SALTWATER INTRUSION IN THE MEKONG RIVER DELTA

PURPOSE

This case study examines the phenomenon of saltwater intrusion in the Mekong River Delta and the challenges faced by environmental managers and policy makers in overcoming this problem in promoting intensive agriculture. Efforts by the Vietnamese government to develop the country's economy through a large-scale infrastructure project in the Delta involving the construction of sluices to prevent salinity intrusion and provide irrigation to allow more intensive rice cropping are documented. Particular attention is given to the appropriateness and effectiveness, limitations and environmental impacts of infrastructure works in different parts of the Delta.

ETP1 COURSE TOPIC COVERAGE:

- SUSTAINABLE DEVELOPMENT AND ENVIRONMENTAL AWARENESS
- ENVIRONMENTAL SCIENCE IN THE MRB
- INTEGRATED RESOURCE AND ENVIRONMENTAL MANAGEMENT (IREM) CONCEPTS AND BENEFITS
- BARRIERS TO IREM
- DEVELOPING EFFECTIVE IREM IN THE MRB
- IREM PRACTICAL TOOLS FOR IMPLEMENTATION
- STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)

ISSUES

Specific issues highlighted by this case study are:

1. Resource use conflicts relating to different resource use priorities and possible alternative management strategies
2. The need for timely management and policy responses even under conditions of scientific and engineering uncertainty
3. The importance of flexible policy and adaptive management in responding to changing circumstances and feedback on the effectiveness of policy and management choices (e.g., rice-farming versus shrimp growing)
4. The need for broad stakeholder involvement and integrated management approaches in addressing complex problems

LEARNING OBJECTIVES

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

- Provide examples showing how ecosystem complexity can complicate environmental management and policy making in the Mekong Delta
- Explain why an integrated management approach is necessary in responding to salinity intrusion in the Delta

- Identify knowledge gaps relating to salinity intrusion and the expected effectiveness of the sluice infrastructure project
- Detail the expected economic benefits of the sluice project
- Discuss limitations of the sluice project in terms of the appropriateness of intensive rice growing in different parts of the Delta
- List the stakeholders involved in natural resource use and management in the Delta
- Provide examples of barriers to effective interagency cooperation in managing the Delta's resources
- Outline possible alternative management options in the Delta

PROJECT SUMMARY

Introduction and Background

Vietnam's Mekong River Delta covers approximately 3.9 millions hectares over twelve provinces and currently supports a population of about 17 million people. The Mekong Delta region of Vietnam is of significant economic importance and is the country's most productive agricultural area.

An impediment to further intensification of agriculture in the Delta is that nearly 2 million ha or about 50% of the region is affected by salinity intrusion (Figure 1). During the dry season when flow rates in the Mekong River as at their lowest, saltwater intrudes up to 30 km into the Delta causing saline conditions in vast areas of cultivated land. Saltwater intrusion is becoming worse as increasing volumes of water are withdrawn from the Mekong River for upstream irrigation purposes in support of rapidly increasing agricultural and urban development. Salinity intrusion reaches its peak from April to May and is lowest in October. During the rainy season, fresh water from the Mekong River and local rainfall push the saline water back towards the sea, allowing for agricultural cropping during an approximately six month period.

In addition to adverse effects of the saltwater intrusion on agriculture, natural ecosystems are increasingly impacted by the more extensive saline water intrusion into the land. Biodiversity in the Mekong Delta has declined in the coastal zone in recent years. Of the 150 species and subspecies of fish and invertebrates listed in the Vietnam's Red Book of endangered species, 40 are fresh and brackish water fish found in the Delta.

Natural Resources in the Mekong Delta

For many centuries the people in the large salt-water affected areas of the Mekong Delta have tried to adapt themselves to the harsh natural conditions. Their income comes mostly from:

- An annual rain-fed paddy crop of approximately 2.0 to 2.5 tonne/ha
- Mangrove forest
- Fisheries

These main natural resources for local communities in the Delta are detailed in the following sections.

Rain-Fed Paddy

The total area of the Mekong Delta is approximately 3.9 million of which 2.7 million ha are presently used for agricultural purposes comprising annual crops (2.1 million ha), perennial trees (370,000 ha), and surface water and aquaculture (203,000 ha). Rice is the primary agricultural crop. Under natural conditions, the growth cycle for all rice varietals is relatively long at more than 160 days. Although the rice quality is good, even for export markets, productivity is relatively low, ranging from only 2.0 to 2.5 tonne/ha. Moreover, in the areas affected by saltwater intrusion, the single crop in the rainy season is often impacted by sea surges caused by typhoons.

The Vietnamese government has responded to low rice productivity in the Delta by developing new policies for water use management to ensure that increasing food requirements are met. Extensive infrastructure has been built over the last 20 years to prevent salinity intrusion, provide irrigation, and improve the drainage system to minimize flooding problems. Rice production has increased substantially as a result of the infrastructure works, allowing farmers to cultivate up to three crops per year compared to the previous single crop.

Mangrove Forest

Mangrove forest is distributed throughout the 650 km long Mekong Delta coastal zone of which 350 km borders the South China Sea and 300km borders the Gulf of Thailand. This wetland provides important habitat for marine and estuarine fish and shrimp, supporting many economically-important shrimp species which spawn in shallow coastal waters. In addition to it's ecological significance, coastal mangroves serve as an important natural barrier to erosion effects of wave action on the shoreline.

The total area of mangrove forest in the Mekong Delta is approximately 120,000 ha, comprising natural mangrove forest (40,000 ha), planted (20,000 ha) and mixed (65,000 ha). *Melaleuca* forest is also widely distributed in the Delta, historically dominating flooded areas. *Melaleuca* forests have been reduced significantly over recent decades with natural and planted forest presently covering only 100,000 ha. Increasing population and urban development in the coastal zone, along with accompanying aquaculture and agriculture activities, has led to the accelerating destruction of mangrove and coastal forests in the Delta.

Fisheries

The Mekong Delta supports significant aquatic fauna in terms of species composition and diversity. Distinct habitats types used by different fish species during their life cycle are:

- Estuarine zone which supports both resident species and diadromous species which seasonally migrate upstream to spawn in brackish or fresh water habitats
- Upstream waters of the Mekong River support many freshwater species

Shrimp species found in the Delta include the freshwater giant prawn which migrate from freshwater to brackish and estuarine waters to spawn. Other species also spawn in estuarine waters from March to August each year. Harvesting of shrimp is an increasing important economic activity in the Delta, especially for the export market. Traditionally, people living in the Delta have alternated between rice growing and shrimp farming from season to season depending on weather conditions (i.e., rainfall, flooding). In this way, farmers could compensate for the inability to grow more than one rice crop each year by growing shrimp in saline waters.

Limited data is available on fishery populations in Mekong Delta, making it difficult to assess the impacts of harvest pressures or habitat destruction and degradation. Although fisheries data are often undependable, the available data indicates that unsustainable capture rates for some species are severely stressing fish populations. Further stresses are the loss and degradation of habitat as a result of development activities, which directly affects resident fish populations while indirectly impacting migratory species who utilize this habitat for breeding and rearing. Another stress on fish populations is poor water quality due to pollution from development activities and reduced flow rates as a result of water diversions for irrigation.

State of the Delta's Environment

The ecological resources of the Mekong Delta are of high importance to the region's inhabitants. Ecological resources have been diagnosed as 'fair' to 'poor' following the post-war reconstruction in Vietnam, involving a rapid expansion of development activities in the Delta and corresponding unintended adverse environmental impacts. The two main contributors to the degradation of ecological resources in the Delta have been:

- Inadequate infrastructure (i.e., water supply, solid waste disposal and sewage treatment) in major urban centres has led to an accelerating decline in receiving environment water quality
- Continuing population growth and poverty in rural communities and a lack of awareness of environmental issues has resulted in unsustainable harvesting of ecological resources and an expansion of primary agriculture into ecologically-sensitive areas

Economic development in the Mekong Delta has been characterized by its rapid expansion attained through intensive exploitation of natural resources and increasing frequency of conflicts among resource users, especially water users. Agriculture is the predominant economic sector in the Delta, expansion of which has been possible in part through increasing use of agro-chemicals. Widespread, heavy use of fertilizers and pesticides can negatively impact on surface and groundwater quality and the health of both humans and animals. A limiting factor to expansion of agriculture in the Delta has been the availability of freshwater for irrigation. Overexploitation of the available fresh water for agricultural and industrial uses has resulted in saline water intruding progressively further inland. Salinity intrusion prevention works, in turn, have changed the hydrological regime in estuary areas, negatively affecting aquatic fauna. In addition, expansion of agricultural land use has negatively impacted aquaculture in the Delta and threatened production of commercially-important species.

To resolve these problems, the need to develop a new strategy for resource management has become increasingly evident. Expected benefits of such an integrated regional development strategy are:

- Long-term protection of natural resources
- Enhance potential for non-deleterious multiple resource uses
- Reduced expenditure of energy and money on conflicts over competing uses (e.g., local farmers may prefer to grow shrimp, which provide a better economic return, instead of planting multiple rice crops every year; in some situations breaches of sluices have occurred to facilitate shrimp growing).
- More rapid and effective rehabilitation of damaged ecosystems to a more usable condition

Sustainable Water Resource Management Policy Example

An example an ongoing integrated management initiative is the Studies of Salinity Intrusion in the Mekong Delta. This joint initiative being undertaken by the Mekong River Commission (MRC) seeks to provide for more effective water use in the Delta by developing a better understanding of the saltwater intrusion phenomenon in determining the best management responses and development strategy. The project aims to:

- Identify all the major factors contributing to the complex salinity intrusion phenomenon, and to assess their relationships as a foundation to guide the optimal and sustainable development of water resources in the Delta
- Provide an advanced tool for planning of development in the entire Mekong River Basin and especially the Mekong Delta including specific projects such as the Tam Phuong Water Control Project
- Increase human resources capacity through training and exchange of experience with international experts, in support of socio-economic improvement in the Delta

The appeal of this integrated approach is that through building effective institutional linkages, environmental managers are enabled to adopt a more holistic perspective and develop strategies which transcend conventional approaches to resource management in the Delta (i.e., moving beyond managing water utilization, aquaculture, and agriculture separately and often inconsistently). Instead management of water resources in the Delta is increasing the responsibility of interdisciplinary teams representing resource management agencies. Such an integrated approach also recognizes the importance of broader community and stakeholder involvement. In this way, environmental managers have more information with which to understand system complexity and, in turn, to develop more effective solutions.

Coordination and technical support, including the input of international experts, for this integrated management initiative has been provided by the MRC. Vietnamese national implementing agencies are the Sub-Institute of Water Resources Planning and Management and the Southern Regional Hydrometeorological Center in Ho Chi Minh City. To date, these organizations have carried out: (i) detailed measurement campaigns and collection of data for thematic studies; (ii) data analysis to determine the major factors of salinity intrusion; and (iii) salinity forecasting. In addition the implementing agencies, responsible authorities from the six provinces affected by salinity intrusion in the Mekong Delta are involved in the initiative. Their feedback on using salinity forecasts in water use planning and management helps the national experts to improve the accuracy of forecasting.

An example of where outputs of this integrated management initiative have been put to use is the Tam Phuong Water Control Project located in Chau Thanh district of Tra Vinh province. This project is designed to irrigate and drain more than 17,000 ha of cultivated area, including 5,980 ha within the Tam Phuong project area itself, and 11,000 ha of adjacent areas which will benefit from the project. In the past, agriculture in the Tam Phuong has been underdeveloped, with production limited to a single annual rice crop of only 2.2 to 2.4 tonne/ha and some vegetable crops due to the acid sulphate soils and saline water conditions. A further constraint on the cultivation of vegetables and greens has been a shortage of fresh water for irrigation. The situation was worsened by the loss of about 1,000 ha each year due to the pumping of saline water by farmers who were unaware of the damaged caused. On a whole, saline water was considered a serious detriment to agriculture in the Tam Phuong area.

Implementation of the Tam Phuong project has increased agricultural production substantially with higher and more stable yields being achieved. Rice yields have increased from an average of 2.3 tonnes/ ha to 4.5 to 5.0 tonne/ha. Project benefits are most evident during the dry season when farmers can decide to retain fresh water in canals and creeks and take preventive measures based on salinity forecasts (Figure 2). In this way, in excess of 20,000 ha of cultivated area have been protected from saltwater. From a wider management perspective, improvements in farming conditions resulting from the Tam Phuong project and the availability of salinity forecasts allows experts and agricultural activities to better plan agricultural activities so as to maximize productivity. For example, since 1995 farms in the Tam

Phuong have typically included two paddies plus one subsidiary crop (i.e., sugarcane and corn hybrids). Farming of pigs and cows for meat, ducks for meat and eggs and aquaculture are also planned in the future.

SITE VISIT METHODOLOGY

Course participants will complete a two day visit to the Tam Phuong Water Control Project which is located about 220 km southwest from Ho Chi Minh City. Participants will be able to observe the engineering of the sluice and irrigation works, interview project managers about the need for and cost of the project and it's operational effectiveness, and speak with farmers about the pros and cons of the project.

Participants will be organized into small groups for the site visit with each group being assigned a specific focus as follows.

SUBJECT	FOCUS
Socio-Economics	Evaluate the before and after social and economic conditions in the project area Are the local people better or worse off as a result of the project? Are similar benefits likely to be seen in all areas of the Mekong Delta?
Engineering	Detail the engineering specifications for the Tam Phuong project Is the same approach being used throughout the Delta? What problems were encountered in undertaking the project? Is the project effective?
Institutional	Identify the stakeholders in water use and management and explain their involvement in planning and implementation of the project Who are the resource users? Who are the responsible authorities and management agencies? What mechanisms were put in place to facilitate stakeholder consultation and promote inter-agency coordination and collaboration
Policy and Planning	Determine why the project was necessary and whether there were other alternatives to the project What was the project rationale? What are the stated objectives of the project? Was a environmental impact assessment done for the project? What difficulties have been encountered in policy implementation?

On completion of the site visit, small groups will be asked to present their findings to the class with emphasis on the practical lessons learned by participants which reinforce 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. Natural ecosystems and socio-economic circumstances should be well understood in advance of undertaking large infrastructure works to maximize project benefits and to minimize unintended environmental and social impacts.

Strategic environmental assessment (SEA) of proposed policies will provide critical feedback on potential direct, indirect and cumulative impacts of alternative actions and help guide planning and implementation.

2. Complex environments such as that found in the Mekong Delta necessitate adaptive approaches to project planning and implementation. Knowledge gaps concerning the salinity intrusion phenomenon in the Delta translate into scientific uncertainty relating to the anticipated effectiveness of the sluice and irrigation system. Under these circumstances it is often best to proceed cautiously with project implementation occurring in phases (i.e., starting with individual projects for which the benefits and environmental impacts are best understood) while additional research and monitoring is undertaken to address knowledge gaps.
3. Involvement of all stakeholders and interested parties is important in understanding the underlying causes of resource use conflicts and in identifying innovative solutions which attempt to address the needs of all stakeholders.
4. Strategic environmental assessment (SEA) projects, policies and programs can provide valuable feedback on their appropriateness and effectiveness, and on unintended consequences. Vietnam's rice self-sufficiency policy, although hugely successful, has led to construction of costly infrastructure projects in the Mekong Delta which may not be uniformly sustainable and cost-effective. In response, the government is increasingly looking at growing saline-tolerant rice varietals and promoting of rice-shrimp intercropping in areas of the Delta where sluices have proven to be less effective.

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FIGURES

Figure 1 Salinity intrusion in the Mekong Delta

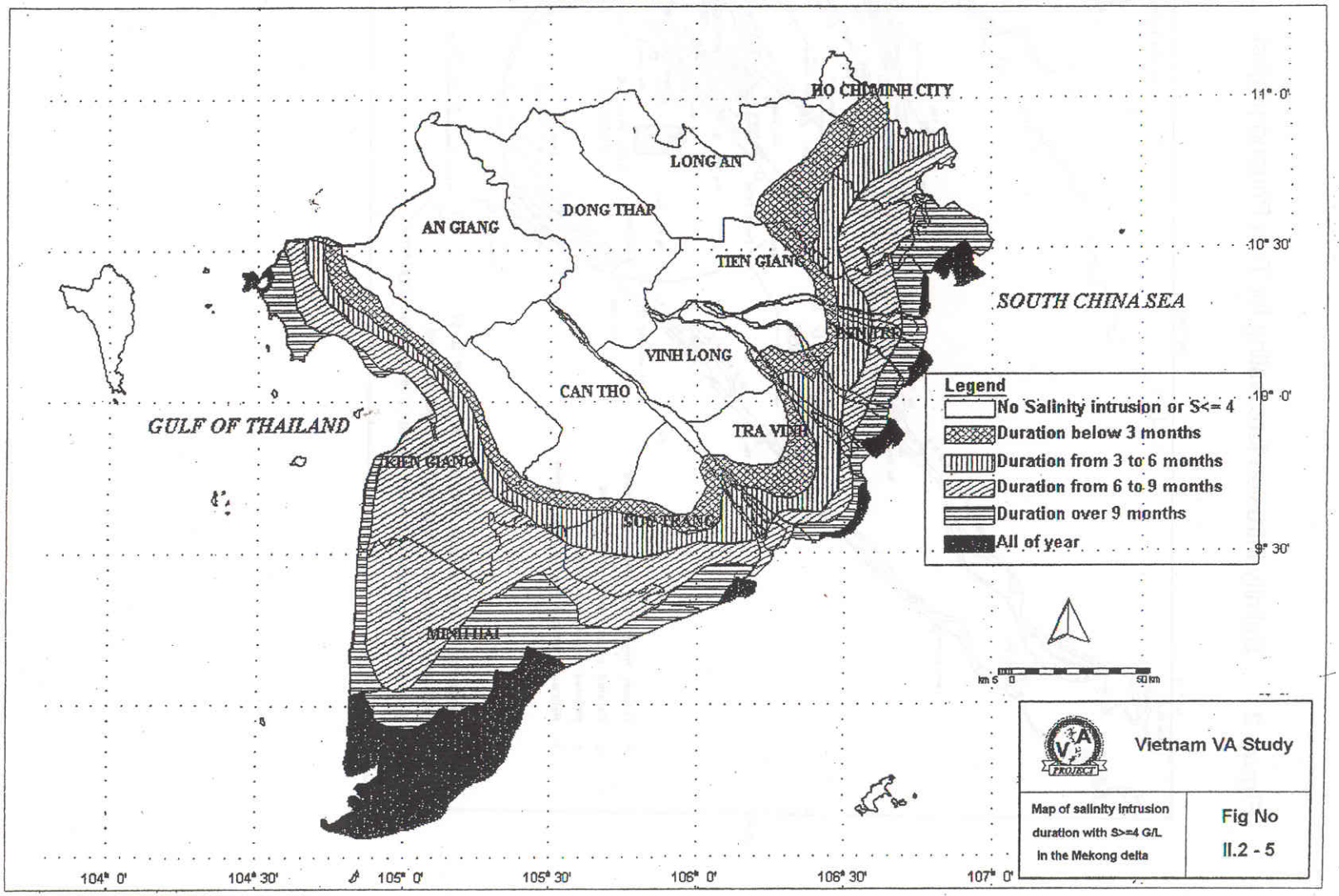

Figure 2 Salinity intrusion forecasting for Tam Phuong project