

MEKONG RIVER BANK PROTECTION IN VIENTIANE

PURPOSE

This case study examines the challenges faced by environmental managers in balancing between infrastructure development projects that benefit society but which, at the same time, cause environmental impacts. Project objectives and the pros and cons of proceeding with large scale river bank protection involving bank stabilization and armouring along the Mekong River as it passes through Vientiane, Lao PDR are examined in detail with an emphasis on the environmental sustainability of this type of infrastructure project. Particular attention is given to engineering strategies being considered and the role of environmental impact assessment (EIA) in guiding project planning and impact mitigation.

ETP1 COURSE TOPIC COVERAGE:

- ▶ SUSTAINABLE DEVELOPMENT AND ENVIRONMENTAL AWARENESS
- ▶ ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
- ▶ CUMULATIVE EFFECTS ASSESSMENT (CEA)
- ▶ INTEGRATED RESOURCE AND ENVIRONMENTAL MANAGEMENT (IREM) CONCEPTS AND BENEFITS
- ▶ IREM PRACTICAL TOOLS FOR IMPLEMENTATION
- ▶ ENVIRONMENTAL ECONOMICS

ISSUES

Specific issues highlighted by this case study are:

1. Cumulative effects of natural and anthropogenic factors leading to river bank erosion in and around Vientiane
2. The scope and limitations of available engineering responses to river bank erosion
3. Potential downstream and transboundary impacts of the Vientiane river bank protection project
4. The critical role of EIA in informing project planning and engineering design and in identifying appropriate environmental impact mitigation measures

LEARNING OBJECTIVES

On completion of this case study, participants will be able to:

- Provide examples of both natural and anthropogenic factors linked to downstream river bank erosion
- Characterize available engineering and non-engineering responses to the river bank erosion problem occurring in Vientiane
- Discuss the role of EIA in project planning and implementation

- Identify potential environmental impacts of the river bank protection project and environmental receptors at risk
- Critique proposed mitigative measures and suggest possible additional measures which could be implemented
- Provide an example of a potential cumulative impact (i.e., domino effect) of the river bank protection project and suggest appropriate planning responses

PROJECT SUMMARY

Introduction and Background

The lower Mekong River is characterized by its winding course and relatively slight gradient. A consequence of these characteristics is natural instability and alternating sequences of erosion and sedimentation. The Mekong River is also subject to significant fluctuations in water level, with large changes in river height occurring between the rainy and dry seasons. Reoccurring flood conditions in the Mekong River and its tributaries cause progressive erosion and weakening of embankments and creates steeply sloping river banks at various locations. These phenomenon pose a serious threat to houses, industrial premises, temples, schools, roads, and agricultural land located along the river. For example, flooding of the Mekong River in 1994 damaged in excess of 28,000 hectares of cropped land in Lao PDR. Subsequent flood events in 1995 and 1996 damaged 87,300 ha and 76,000 ha of cropland, in these respective years. Considerable additional damage to irrigation systems, fishponds, and other infrastructure has resulted from river bank erosion.

Causal and Contributing Factors of River Bank Erosion

Erosion is affected by many natural factors such as rainfall, vegetation cover, river bank soil stability, river sediment and bedrock characteristics, relief-slope characteristics, and hydraulic conditions. Human activities occurring upstream which are thought to exacerbate erosion and sedimentation in the Mekong River include: (i) clearing of vegetation along the river banks; (ii) construction of bank protection works; (iii) sand and gravel extraction; (iv) broad-scale deforestation; and (v) large dam construction.

In Vientiane itself, the majority of the river bank have been cleared of trees and dense natural vegetation and planted with vegetables and crops – raising concerns about the potential for increased erosion of the unprotected river banks during high flow periods.

Experience with existing revetments (i.e., a constructed wall to armour the river bank) along the Mekong River in and around Vientiane has shown that additional bank erosion and scouring can occur: (i) at the toe of revetment; (ii) immediately downstream of bank protection work (e.g., due to turbulence caused by a rough end to the revetment walls, or by a sudden change in roughness leading to an

increase in velocity at the end of the revetment); and (iii) on the opposite side of the river, downstream from the revetment.

Sand and gravel extraction can cause: (i) upstream and downstream deepening of the riverbed; (ii) destruction of the armour layer of the river bed (i.e., a layer of compacted coarse material such as gravel that forms on the riverbed); and (iii) changes to the river bottom and bank profile as a result of jetty construction to provide access for the gravel extractors and trucks.

Widespread deforestation has occurred in the Mekong River watershed in Laos. In 1970, the country's forests covered more than 73% of the total land area. By 1985, increased population pressure and subsequent changes in shifting cultivation patterns had significantly reduced forest cover to an estimated 47% of the country's land area. The potential link between upstream deforestation and increased sedimentation and flooding in the Mekong River is a major concern.

Engineering Solutions

Bank revetment is considered to be the best available engineering response to the serious river bank erosion occurring along the Mekong River in and around Vientiane. To date, approximately 2.5 km of revetment works have been undertaken at Kaolieo, Sibounheuang, Muangwa, Wattay, Watsop, Ban Hatdokkeo, the National Culture Park, and Thadeua with foreign technical assistance and funding (Figure 1). At Thadeua, for instance, bank protection has been completed along a 250 metre section of the river bank. Although alternative bank protection methods are currently being researched (e.g., the Japan International Cooperation Agency [JICA] is investigating the potential of special grass planting methods in stabilizing river banks), proven technologies still predominate. The 15 m high wall constructed at Thadeua involved extensive slope cutting and the combination of rock-filled mattresses and gambion walls (Note: technical design and construction details are provided in the attached reference readings).

Environmental Concerns

River bank protection works are exempted under Laos' environmental assessment regulations due to the urgency of preventing economic losses caused by erosion of the Mekong River bank in and around Vientiane. Likewise, donor countries rarely stipulate that an EIA be completed for this type of infrastructure project. Since bank revetment is typically funded by donors on a project-by-project basis, no funding is available for broad-scale assessment of the cumulative impacts of the numerous existing and planned revetment works on the Mekong River as it passes through Vientiane.

Impacts associated with bank protection projects include: (i) loss of highly fertile land along the river bank for cultivation in the dry season, (ii) loss of habitat used by resident and migratory fish species; and (iii) domino-effect river bank erosion downstream of revetments either on the same bank or on the opposite bank of the

river. Depending on the magnitude of a project, impacts to local communities can occur. For example, the revetment work completed at Thadeua necessitated the resettlement of some local residents, replacement of electric transmission lines, and relocation of roads. Other indirect impacts occurring during the project construction phase included traffic congestion and increased air and noise pollution related to the movement of large trucks transporting concrete, rock, sand and gravel to the project location. Construction materials used in the Thadeau project were transported from sources 15 to 280 km from the work site.

Potential impacts to local fisheries is perhaps the major environmental concern relating to bank protection activities in and around Vientiane. Fish constitute an important part of the Lao diet, with fish protein making up almost 40% of the average person's diet (ie., 7 to 8 out of 20 kg/cap/yr). Approximately, 20,000 tonnes of riverine fish are landed each year in the Mekong River mainstream at Vientiane and further downstream around the confluence with the Mun tributary near Pakse.

In addition to negative impacts, some positive environmental effects of bank protection can be attributed to proactive revetment of unstable areas of river bank, such as: (i) preventing the loss of additional terrestrial wildlife habitat; (ii) protection of downstream fish habitat from further bank erosion; and (iii) improving water quality (e.g., lower turbidity due to reduced soil and sediment particulate loadings).

Economic Justification and Project Decision Making

Arguably river bank protection activities in and around Vientiane are fully justified by the high economic losses associated with bank erosion. Project costs and benefits for the bank protection work completed at Thadeau are provided as an example in the following table.

The cost-benefit analysis completed for the Thadeau revetment project indicates that the project benefits substantially exceed the project costs. This equation can be generalized to river bank protection projects in general in and around Vientiane. The annual cost of the losses due to bank erosion on residential land is far less than the annual cost of revetment.

In most cases, decisions to proceed with revetment works along the river bank in Vientiane are made jointly by both local and central government authorities (e.g. the Waterway Administrative Division). Prioritization of public revetment works is generally determined by the perceived threats from further bank erosion to residential housing, temples and infrastructure in Vientiane.

ACTIVITY	QUANTITY	UNIT COST (KIP)	MILLION KIP		
			COST	RECOVERABLE COST	BENEFIT
Resettlement:					
- Land purchase	210,000 m ²	150	31.50	-	31.50
- Cost of houses	150 units	1,500,000	225.00	100.00	125.00
Transmission Line Replacement:					
- Post implantation	105 posts	15,000	1,575	0.50	1.075
- Cost of houses	10,000 m	15,000	15.00	10.00	5.00
- Installation cost			4.97	-	4.97
Road Relocation:					
- Survey/design work	12.5 ha	60,000	0.75	-	0.75
- Land clearing	12.5 ha	30,000	0.375	-	0.375
- Construction	5,000 m	54,000	270.00	-	270.00
Total (Million Kip)			549.17	110.50	438.67
Total (in million USD1 00/350 Kip)			1.57	0.32	1.25

Exceptions to this decision-making process are private river bank protection works paid for by individuals and entities to protect their own property – these privately-funded revetments are typically poorly engineered and usually fail after only a few flooding seasons.

The most important consideration for responsible authorities in deciding whether to proceed with public revetment works along the Mekong River is their long-term viability. Based on past experience, engineers know that if revetment occupies only a small portion of a bend, the remainder of the bend tends to wrap around the revetment with time as the channel migrates resulting in destruction of the revetment. From an engineering perspective, it is better to construct revetments to protect the full length of a bend, rather than only small sections. A drawback of this strategy are the prohibitive costs of protecting the entire river bank. Existing construction methods for revetments, using a combination of slope-cover materials such as geo-textiles and rock-filled gambions, are very expensive. In response, engineers are examining the possible application of less expensive, but as yet unproven, technologies which could be applied in Vientiane.

From both an environmental and aesthetic perspective, arguments for the necessity of protecting the entire Vientiane river bank are less compelling. Revetment projects are generally aesthetically unsightly (i.e., revetments are essentially a concrete and rock wall covering the entire river bank) and would result in the loss of river bank vegetation which may constitute important fish habitat. There are also concerns regarding possible domino effects where revetment works undertaken in Vientiane to prevent bank erosion could lead to increased bank

erosion further downstream – impacting both the Laos and Thai sides of the Mekong River.

SITE VISIT METHODOLOGY

Course participants will have an opportunity to observe bank protection works in detail during a one-day duration site visit. A number of revetment works along the Mekong River will be viewed by boat from Kaolieo, the most upstream point, to Thadeua, the most downstream point of Vientiane. Participants will be able to closely observe the differences between protected and unprotected parts of the river bank. Resource persons and representatives from the Waterway Administration Division will provide an initial technical briefing and will then accompany participants during the site visit to explain about the bank revetment projects which have been completed to date. During the site visit, participants will be expected to consider the following questions:

- Why should revetments be built?
- What phenomenon can cause bank erosion?
- What are the advantages of river bank protection?
- What will be the positive and negative impacts on the surrounding environment during construction? And after completion?
- What other impacts may occur downstream of the revetment?
- What recommendations would you make to protect the river bank from soil erosion?

On completion of the site visit, participants will discuss their findings with emphasis on the practical lessons learned which reinforce EIA and IREM theory taught in the course.

TAKE HOME MESSAGES

Anticipated lessons learned by course participants in completing the case study and site visit might include:

1. Bank protection activities being undertaken in and around Vientiane should ideally be considered as part of an integrated planning and management process. The advantage of adopting an integrated approach, in favour of the current project-by-project piecemeal approach, is that engineers, environmental scientists and decision makers could consider the issue of bank erosion in a holistic manner and act accordingly (e.g., considering the potential for downstream cumulative impacts before proceeding with large scale revetment).

2. Lack of information on the potential ecological impacts of river bank protection projects can bias decision making towards purely engineering and economic considerations. Environmental assessments should be completed for all projects to ensure that potentially significant environmental impacts are properly understood and that appropriate mitigation measures are taken.
3. Possible consideration of 'alternative means of' or 'alternatives to' conventional engineering responses to bank protection. Ideally planning measures should be implemented proactively to prevent or minimize bank erosion occurring as a result of human activities upstream and to consider the potential for naturally-occurring bank erosion in building and infrastructure siting. Alternative engineering approaches might also be adopted in stabilization of river bank using appropriate technology such as tree and grass planting.

REFERENCE READING

- Bergado, D.T., P.V. Long and J. Dezure. 1994. Mekong River Bank Slope Protection of Thadeau and Muangwa, Vientiane, Laos.
- FAO. 1999. Flood Management and Mitigation in the Mekong River Basin. RAP publication 1999/14. Food and Agriculture Organization, United Nations Development Program and Department of Irrigation, Ministry of Agriculture and Forestry, Lao PDR.
- Rutherford, I. and P. Bishop. 1996. Morphology and Bank Protection of the Mekong River in the Vientiane – Nong Kai Reach, Lao PDR and Thailand. Report prepared for the Mekong River Commission.
- UNDP. 1992. Fisheries in the Lower Mekong Basin (Review of the Fishery Sector in the Lower Mekong Basin). Annexes. Interim Committee for Coordination of Investigations of the Lower Mekong Basin. United Nations Development Program.

FIGURES

Figure 1 Planned and completed bank revetment sites in the Mekong River near Vientiane.

