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REVIEW

# Action Program for Small-scale Riverbank Protection in a Bangladesh Village

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## Abstract

We executed an action program to protect riverbanks from erosion for two years in a village in Bangladesh under the JSRDE (Joint Study on Rural Development Experiment) project funded by JICA. This paper describes the physical damage of riverbank erosion and its impact on the villagers, and discusses protection methods derived from existing local technology. We constructed palisades, in the river to protect the riverbank. On the advice of the villagers and other relevant individuals, the palisades were four-sided fences constructed out of bamboo tied vertically and horizontally in a checker pattern and iron boards made from stretched out oil drums. The program of using palisades for two years was successful because palisades were effective not only in protecting the riverbank from erosion but they also accelerated soil sedimentation along the riverside. Moreover, planting vegetation on the riverside to protect from erosion, which is a local technique, was also confirmed to be effective. We emphasize the importance of learning about and positively evaluating existing local technology for rural development programs in developing countries like Bangladesh.

**Discipline:** Agricultural environment / engineering

**Additional key words:** erosion, palisade, soil sedimentation, local existing technology, rural development program

## Introduction

Bangladesh is one of the largest deltas in the world with a total area of 147,570 sq km. It has a population of about 140 million, making it one of the most densely populated countries in the world. It has an agrarian economy, although the share of agriculture to GDP has been decreasing over the last few years. Nevertheless, agriculture dominates the economy and accommodates a major rural labor force. The real growth rate of the GDP of Bangladesh was 5.4% and per capita GDP was US$ 559 in 2009[4].

The country is covered with a network of rivers and canals forming a maze of interconnecting channels, which can cause natural disasters easily. Floods and cyclones endangering human life in Bangladesh are reported frequently both domestically and abroad. Not only natural calamities but riverbank erosion is also serious problem along rivers of various sizes. Severe riverbank erosion deprives the people of their assets and their basic means of livelihood, such as their houses and land. They suffer from the damage in the long term. According to reports, the number of people who are directly affected

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by riverbank erosion is about one million, and the total damage amounts to 200 million Tk. (1 dollar was 65 Tk. in 2007) annually[16]. The three largest rivers in Bangladesh, namely the Jamuna, Ganges, and Meghna (Fig. 1), are reported to have been eroded 163 km, 94 km, and 67 km, respectively, in 1985. Moreover, a total of 115 km of another 13 medium-sized crossing rivers in the delta were eroded. The annual load of sediments carried out from the country is about 1,500 million tons[13]. The main reasons for riverbank erosion are the high-speed water flow and high water levels of the rivers in the rainy season, the sandy riverbank, and poor vegetation along the riverside. These four factors accelerate riverbank erosion in combination with undeveloped bank protection throughout the country[11]. To draw the world's attention to this, there have been several attempts by foreign aid groups to show the extent of the damage and the responses of local residents[6,10]. The locals' preferred countermeasures, such as provision of boats, low interest loans and residential rights on public embankments etc., have been clarified[7,17]. Moreover, some political proposals, such as distribution of land to disaster victims, clarification of all political parties' positions on the disaster in their election manifestos, etc., have been put forward[2,14].

This report describes the physical damage of local riverbank erosion and its impact on villagers and our action program against erosion in the target Dakhshin Chamuria village (hereafter, D village), Tangail district, under the Joint Study on Rural Development Experiment (JSRDE) project from 1992 to 1995. The project was funded by the Japan International Cooperation Agency (JICA) and jointly implemented by JICA and the Ministry of Local Government, Rural Development & Cooperatives, Bangladesh. The important process of our experiments on riverbank protection is documented in this report.†

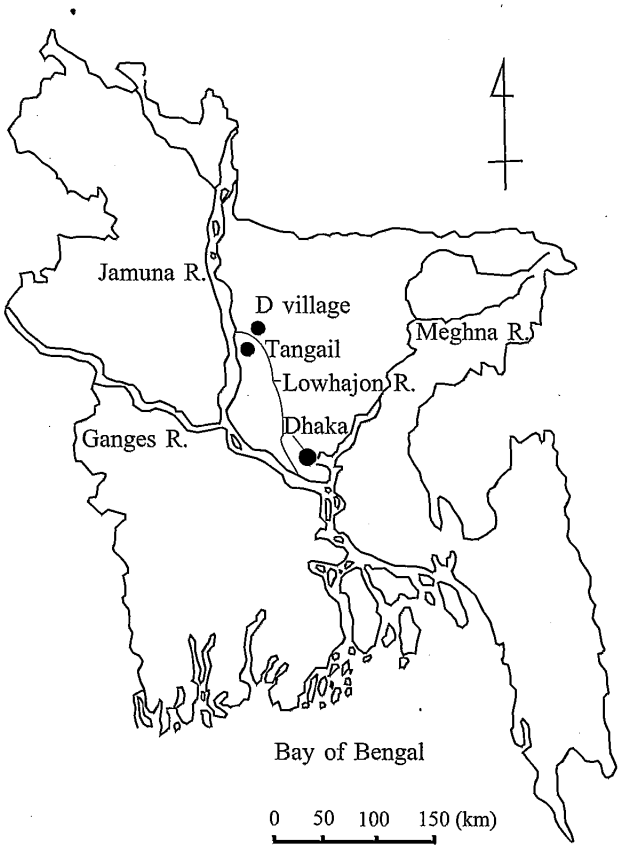


**Fig. 1. Location of Dakhshin Chamuria (D) village**

## D village and JSRDE project

D village is located on a small floodplain of the Lowhajon River, a tributary of the Jamuna River, about 9 km north-east of Tangail town (Fig. 1). The Lowhajon River and rainfall bring rapid inundation to the village in July. The highest water level is 1 to 3 m in the flooded fields during August and September, when homesteads are not inundated. The flood water quickly recedes into the Lowhajon River from late October. Most of the annual 1,750 mm precipitation is concentrated in the rainy season from June to October. Soils are classified as Silmandi and are mainly loamy and sandy with high water-holding capacity. The general topography of the area is flat. The village has a total area of 184 ha with a population of 2,198, making 386 households. More than half of the population is engaged in agriculture[18].

In this village, we were engaged in a project implemented under the Joint Study on Agricultural and Rural Development (JSARD) project from 1986 to 1990, which preceded JSRDE. The purpose of JSARD was to isolate the key questions and ideas behind rural development in the village. With a strong focus on the outcome of JSARD, the JSRDE project started implementing action programs on an experimental basis, such as village road construction, water hyacinth control, riverbank protection, and the establishment of a village committee[9].

## JSRDE approach and village committee

There are two main approaches to implementing rural development programs in Bangladesh[15]. One is the

† Following JSRDE project, which closed in 1995, JICA started the Participatory Rural Development Project (PRDP) in 2000, aiming to strengthen the relationship between administrative departments and the village committee, called "link-model". After the excellent rating of the project[21], the second phase of the PRDP was implementing in 2005 in three areas of Bangladesh[8].

target group approach and the other is the community development approach. The target group approach organizes social strata, such as landless farmers, women, the poor, etc., and enables them to alleviate their poverty themselves. Members of the targeted group receive services such as loans, job training, literacy education, etc., from an organizer outside the village. The organizer (an NGO or the government) can control and monitor the activities easily. On the other hand, the program cannot be shared by villagers who do not belong to the target group, which can cause conflict among the villagers.

The community development approach organizes the community, namely all members of the village. In this case, members come from a diverse range of backgrounds, and it is difficult to control and monitor the program. However, the input resources of the organizer are increasingly likely to circulate among all members of the community. JSRDE adopted this approach in order to supply everybody with the results of the program.

A village in Bangladesh usually consists of several small communities called '*para*'. Each *para* has several traditional leaders or *matabbor*s, some of whom are active and devoted to village public affairs, for example, the village court. If there happens to be some a trouble in a *para*, the *matabbor*s of the *para* discuss possible solutions with invited *matabbor*(s) from other *para*(s) as shown in Fig. 2[1]. In the case of village matters, *matabbor*(s) from all *para*(s) and, sometimes with invited *matabbor*(s) from other village(s), hold a council. Inviting *matabbor*(s) or borrowing authority from outside the community is necessary to gain the confidence of the community in solving disputes, and at the same time, they can minimize bad relationships within the community, which might result from a decision or judgment. Thus, decision-making in a village has traditionally been practiced through a council of *matabbor*(s). Reflecting this tradition, JSRDE decided to adapt to the rural society and encourage the function of *matabbor*(s) as motivators.

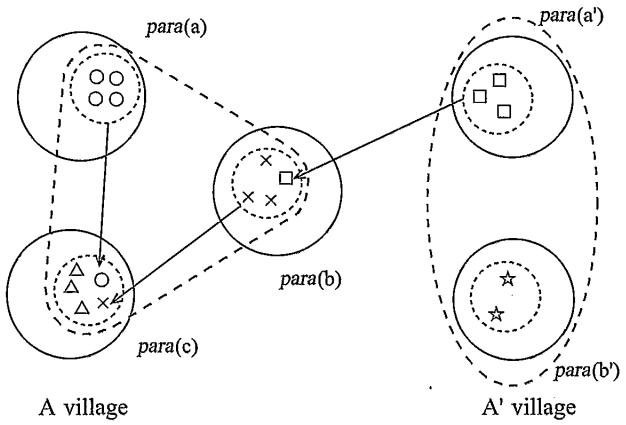


**Fig. 2. Decision-making system in a village of Bangladesh**
○, △, ×, □, ☆ : *matabbor*
⟵ : invited *matabbor*
-------- : Council of plural *matabbors* (*para*)
- - - - - : Council of plural *matabbors* (village)

For this purpose, a village committee was established in D village[20] in January, 1993. The committee consisted of 18 *matabbor*(s) selected by the villagers for an unfixed term. It convened monthly to discuss common problems and to prepare programs for possible solutions, and their door was always open to the villagers. The committee enabled consensus building for action programs through discussion by the whole village. Several activities have been tried in the village led by the committee. Programs such as improvement of rural infrastructure have been planned and implemented. For the actual operation of the programs, the JSRDE staff of D village was employed at the beginning of the project. They were D villagers who had been engaged in our field research survey since 1986 under the JSARD project. They managed part of the project, such as the establishment and holding of the village committee, collecting local information, and implementing the action programs.

In 1993, a riverbank protection program was proposed by the village committee to the JSRDE project. The villagers were very concerned about riverbank erosion, because the Lowhajon River, flowing across the neighboring village, was changing its course continuously. They thought D village would be affected by the river in the near future. Therefore, we executed an action program to protect the Lowhajon River bank from erosion for two years.

## Riverbank erosion on the Lowhajon River

Figure 3 shows the course of the Lowhajon River in the 1910s as remembered by elderly villagers. The Lowhajon River, which flows through fine-sandy area, has changed its course substantially during these 80 years in spite of the shelving riverbed slope of 1/15,000. The maximum movement is around 500 m from west to east and the river has been eroded about 6 m annually on average. Such severe riverbank erosion continues even today, and 98 families have lost their premises over the last 25 years in the neighboring village. Fifty-two families out of the displaced families made their home on the same riverside, and 33 families shifted to the *char* or alluvial island on the western side of the river. The remaining 13 families left the village. Erosion-induced displacement in Bangladesh prompts close-range migration, as in the

case of this village[5]. The majority of the displaced moved to a nearby *char* or riverside, within 10 km of their village, where erosion disaster could easily occur again. They tend not to consider long-distance migration as an option, even though they may be victims of further erosion-related disaster and have to move again.

The Lowhajon River has taken land and homes from the villagers irrespective of whether they are rich or poor. Confronted with such severity, villagers not only in the neighboring village but also in D village were anxious about ongoing riverbank erosion. Thus, the riverbank protection program was proposed by the village committee of D village. We and the JSRDE staff have succeeded in implementing the riverbank protection program through the use of inexpensive small-size structures with materials obtainable in the village.

## Action program for small-scale riverbank protection

### 1. Bank protection work in Bangladesh

At present in Bangladesh, there are two main methods for bank protection other than riverbed dredging to increase river discharge to stabilize a river course. The most effective and long-term method using substantial structures is concrete lining or revetment[23]. Another method is palisades. In the first case, the construction work can start only when the proposed structure's cost-benefit are favorable because of the high amount of expenditure. Nevertheless, it is reported that Brahmaputra Right Embankment (BRE), which is famous for its scale, has been eroded in large part in the 20 years since its construction[24]. Moreover, it is said the eroded embankment caused heavy floods in the area. The suitability of such massive structures on large rivers in Bangladesh is doubtful. A palisade, which is called a *bandal* in some areas, is a less durable, temporary structure made of locally available materials, like bamboo, timber, and jute. The first description of a *bandal* can be found in a book from the British colonial period[22] and, even now, some researchers are conducting studies on its engineering feasibility[12]. In this method, a fence made of timber or bamboo is set on the riverside to cover the riverbank or, in some cases, two teak-wood fences facing each other are set in a river to reduce the velocity of the water flow. Because of the low cost and easy handling, local government offices are installing such kind of small structures in the rivers. Ordinarily the structure is set at an acute angle to the protected riverside, but according to reports, it has been set in the wrong position so that it was perpendicular to the riverside and has caused 30 m of riverbank erosion locally[19]. This means even such a small structure can affect the river flow and lead to erosion.

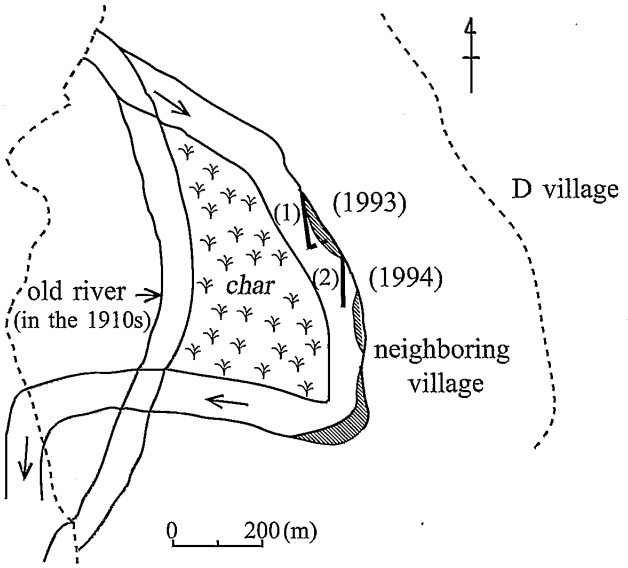


**Fig. 3. Course change and palisades in the Lowhajon River**
: eroded in 1993
: water flow
: *char* (alluvial islands)
: village border

### 2. Structure of the palisade

JSRDE decided to base its constructions on the palisade method in the neighboring village. We have repeatedly discussed the structure with the relevant JSRDE staff; a contractor living in a nearby village who had some experience in undertaking bank protection work; a *thana* engineer or an engineering officer of the administrative department of the county; and a few *matabbor*s. We have decided on the final design of the palisade based on the villagers' information that much sand had deposited under the fish-catching bamboo fences set in the upper Lowhajon River and on the suggestions of the contractor. The contractor claimed iron boards should be attached to decrease stream velocity and to accelerate soil sedimentation even though they are expensive. In the end, JSRDE agreed to adopt the bamboo and iron boards as the main materials for the palisades.

The final design was decided as follows: a four-sided fence constructed out of bamboo tied vertically and horizontally in a checker pattern and iron boards made from stretched out oil drums (Photo 1). The size of each iron board is 0.6 m×1.2 m, the standing bamboo is placed 0.3 m apart, and two bamboo lines are placed horizontally 1m apart. The standing bamboo is installed at 1.5 m depth in the riverbed, and supported by the same materials at 3 m intervals at an angle to the riverside.

Bamboo was used instead of wood to lower the cost.

On the other hand, the main reason for using the iron boards was to examine their effectiveness as a material for the palisade. What makes the palisade unprecedented is the use of iron boards to decrease the stream velocity and to accelerate soil sedimentation, which had not been seen in Bangladesh before.

### 3. Construction of palisades

Palisades (1) and (2) were constructed in 1993 and 1994 respectively as shown in Fig. 3. Palisade (1) was initially L-shaped, with the longer-side reinforced with iron boards and the shorter-side without iron boards. Palisade (2) was straight and reinforced with iron boards. Both of these structures were set to face the home of a villager in the neighboring village that had suffered from annual erosion. The length was 20 m and the height was 3 m, and the total cost including expenses for labor was 15,180 Tk. for palisade (1). The length was 30 m, the height was 3 m, and the total cost was 20,000 Tk. for palisade (2) (Table 1). The government had been using teakwood to make palisades. If we had used the same amount of teakwood instead of bamboo for the new palisade, we would have had to pay 90,000 Tk. just for the wood[3], which means four to five times the total expenditure. It took two weeks from mid-March to the end of March to install both palisades.

The deeply eroded section of the riverbed had been filled with soil before the installation of the former palisade. Therefore, it could be set deeply in the riverbed. On the other hand, the new palisade could not be set deeply because there was still water 1.5 m deep in the lower part of the riverbed. At installation, each bamboo was set in a hole dug in the riverbed and knocked in with a hammer. According to the contractor, it usually had to be hammered to a depth of 1.5 m, but the new palisade had been hammered only 1 m deep, which caused the lower part of the palisade to wash away later.

The chairman and secretary of the village committee of D village met with *matabbor*s of the neighboring village to ask for their cooperation in providing materials and labor at the beginning of 1994, but JSRDE could not get enough assistance.

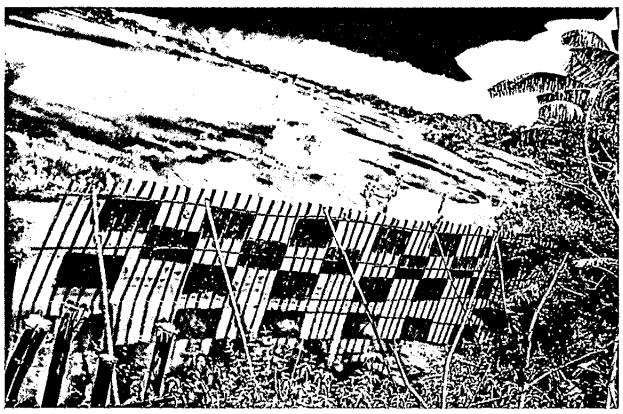

**Photo 1. Palisade in the Lowhajon River (May 1994)**

**Table 1. Amount of cost for palisades (Tk.)**

| Construction period | ①Mar. 14, '93 -Mar. 28, '93 | ②Mar. 18, '94 -Mar. 28, '94 |
|---|---|---|
| Length | 20 m | 30 m |
| Metallic drum | 3,060 | 2,750 |
| Bamboo | 9,280 | 10,850 |
| Labor | 1,700 | 5,120 |
| Nail, paint etc. | 1,140 | 1,280 |
| Total | 15,180 | 20,000 |

1 dollar = 65 Tk.

### 4. Progress after setting palisades

Table 2 shows the problems for palisades. The short-side of Palisade (1) had been washed away July 8, 1993, in the rainy season. As shown in Fig. 4, the quantity of precipitation was less than 20 mm at the time, but the water level was higher because of the preceding rainfall. In 1994, only the longer-side of the palisade was repaired and located at the same site as the previous year. Rising water levels loosened the knots of the lower part of the palisade and an engine boat crashed into its center, causing part of it to be lost, on the night of August 22. The lower part of Palisade (2) was washed away. One reason is that the knots were loosened by high waves caused by engine boats. Another reason is that this new palisade had not been installed deeply when it had been constructed.

All the iron boards attached to Palisade (1) had been stolen by somebody in October 1993 when the water levels decreased, which caused a more than 3,000 Tk. loss to the JSRDE budget. JSRDE had to buy iron boards to repair the palisade in March 1994.

### 5. Efficiency of palisades and utility of vegetation

Experimental action programs using palisades seemed to be successful despite the physical damage and local problems mentioned above. The palisades proved not only to be effective in protecting the riverbank from erosion but also effective in promoting soil sedimentation. The villager whose premise was protected by the palisades informed us that the riverbank eroded only 1.5 m in the 1993 rainy season even though rainfall was higher than usual. He thought half of his home might have been lost if there had not been a palisade. He had doubted the efficiency of the palisade, but one year later, he

was convinced.

We observed tangible results for the structures over the two years (Fig. 5). First of all, 0.6 m sand deposited in a hole located downstream in 1993, and infilled completely it, and a small *char* appeared there in 1994. Regarding palisade (1), the lower part of the palisade had been buried for one year, and 0.45 m of earth and sand (lower 0.3 m was sand, upper 0.15 m was silt, approximately) was deposited annually on the riverside. As for palisade (2), the lower part of the structure had been buried and 1.2 m of sand was deposited on the riverside. According to the villagers, it was due to the efficacy of the palisades that a large *char* appeared in the center of the

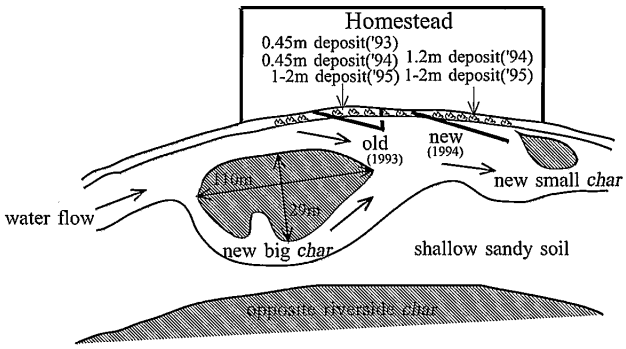


**Fig. 5. Soil deposition by palisades (Dec. 1994)**
: *char*
: *dhol kalmi* (vegetation)

**Table 2. Troubles and supporting actions for palisades**

| Year/Month | Trouble | Supporting action |
|---|---|---|
| 1993 Mar. | Old palisade (1) setting | |
| 1993 July | Short-side of (1) washed away | Only long-side of (1) repaired (1994 Mar.) |
| 1993 Oct. | Iron boards of (1) stolen | Repurchase (1994 Mar.) |
| 1994 Mar. | Long-side of (1) repaired and setting | |
| | New palisade (2) setting | |
| 1994 June | Center of (1) damaged | None |
| 1994 Aug. | Center of (1) broken | None |
| | Lower part of (2) washed away | None |

(1): Old palisade set in 1993
(2): New palisade set in 1994

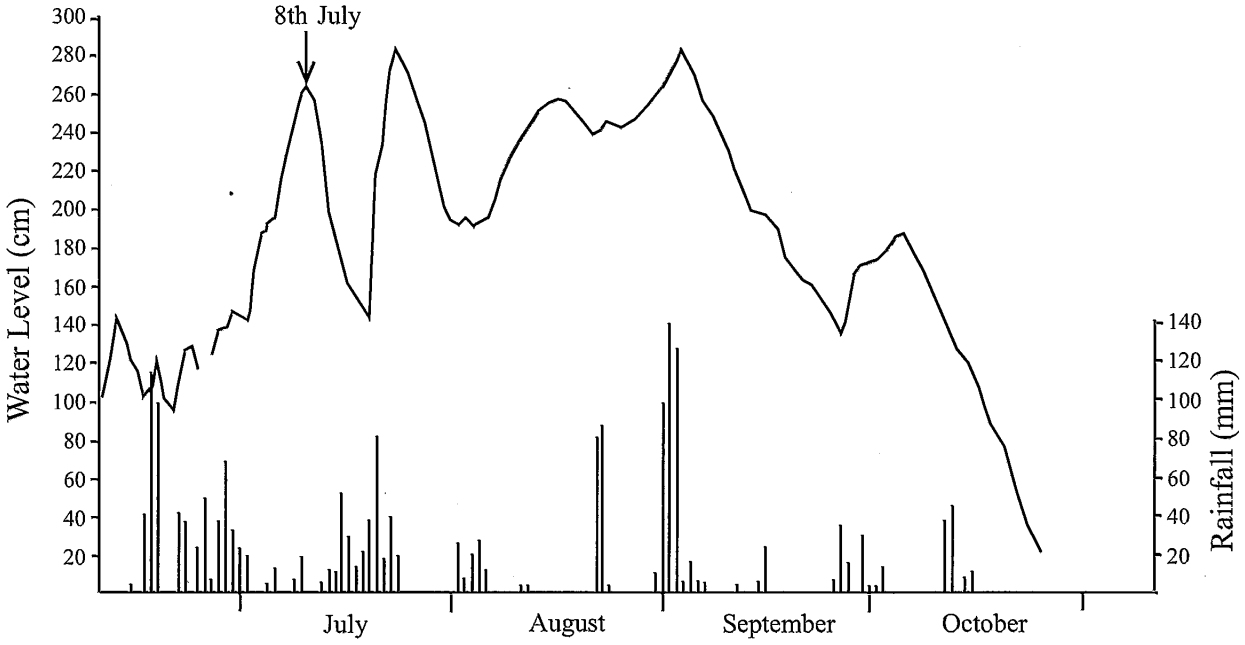


**Fig. 4. Water level of the Lowhajon River in the rainy season (1993)**

upper riverbed, which was utilized as a *boro* (winter rice) seedbed in December 1994. In 1995, riverside deposits were observed by villagers about 2 to 3 meters near the palisades.

It has been confirmed that the palisades are not only effective in protecting the riverbank from erosion, but also effective in promoting soil sedimentation. We have tried to improve the efficacy of the palisades by planting vegetation on the riverside. One of plants usable for this purpose is *dhol kalmi* (*Ipomea fistulosa Mart.*). This is a plant that was introduced to D village around 1974 to protect lands from erosion, and it is common in the village now. A cutting of *dhol kalmi* planted on the newly deposited riverside after the rainy season of 1993 took root and seemed to be effective for erosion protection. In 1994, we sowed *deshi doncha* (*Sesbania aculeata*) on the riverside near the new palisade, but all the seeds were washed away by the rain. Therefore, we had to plant *dhol kalmi* again. We are sure it is important not only to provide palisades for the direct protection of the riverbank and promotion of soil sedimentation on the riverside but also to protect the newly deposited riverbank by planting vegetation.

## Conclusion

The JSRDE palisade program was implemented by combining two forms of local existing technology: the fishing fence, and vegetation usage. This program proved that it is possible to find and develop these kinds of technology through cooperation with farmers and specialists. This program also showed that the participation of local people is indispensable to develop efficient and low-costing technology in developing countries.

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