thus, the attending landowners will provide the information about his plots as well about the plots of his neighbors if they fail to be there. When preparation of list of a part will be complete, next plot will be selected for it following the same procedure. Project's Facilitator, Community Organizer, WMCA and operation and maintenance subcommittee members will participate in the preparation of the list. Two types of list can be prepared from the information to be collected from the beneficiaries. For example:

- Direct beneficiaries.
- Indirect beneficiaries.

Direct beneficiaries: The owners of land within the subproject area will only be considered as the direct beneficiaries. The list will again include men and women beneficiaries. If any household is headed by woman in this case her name should be listed. However, in some cases fishers can be the main beneficiaries. Accordingly, the list should be finalized with precise identification of landowners, farmers and fishers.

Indirect beneficiaries: There could be many households without owning any agricultural land within the subproject boundary. However, they can be benefitted in one form or another for the subproject implementation. For example, employment generation, increase in crop production, opportunity for marketing, improvement of communication, and so on which may provide more employment opportunity and increase incomes. Indirect beneficiaries may include landless, small businessmen, fishing community (fishers), boatmen and other communities and occupational people. These occupational people should be listed and they can be members of WMCA. However, they are not obligated to provide fees for the operation and maintenance activities excepting fishers in especial case. It can be mentioned that other procedure can be used if this list cannot be prepared from the beneficiaries map.

COLLECTION OF OPERATION AND MAINTENANCE FUND

The main objective of the formation of Water Management Cooperative Association (WMCA) in this project is to ensure proper operation and maintenance of infrastructure. Each member has participation or share in WMCA. Moreover, every member contributes monthly to the WMCA saving fund. Again, the members also share the WMCA expenditures through the contribution of fees to miscellaneous funds. The WMCA capital fund is formed through the shares and saving by the members. WMCA makes profit with the investment of this capital and distribute the profits among the members. In this way all the existing cooperative associations in the country operate various activities to create the capital and make profits. In addition to current activities the Water Management Cooperative Association has the responsibility of operation and maintenance of water management infrastructure such as khal, embankment, sluice gate, and regulator and so on. Accordingly, there are some differences in the procedures for fund collection to carry out these activities. Maintenance works cannot be undertaken utilizing the fund which will be collected through share and savings. It should be noted that the primary responsibility for the maintenance related works rests with WMCA. Excepting the regular (routine) maintenance, WMCA will undertake minor type

of urgent maintenance work from its own fund. However, it can receive support from the government revenue fund for major type of urgent maintenance works. A guideline should be followed to get support for this type of fund. The availability of fund will depend on the WMCA organizational capability and maintenance skill. In general, this fund will be developed primarily with the contribution from among the subproject beneficiaries. Land owners or cultivators within the subproject area and landowners who directly benefit for the subproject infrastructure, or increased income for the fisheries within subproject structure, even he is not a member of the association, is identified as main or direct beneficiaries of subproject in accordance with the Project concept. The operation and maintenance committee to be formed comprising beneficiaries and management committee members will prepare operation and maintenance budget and develop a fund with the fixation of beneficiaries' contribution rate to implement the plan according to the budget. The operation and maintenance fund will be collected from the following sources:

- a) The contribution collected from the beneficiaries before the implementation of the subproject;
- b) Monthly collection of fees to be fixed at certain figure (in addition to share savings) from beneficiaries members;
- c) Collection of produce at certain rate during the harvest period;
- d) Fixation of rate according to the size of land benefits for flood control and drainage system;
- e) Profit made by the association for the investment on various economic or income generation projects, for example some associations invest on micro-credit, duck poultry farming and other sector, part of profit margins from this type of investment;
- f) Part of income from fisheries if there is any opportunity for fisheries in the subproject area;
- g) Contribution from any local organization, local government institution;
- h) Income from plantation within the subproject area;
- i) Collection of fees at a fixed rate from the beneficiary if he irrigates water from the khal within the subproject area; and
- j) Fund allocated by the government.

The beneficiaries should deposit the total fund on account of "contribution" before the small scale water resources subproject work starts. However, this contribution fund will not be used directly for the implementation of structure. A reserved fund will be created using this fund for the purpose of operation and maintenance according to the following procedures:

- a) Fixed-deposit of the beneficiary contribution to a schedule bank account opened by Executive Engineer and WMCA President/Secretary. The name of the account should be "Operation and Maintenance Fund". The receipts of this account will be retained by the Executive Engineer until the handover of the subproject.
- b) This fund will not be required to use in the first three years, therefore fixed deposit at the primary stage will be useful.
- c) At the end of the construction works, an account in the name of "Operation and Maintenance Fund (Operating account)" should be opened for the maintenance in a schedule bank with joint signatures of WMCA President and Secretary. Fund from beneficiaries should be collected and deposited to this account for the maintenance. In this saving account cumulative amount of interest obtained during handover and later on annual interest from fixed deposit should be directly placed. Instruction should be given regarding issue during opening of fixed deposit account with Upazila Engineer and WMCA.
- d) In the subproject handover meeting, the receipt of the fixed-deposit should be handed over to transfer the fund excluding the total profit in the saving account operated in the name of "operation and maintenance fund" jointly by Upazila Engineer and WMCA President/Secretary.
- e) Operation and maintenance sub-committee will collect fund every year from the beneficiaries after the preparation of annual maintenance budget. However, effort should be made to raise the fund collection equal to the contribution money as the maintenance cost can increase later compared to that at the beginning.

Generally, the annual operation and maintenance fund is collected at a rate of 3% of the total cost for earthworks and 1.5% of the total cost for the construction of structure. Although volume of maintenance works will not be bigger in 1 to 2 years in the completed subproject, equal amount of contribution should be collected from the beneficiaries. The fund should be collected on the basis of the proportion of land owned by the individual beneficiaries. Specially, step should be taken particularly during the harvest season as an appropriate time for the fund collection.

The rate of contribution or fees should be decided from the beneficiaries list in the general meeting. Fees can be better decided on the basis of per acre of land benefits. Later, subproject can be divided into several

small parts. One member from each of WMCA management committee and operation and maintenance committee can be given responsibility of each part of the subproject area for the collection of fund. They should discuss about the fund collection with the beneficiary farmers in a meeting. Produce for the maintenance fund can be collected corresponding with the crop season, at least twice in the year (mid April to mid May and mid December to mid January).

MANAGEMENT OF OPERATION AND MAINTENANCE FUND

An account should be opened in the name of “Operation and Maintenance Fund (Operating Account)” in a schedule bank with joint signatures of WMCA President/ General Secretary. Fund can be withdrawn from the account operated in the name of “operation and maintenance fund” over the joint signature by WMCA President and General Secretary. This fund can be used for the operation and maintenance of subproject infrastructure and on account of remuneration for gate operator. The fund should be used according to the following guidelines:

- a) The total contribution by the beneficiaries should be fixed-deposited in joint account opened by Executive Engineer and WMCA before work starts (1st fixed account).
- b) During the handing-over the total amount of 1st fixed account excluding profit should be deposited in another joint account opened by the Upazila Engineer and WMCA.

This fixed account will be considered as reserved O&M fund (2nd fixed account).

- c) After the completion of the subproject, beneficiaries list should be updated by the WMCA during the period of joint operation and maintenance (before the handing over) to collect contribution from the beneficiaries for the operation and maintenance.

This can be discussed in a general meeting before the collection of contribution.

- d) A joint savings account (Operating Account) is to be opened jointly by WMCA, President and Secretary to deposit the collected fund. Accumulated interest obtains from 1st fixed deposit account during handover and subsequent annual interest to be directly placed in this account. This fund can be used for routine maintenance and remuneration for gate operator etc can be paid. Instruction should be given during opening of 2nd fixed deposit account.
- e) To bring the existing WMCAs under the same system following steps to be taken. For those subprojects showing maturity and capability in O&M and institutional activities, Upazila Engineer can send recommendation to Executive Engineer to transfer the reserved fund account to existing O&M account (Operating Account). Executive Engineer will thoroughly review and examine the case. If the recommendation from UZ Engineer is found justified Executive Engineer will give instruction to transfer the total reserved fund of the WMCA to O&M Account (Operating Account). Gradually all the O&M Account (Operating) will come under same type fund management.

GUIDELINES FOR THE USE OF GOVERNMENT FUND

The responsibility for the regular activities related to maintenance of subproject infrastructure rests with WMCA. However, additional fund may be required to repair the subproject infrastructure for the damage by natural disaster. This fund can be available from the government. The fund to be available from the government should be used according to the following guidelines:

- a) This fund can be used for the repair of infrastructure which have been properly operated and regularly maintained through the beneficiaries’ contribution in the subprojects constructed under small scale water resources project, rubber dam and other water resources infrastructure/scheme implemented by LGED.
- b) This fund can be used only for the major type of seasonal and emergency maintenance works.
- c) Priority will be given to the subprojects in which WMCAs have been collecting operation and maintenance fund regularly and participating actively in operation and regular maintenance and minor type of emergency maintenance works.
- d) Priority will be given to the subprojects where the WMCAs spend a share of profits from the income generation activities for operation and maintenance of infrastructure.
- e) The fund can be available for the repair of the embankments which are on the brink of breaching for the proximity of river. However, the fund cannot be used if there will any possibility of breaching of the embankment every year. Thus, the nature of river and possibility of breaching of the embankment should be checked before the utilization of fund.
- f) There should be a joint fixed account in the name of “operation and maintenance fund” by Upazila Engineer and WMCA.

- g) There should be a joint savings account opened in the name of “operation and maintenance fund (operating account)” by WMCA chairman and secretary.
- h) At the rate of 10 percent for up to Taka 100,000 and at the rate of 5% for the additional amount should be deposited in “operation and maintenance fund” account before the maintenance works start using the government fund. This could be later used for regular maintenance work.
- i) The fund will be available in the subprojects where the beneficiaries’ have received the ownership of subproject infrastructure for their use, but fund for silt removal cannot be given within three years from handover.
- j) During silt removal a bed block should be constructed at every km of khal

Before the maintenance work starts, operation and maintenance committee should discuss with the WMCA management committee for the allocation of budget and approval. Every year, the operation and maintenance committee should submit a report after the completion of maintenance work. The WMCA will call a general meeting to present the report to the beneficiaries. The operation and maintenance committee will be responsible jointly with WMCA management committee for the implementation of maintenance work.

PREPARATION OF ESTIMATE FOR MAINTENANCE

The initial requirement for the preparation of maintenance plan and budget is the assessment of the volume of maintenance work and estimate. Primarily, LGED and WMCA shall jointly visit every khal, embankment after the rainy season and assess the extent of damage. An estimate and budget should be prepared with the determination of applicable rehabilitation system for the annual maintenance of flood control embankment, drainage khal and water control structure.

- a) **Regular (routine) maintenance:** Estimate of this type of maintenance work will jointly be prepared by Upazila Engineer office and WMCA and will be implemented by WMCA. Bill of implemented work will be paid from WMCA own fund.
- b) **Periodic and emergency work:** In this case Upazila Engineer Office and WMCA will jointly visit the infrastructure and prepared the estimate and will send to district Executive Engineer, LGED. Executive Engineer considering the field condition will make a priority list and will send to Zonal Superintending Engineer with recommendation. Estimate sent by Executive Engineer will be scrutinized by Zonal SE office and estimated amount above 10 lac will be sent to IWRM Unit for approval. Estimate below Tk. 10 lac will be approved by Zonal SE.
- c) For allotment of GoB fund there should be O&M plan. Moreover, additional money should be deposited in O&M fund within January at the following rate every year depending on amount of allotment of fund.
 - At the rate of 10 percent for up to Taka 100,000.
 - At the rate of 5 percent for the amount in addition to Taka 100,000.
- d) The cost for the removal of silt will be provided from the government fund. However, according to silt removing guidelines, the WMCA will identify the khal in O&M plan earlier for the removal of silt and complete the work with 50 percent of the total cost or volunteer labor. Fund will be available from the emergency fund to complete the remaining part.
- e) The portion of khal from where the WMCA needs to remove silt should be specified in the O&M plan and shown in map by chain age. Usually, it is observed that WMCA changes the decision on the removal of silt. As a result problem arises on the use of O&M fund. Thus, decision on the removal of silt should be taken with the discussion among the beneficiaries and finalized during the preparation of O&M plan.
- f) No cash will be available from the emergency fund for the procurement of gate or any of its part when stolen.
- g) The gate painting, greasing, hoist system servicing, smaller rain cult repairs, embankment grass turfing and minor emergency works should be completed as a routine responsibility of WMCA and to be done from WMCA own fund. The description of these works should be sent in the specific format.
- h) Emergency fund will be available once for change of rubber seal later on WMCA will use their own fund for changing rubber seal.
- i) Two copies of the maintenance work estimate using the fund from irrigation infrastructure should be sent for approval.

Fund allocation

Fund from the government revenue budget will be distributed to the district level by the IWRM Unit at LGED headquarters for the maintenance of subprojects constructed under the small scale water resources development sector according to the specific principles. It should be noted that the allocation against a district will depend on the actual requirement in the district, WMCA maintenance skill which will be

decided reasonably in consideration with the actual situation. The following should be considered with importance for the allocation of this fund to the district levels:

- Priority list as per grading.
- To give priority to maintenance of structure. For maintenance of earthwork proper justification should be given.
- If earlier allotment is taken from GoB fund, a report on amount of fund received and statement of expenditure to be provided.
- Role of WMCA in maintenance work and fund collection.

Preparation of annual procurement plan

Annual procurement should be prepared by the Executive Engineer of the relevant district for the current financial year within two weeks after the availability of fund from “irrigation infrastructure” account for the repair of small scale water resources infrastructure. The plan should be sent to the IWRM Unit.

For this O&M plan should be reached at IWRM Unit from the field within 30 November. This will be reviewed to provide fund within December. In continuity, annual procurement plan should be received by the IWRM Unit as latest as second week of January.

Implementation method

In course of activities related to water resources infrastructure operation and maintenance opportunity for the participation of local people or LCS should be identified in supporting the poverty reduction effort by the Project. The following works with a total cost of 500,000 or less can be carried out through the LCS.

- a) Block making, leveling, dressing and placement with filter material;
- b) Gate repair, replacement of rubber seal, increase of gate height, repairing of shaft and hoist system, changes of skin plate, and so on;
- c) Repairing of parts of regulator; and
- d) Gauge marking and painting on regulator.

The number of LCS member should be 10-25 for earthworks and 5-15 for pucca works. The pucca work with a cost of more than Taka 500,000 cannot be divided to distribute among the LCSs. In accordance of this decision, water resources infrastructure operation and maintenance works should be carried out. District Executive Engineer should prepare annual procurement plan within 2 (two) weeks after the receiving fund in each financial year to send at LGED headquarters for approval. Step should be taken for implementation after the approval. LCS management guidelines should be followed for the LCS formation and payments. Moreover, relating to the LCS formation the section number 69 in the LCS management guidelines will be considered as corrected according to the subsection 18.6.1 in the present guidelines. WMCA and LGED jointly implement the subproject operation and maintenance works. The maintenance of structure has to be implemented following the Public Procurement Regulations 2008 through contractor and LCS. The total earthworks have to be carried out by LCS. However, the structure maintenance can be implemented by LCS if the cost limits within Taka 500,000 as mentioned in subsection 18.6.1. For works costing above Taka 500,000 should be implemented through contractor as in the past following public procurement rule 2008. Upazila Engineer will discuss concerned WMCA members for the preparation of a realistic estimate to implement the work as described in 18.6.1 above through LCS. The estimate has to be sent to district Executive Engineer. The Executive Engineer will thoroughly review the estimate for approval and will send to zonal Superintending Engineer for approval. The general maintenance works have to be completed within May. Only turfing work can be carried out between May end to mid June so that grass can grow well from the rainfall. WMCA O&M committee will oversee the maintenance works and on behalf of LGED Upazila Engineer, Upazila Assistant Engineer, Upazila Sub-Assistant Engineer/CS and technical person engaged in Small Scale Water Resources Project will directly be involved in this activity. District Socio-economist and those involved in institutional development work in district and upazila (CPO, Socio-economist, CA/Facilitator) be involved for the monitoring of this work. It can be mentioned here that after handing-over, WMCA will carry out the joint inspection with LGED twice in a year (before and after the rainy season). Later WMCA with its own initiative will inspect structure twice in a year and send a report on it to the IWRM. The specified format for this inspection has to be sent to every WMCA from IWRM Unit. WMCA can take help from LGED field level officials for this work.

Progress report: The report on the progress this work should be sent within fifth day of each month. Upazila Engineer shall be fully responsible for the satisfactory progress of work maintaining the quality of all works at upazila level. Executive Engineer will regularly supervise the maintenance activities in the district and ensure proper implementation of this program. LGED zonal Superintending Engineer will review the progress and implementation quality. He will provide necessary instruction at the field level.

Completion of work: The entire work should be completed before 30 April. Inconsideration with this a work plan should be sent to IWRM Unit with operation and maintenance plan for the implementation of this work.

QUALITY CONTROL OF MAINTENANCE WORK

Especially attention should be given to the quality control of maintenance work. If there is any negligence in maintaining quality the concerned officer/staff will be responsible for it. Use of hammer for the compaction of earth works on embankment and in the rehabilitation of embankment with 15 mm layers should be observed at the field level and the result should be known with laboratory test. Bill should not be paid if the work is found to be unsatisfactory. O&M committee will supervise the work on behalf of WMCA for quality control and complain to LGED if necessary. In this regard, the booklet on “Role of subproject construction monitoring committee” (2010), published by Integrated Water Management Unit should be followed.

BILL PREPARATION AND PAYMENT

a) In case of regular Maintenance:

The offices at Upazila level will record the work implemented under WMCA in MB(measurement book) specified by the government and accordingly prepare bill and submit to the Upazila Engineer’s office with the signature by WMCA chairman/ secretary and operation and maintenance committee chairman/secretary for the payment of bill. Upazila Engineer will check the bill according to the rules and pay it. The bill should be paid through bank check jointly signed by WMCA chairman and secretary from the bank account operated in the name of “Operation and Maintenance Fund”. All records regarding quantity of works and bill will be preserved by WMCA for audit.

b) In case of emergency and periodic maintenance:

Bill for periodic and emergency maintenance to be prepared after joint inspection by WMCA and official in-charge in Upazila level, will entered in Govt. measurement book (MB), will prepared the bill in bill form and will send to Upazila Engineer with recommendation. Upazila Engineer/Assistant Upazila Engineer will review and examine the bill as per rules and regulation and will send to Executive Engineer with recommendation who after scrutiny and review will arrange for payment.

SUBPROJECT HANDOVER PROCESS

Handover process of subprojects implemented under SSWRD Projects

It can be mentioned that participation of beneficiary people is the characteristic of the Small Scale Water Resources Development Project. Because the ownership for the use of completed subprojects is handed over to the beneficiaries and beneficiary people take the responsibility for subproject maintenance. Thus, on principle the matter of sub project handover process should be undertaken on the basis of participation (Exhibit G8-9). The process which to be followed to handover the subprojects implemented under the Small Scale Water Resources Development Project is described below.

A. Completion of subproject construction works and joint inspection

As soon as Contractor completes construction of all works of the subproject, Executive Engineer will undertake a joint inspection of the subproject with Upazila Engineer, Project Consultants, Management Committee of WMCA including Construction Monitoring Committee and O&M Subcommittee and the Contractor. The joint inspection will particularly focus on construction of hydraulic structures and their gates – their easy and flawless lifting and closing and leak-proof water sealing and appropriate painting, greasing, etc. For hydraulic structures, if defects/outstanding works are such that the structures cannot be put to immediate use due to those, the defects/outstanding works shall be grouped as “immediate rectification works” and must be rectified by the Contractor immediately making the structures fully fit-for-use. Dates for completion of these rectifications will be agreed and recorded in the inspection report. Any other defects/ outstanding works to be rectified in the maintenance (defects liability) period shall also be identified and their committed dates of rectification, decided based on functioning of the structures, shall be mentioned in the joint inspection report. The Contractor will undertake the required “immediate rectification works” first and complete them within the specified dates. These works will again be inspected and if found properly done, the works can be considered substantially complete and the hand over process will be undertaken.

B. Handover ceremony

The subproject handover process should be completed in a public-function. WMCA will be the organizer of this function. LGED will provide all support to the WMCA. The Deputy Commissioner/Zonal Superintending Engineer, LGED/Upazila Chairman/Upazila Nirbahi Officer or any other respected elite person can be invited as chief guest in this function. In addition, the district and upazila officers of agriculture, cooperative, fisheries, land administration, Water Development Board and other government agencies should be invited. WMCA will ensure all arrangement so that the WMCA general members can participate in the public-function spontaneously. The program of the function as usual should be informed to the project headquarter. Purpose of SSWRD projects in general, description and objectives of the subproject, procedure of O&M and purpose of the handover agreement will be disseminated in the meeting and the handover deed will be signed in the meeting in public.

C. Joint O&M

The 1-year LGED-WMCA joint O&M of the subproject will commence from the date of hand over of the subproject to the WMCA. For this, Executive Engineer will circulate a notification about the joint operation and maintenance. In this notification he will clearly describe the specific responsibilities of Upazila Engineer and WMCA operation and maintenance sub-committee and mention when the tenure of joint operation and maintenance will end. The Upazila Engineer's responsibilities will include arranging training for the operation and maintenance sub-committee, preparation of operation and maintenance budget and fund collection. The main activities of the joint O&M period are as follow:

- Training of O&M sub-committee on operation and maintenance by LGED.
- Inspect infrastructure jointly and prepared operation and maintenance plan.
- Start joint operation and maintenance and rectify all the infrastructure faults.
- Opening of joint operation and maintenance account (Operating Account) and collection of fund from various sources.
- O&M Subcommittee prepare for undertaking O&M responsibilities by themselves
- Contractor performs all defects liability maintenance during this period.

RESPONSIBILITIES OF DIFFERENT LOCAL GOVERNMENTS IN SUBPROJECT O&M

Different bodies are involved in the implementation of operation and maintenance activities of subproject infrastructure in various ways. Although the main responsibilities with the beneficiaries. Still many individuals/groups/organizations have numerous responsibilities to provide technical, financial, management and related supports. In fact it is not that other works will not be implemented by the concerned individual/bodies beyond those described here. The responsibilities of the concerns' are separately described below.

1) Local Government Engineering Department (LGED)

LGED will provide all the technical supports and guidance in subproject operation and maintenance. The extent of responsibilities of the officer and staff at district and upazila levels involved in subproject operation and maintenance are given below.

Superintending Engineer (Region): By optimum utilization of water resource to increase agriculture and fish production and thereby with an aim to socio-economic development O&M aspect of SSWRDP, duties of Superintending Engineer are as follows:

- Monitoring of O&M of Small Scale Water Resources Subproject and activities of WMCA.
- Review the priority list as received from district and prepare a priority list for onward transmission to IWRMU
- Each year from list of subprojects finally selected by IWRMU for O&M, approval of estimate and implementation to be awarded costing less than Tk. 10 lac.
- Estimates which cost over Tk. 10 lac to be send to IWRMU for approval.
- To review the O&M activities in monthly meeting and provide proper guidance to Executive Engineer and Upazila Engineer in this regard.
- To monitor that in O&M activities environment, gender development, climate change, national water policy and guidelines of participatory water management are followed.
- Provide guidance and collect information whether handed over of SPs and O&M activities of handed over subprojects being monitored properly by district and upazila officials.
- To ensure that annual O&M activities are being completed as per plan and report of progress and other related issues to IWRMU unit.
- To ensure the quality of works and inspects at least 10% of works and submit the report to IWRMU

To resolve the conflicts in O&M activities.

Executive Engineer: According to the Project arrangements overall responsibilities related to operation and maintenance rest with Executive Engineer. The responsibilities of Executive Engineer for the operation and maintenance activities in general will be as follow:

Each year to prepare a priority list for maintenance works from Grading list and other related information sent by Upazila offices and will ensure to send list to Zonal Superintending Engineer office with recommendation.

Ensure to send the maintenance plan and estimate prepares as per O&M Guidelines to Zonal Office.

Ensure quality of maintenance works and examine measurement of at least 15% of works.

To coordinate all works regarding O&M.

To ensure that WMCA/O&M sub-committees to receive technical guideline from LGED.

To provide advice to Upazila Engineer/Project Staff regarding O&M work.

Monitor all works of O&M under his district and send monthly report to Head Quarter with overall evaluation of the work and provide necessary recommendation.

Take initiative in Hand over of sub-projects. In this regard will give necessary advice to Upazila Engineer.

To take step of cooperation from other agency in the field of operation and maintenance work.

To ensure that all works are being done following the O&M Guidelines published from IWRMU

Senior Assistant Engineer: Planning implementation and operation and maintenance program is carried out with the technical mater of all subproject activities inconsideration with socio-economic, agriculture, environment, fisheries and other matters. In the context of implementation of operation & maintenance activities duties and responsibilities of Senior Assistant Engineer are as follows:

To assist Executive Engineer to prepare list of priority subproject as per plan of the district.

To ensure quality of works examine at list 25 percent of works.

To assist Executive Engineer to monitor O&M works of Upazila Engineers.

To provide technical Assistance and advise WMCA/O&M Sub-committee.

To take instigative and assist Upazila Engineer if required.

To ensure use of O&M guideline in O&M activities.

To co-ordinate each year after monsoon for measurement of the volume of subproject maintenance works, prepare estimate and co-ordinate implementation works as per plan.

To give proper guidance for O&M works as per plan and carefully monitor quality of works.

To monitor O&M works to take initiative for sending to head quarter.

To ensure works in O&M works socio-economic, climate change, gender and development aspect are been followed.

Arrange training for the person (operator) responsible for O&M and provide technical guidance and assists in this matter if any problems arise.

Assistant Engineer: For O&M activities for Small Scale Water Resources subproject duties of Assistant Engineer, in District Executive Engineer LGED is as follows:

To assist in planning and O&M activities considering Socio-economic, Agriculture, Environment, Fishery and Climate Change aspects.

Following O&M Guidelines to select Subprojects for maintenance activities.

To coordinate in each year following monsoon measurement of the volume of subproject maintenance work, preparation of estimate and implementation works.

To ensure quality of maintenance works of different schemes.

To assist in handover process of subprojects.

To assist in WMCA and other project officials for preparing monthly report and inform Executive Engineer in this regards.

To attend in different meetings regarding O&M issues and provide advice in technical matters and assist in O&M activities.

Arrange training for the person (operator) responsible for operation and maintenance and provide technical guidelines and assist in this matter.

To ensure quality of works and examine at least 25% of works in field.

Collection of data and information regarding O&M, prepare data base and management of the same.

To provide technical guidelines to WMCA as and when required.

Sociologist/Socio-economist: The Project Socio-economist at district level irresponsible for overall socio-economic activities in the subproject. His major responsibilities on subproject operation and maintenance in particular are described below:

- To Ensure that Socio-economic activities in consider in O&M works;
- Take overall initiative to assist beneficiaries about the formation of subproject WMCA/sub-committee/village committee;
- Arrange training for WMCA/sub-committee and participate as trainer;
- Integration of activities related to preparation of subproject beneficiary map and beneficiary list;
- Integration of activities related to fund collection from the beneficiaries for the operation and maintenance provide necessary guidance to the committee responsible for this activities;
- Integration of activities of the Facilitators responsible operation and maintenance works and accordingly provide necessary guidance/assistance;
- Take necessary step for strengthening of operation and maintenance activities as well as subproject socio-economic activities; and
- Preparation of monthly report regularly collecting information regarding O&M activities from Upazila levels.

Upazila Engineer: Upazila Engineer will involve himself in all activities related to O&M of subprojects. Duties of Upazila Engineer in brief will be:

- Ensure that for O&M the prescribed grading format field up with information will be sent to Executive Engineer office in due time.
- To coordinate in technical aspect in planning, design, implementation and O&M activities of Small Scale Water Resources subprojects.
- To assist technical aspect regarding O&M to concern WMCA/O&M subcommittee.
- To provide proper guidance to Sub-Assistant Engineer, Surveyor and Community Organizer regarding O&M activities.
- To Ensure quality of works and examine measurement of at least 50% of works.
- To take initiative in handing over of subproject in ceremonial manner and coordinate with XEN regarding the same.
- To implement the O&M works as per instruction from District Executive Engineer, Zonal Superintending Engineer and Head Office.
- To ensure that in O&M works socio-economic, climate change, Gender and Development aspects are followed:
- Provide necessary direction and assistance to the project's other officials/staff and integrate their works.

Upazila Assistant Engineer: In consideration with subproject operation and maintenance and other technical matters and assistance to the subproject works the responsibilities are as follow:

Measurement of the volume of maintenance works of subproject infrastructure after the rainy season each year, preparation of estimate and provide assistance in implementation; to coordinate with Upazila Engineer for maintenance each year;

To maintain the quality control of works and check measurement of at least 50% of works.

Assist in quality control of subproject operation and maintenance works;

Guidance to the WMCA/sub-committee on the subproject operation and maintenance;

Assist WMCA and Project's other officials in preparing monthly report including other;

Assist Upazila engineer in taking initiative to handover the subproject;

Attend meeting at various level on matters related to operation and maintenance and provide guidance and assistance on technical and institutional matters;

Take initiative for the execution of necessary instructions as given by the Executive Engineer and headquarters;

Provide training to the person responsible for operation of regulator/slucice gate and necessary step to resolve any technical problem when arises; and

Provide necessary directions and assistance on this to the Project's other official/staff and integrates their works.

Sub-Assistant Engineer: The duties of the Sub-Assistant Engineer at Upazila Engineer office are as follow: With the involvement of subproject activities supply of all types of engineering data and survey such as plane table, geodetic, and leveling information;

Attend sub-soil boring and supply underground water level and land elevation data;

Clear conception about structural design and to maintain quality of work, supervise implementation works. This supervision is also applicable for earthworks;
 Involvement with technical matter of operation and maintenance and provide assistance to the WMCA in the implementation of such work;
 Provide technical instruction in consultation with Upazila Engineer to the WMCA if any problem arises on the operation and maintenance;
 Ensure soil compaction of flood control embankment in order to maintain 90% dry density;
 Ensure dressing and turfing on the side slopes of the flood control embankment;
 Assist Upazila Engineer according to his instruction in resolving any problem related to subproject.
 Ensure quality control of the work ensure entering measurement book of works completed and prepare bill and submit to Upazila Engineer.
 To collect all information regarding O&M in database.

Community Organizer: Community Organizer at Upazila level is responsible for providing support to socio-economic activities in various projects of LGED. To perform all activities regarding O&M, the Community Organizer will have following responsibilities:

- With Project's other official ensure formation of WMCA/sub-committee/village committee and provide necessary support according to the plan;
- Preparation of beneficiaries list and take initiative for the collection of operation and maintenance fund;
- Ensure communication between officer/staff at Upazila level and subproject WMCA and other committee to provide support on operation and maintenance activities;
- Initially as an observer attend the training courses on operation and maintenance for WMCA/sub-committee/village committee and later participate as a trainer;
- Assist Project's other officials in the preparation of monthly report and later participate to implement those activities on own initiative.
- Preparation of regular report on operation and maintenance;
- Motivation and inspiration of beneficiaries for the collection of operation and maintenance fund including providing of necessary suggestions.
- Assist in resolution of conflict among the WMCA/sub-committee/village committee;
- Preparation of regular (monthly) report on the operation and maintenance;
- Identification of problem/limitation and so on and preparation of necessary and potential recommendations; and
- Assist WMCA/committee in preparing subproject beneficiaries map and list.
- Assist in the preparation of household list in subproject area, preparation of list of beneficiaries and affected person and co-ordinate in arranging meeting in village or para for raising awareness on O&M.
- To help WMCA in all respect for signing implementation agreement.
- During implementation to help WMCA/LGED in forming LCS groups.
- After completion of infrastructure assist in capacity development of WMCA for O&M activities before & after handover.
- Monitoring of WMCA office and accounting activities.
- To assist increasing share & saving of WMCA.
- To ensure holding of weekly meeting and monthly meeting of Management committee.
- To monitor the micro-credit activities of WMCA and update the information.
- To assist WMCA in preparation of poverty reduction plan and implementation of the same.

WATER MANAGEMENT COOPERATIVE ASSOCIATION (WMCA)

WMCA is the authorized user right of all infrastructure constructed, re-constructed and rehabilitated by the Small Scale Water Resources Development Project. WMCA also contribute a small percentage for O&M before implementation of the subproject and play an important role in controlling quality of construction works. On the basis of implementation agreement before the beginning of project activities and ownership agreement after the completion of construction between LGED and WMCA, the latter will be responsible for the operation and maintenance of infrastructure.

The main objective of the WMCA is operation and maintenance and to complete it correctly. WMCA should give attention to the following for the proper operation and maintenance.

General:

- Formation of operation and maintenance sub-committee.
- Raise the O&M issue in monthly meeting as an agenda.
- Arrangement to deposit profit from micro-credit operation and the income generation activities to operation and maintenance fund.
- Responsible for sending expenditure for O&M by WMCA from its own fund and through volunteer labor.
- Contact to LGED for emergency maintenance.
- Collection of O&M fund for regular and minor emergency maintenance every year.
- Identification of sources for the collection of O&M fund.

Operation:

- Before the rainy season ensure that gate can be raised properly.
- Appointment of get operator.
- Preparation of operator calendar in water conservation subproject and operation of the gat according to the time of water requirements.
- Recording of water level during gate operation in register.
- Arrangement of meeting to resolve conflict if arises among the beneficiaries during the irrigation water supply.

Maintenance:

- Field inspection of infrastructure after and before the rainy season each year.
- Preparation of maintenance plan and budget on the basis of inspection after the rainy season.
- Identification routine and emergency works.
- Attention to the timely completion of maintenance works.
- Work as observer to check that emergency work with the use of government fund is carried out properly.
- Initiative for removing water weeds as routine activity and removal of silt with volunteer labor.
- Take initiative to arrange a special meeting on operation and maintenance.
- Presentation of details of maintenance works carried at a special meeting so that beneficiaries can be involved in operation and maintenance.
- Duties of gate operator employed by WMCA
- Ensure security of water control structure (sluice gate/regulator etc.);
- Operation of gate as decided by WMCA/operation and maintenance subcommittee.
- Use of fallboard (where applicable) with care and store it on own responsibility.
- If structure found to be vulnerable for flooding or any other reason, inform WMCA/O&M sub-committee about it immediately and take necessary action; and
- Recording of water level.

1) Union Parishad

Union Parishad will be involved from the beginning of subproject proposal to operation and maintenance in any way. Concerned Union Parishad Chairman will play an important role on the subproject operation and maintenance activities. The major responsibilities are:

- Active participation in organizing of people for WMCA formation activities;
- Identification of conflict if arises any on structure operation and provide possible support to WMCA/sub-committee to resolve it;
- Support to the preparation of beneficiary map, beneficiaries list (collection of mauza map and all information);
- Support to collection of required contribution fund for the operation and maintenance;
- Participation in training organized by the Project;
- Allocation of fund by the Union Parishad for emergency repair;
- Communication to Upazila Development Committee and other organizations for emergency repairing and provide support about it.
- To include representative of WMCA as member of UDCC.

2) Upazila Parishad: Conflict resolution committee

If there arises any conflict between beneficiaries and affected persons on subproject operation and maintenance, the aggrieved party will first attempt to solve the matter with direct discussion between both parties. If it is not resolved through the discussion, then resolve the dispute at the Upazila Parishad according to the notification (Exhibit G8-10) issued by the Local Government Division (No. Pro: Au:-2/Pani-5/2001/418 (2347), dated: 23-04-2002 Eng).

CONCLUSION

- Low irrigation service collection which is inadequate to support system O&M.
- No systematic procedure for asset management and to identify O&M needs
- Limited participation and consultation with beneficiaries on O&M requirements
- Lack of asset inventory and condition survey on which to develop maintenance budget
- Proposed annual budgets for O&M are curtailed due to insufficient funds
- Funds released for O&M do not reflect requirements for annual, periodic or emergency maintenance of a system
- Lack of enforcement of cost recovery or contribution to O&M costs in particular for annual maintenance

RECOMMENDATIONS

Based on the study, the recommendations are given below:

1. In Upazila and district LGED office, WMCA monitoring issue needs to be more emphasized and included as one of the reporting agenda in monthly meeting. This will increase experiences and understand on SSWRD by concerned engineers in the field in terms of better water resource management.
2. In Upazila and district LGED office, WMCA operations issue needs to be included as one of the reporting agenda of monthly meeting. This will increase experiences and understand on SSWRD by concerned engineers in the field in terms of better water resource management.
3. In Upazila and district LGED office, WMCA maintenances issue needs to be included as one of the reporting agenda of monthly meeting.
4. LGED can take necessary step to include WMCA in Upazila Level Water Management Committee and Union level water resources Management committee formed as per Water Rule-2018. It is urgent to continue these Union and Upazila level meeting regular monthly basis.
5. Member Education Programme (MEP) of all members should be continue at least twice a year. Members should be aware about Operation and Maintenance and Service Charges. More motivational work at WMCA member level should necessary.
6. More Good Governance should practice in WMCA and record keeping and more Transparency should practice in WMCA.
7. Operation and Maintenance Plan Book preparation (following Joint Visit) should be mandatory to each WMCA which may include in grading data.
8. All the concerned LGED officials in the field need to get training on latest operation and maintenance related techniques and technologies with the cooperation from government fund.
9. All the concerned LGED officials in the management level need to visit those developed countries where operation and maintenance are done by using latest techniques and technologies so that they can get experiences from those countries and can apply those latest techniques and technologies in Bangladesh.
10. UDCC can be utilized as dissemination and discussion forum of SSWRD concept. LGED can take necessary step to include WMCA in Upazila Level Water Management Committee formed as per Water Rule-2018.
11. It need to follow the participatory approach by all the departments (35nos organization according to 8th five year plan) working in this sector.
12. In order to increase capacity of WMCA, periodical training on various issues, such as cooperative management, Surface Water Management, Operation and Maintenance, etc. That of agricultural, fishery, agriculture marketing, value chain etc. training through different Line agencies.
13. Exchange Visit a good WMCA of nearby area and Horizontal learning may be more emphasis through government fund effective capacity development method.
14. O & M related including all necessary training; Farmers (WMCA members) can train through farmers' trainers' pool member.
15. On line MIS base Institutional and O&M monitoring recommended.
16. Government should put more funds against IWRMU LGED.
17. Further more study on sustainability of Surface Water Management should recommend.

REFERENCES

1. Asian Development Bank (2020) Completion Report: Participatory Small Scale Water Resources Development Sector Project in Bangladesh, Manila, Philippines.
2. Government of Bangladesh Planning Commission (2008) Moving Ahead: National Strategy for Accelerated Poverty Reduction II (FY2009–FY2011), Dhaka, Bangladesh.
3. Asian Development Bank (2005) Country Strategy and Program for Bangladesh: 2006–2010, Manila, Philippines.
4. Asian Development Bank (2016) ADB's Country Partnership Strategy for Bangladesh: 2016–2020, Manila, Philippines.
5. Asian Development Bank (2018) Strategy 2030: Achieving a Prosperous, Inclusive, Resilient and Sustainable Asia and Pacific. Manila, Philippines.
6. Local Government Engineering Department (2018) Project Final Report: Project Implementation Support Consultant for the Participatory Small-Scale Water Resources Sector Project. Dhaka.
7. The block leaders are members of the O&M committee in each subproject.
8. ADB (South Asia Department). 2021. Interdepartmental Review on the Draft Project Completion Report Validation on Participatory Small-Scale Water Resources Sector Project. 08 June (internal).
9. JICA-LGED TA Project/Case Study Report/2013
10. Asian Development Bank (2014) Aide Memoire of the Joint Mid-Term Review Mission.
11. Independent Office of Evaluation of IFAD (2016) People's Republic of Bangladesh Country Programme Evaluation.
12. Local Government Engineering Department (2007) Participatory Small Scale Water Resources Development Project, Outline of Proposed Project.

