PROJECT TITLE

Increasing water productivity by managing land-water interface: effective water control for solving conflicts among agriculture-fisheries-aquaculture in coastal zones.

SUMMARY

PROJECT MANAGER

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PRINCIPAL INVESTIGATORS, COLLABORATORS & PARTNERS

Name	Position and affiliation	Responsibilities in the project
M. Prein	Leader of Freshwater Resources Research Program ICLARM - The World Fish Center, GPO Box 500, 10670 Penang, Malaysia m.prein@cgiar.org	PI; project leader; analysis of fisheries-water relations and synthesizes project results
T.P. Tuong	Water management engineer and Acting Head of Crop, Soil and Water Sciences Division, International Rice Research Institute (IRRI), DAPO 7777, Manila, Philippines t.tuong@cgiar.org	PI; project management at IRRI; data analysis and synthesis
C.T. Hoanh	GIS modeler, International Rice Research Institute (IRRI), DAPO 7777, Manila, Philippines c.hoanh@cgiar.org	PI; water modeling, scenario analysis
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D. V. Ni	Can Tho University (CTU), Can Tho, Vietnam dvni@ctu.edu.vn dtdung@ctu.edu.vn	Key partners in project management; farming system analyst
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N. D. Phong	University of Agro-Forestry (UAF) of Ho Chi Minh City, Vietnam uaf.watman@fmail.vnn.vn	GIS and water modeler; water quality survey and modeling; PhD candidate
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ABSTRACT

The tidal saline sub-ecosystem accounts for more than 2 million hectares of rice land in South and South East Asia. One strategy for improving agricultural production is to install dikes and sluices for salinity protection. Such intervention has both positive and negative impact on people's livelihood, depending on resource use types (e.g. agriculture vs fisheries and aquaculture). In depth analysis of the effects of salinity control on farmer livelihoods in the southern part of the Mekong River Delta of Vietnam confirmed that in farmers can intensify their rice cropping and improve their livelihood. On the other hand, freshening caused negative effects on livelihood of people who relied on catching fish due to the decline of brackish species. The sluice operation options determined by water modeling were adapted by provincial authorities to turn around the land use policy from monoculture rice production to diversification with shrimp-rice systems. Stakeholders in the region proposed that the study should be extended to surrounding provinces and take into account "downstream effects" outside the protected areas. This is particularly important for the acid pollution due to the conversion of lands with acid sulphate soils to agriculture and aquaculture production.

Therefore in the proposed project, an existing water model will to be refined so that it can simulate the acidity generation (from soil) and transportation in the canal network. The model will furthermore be linked with the analysis of fisheries-relevant water quality parameters, and will incorporate the socio-economic and livelihood analysis into the land-water management scenario analysis. The proposed project will also adapt the need to synthesize the findings in such a way that effective management strategies can be disseminated to other similar coastal areas, not only in Vietnam but also in other countries such as Thailand, Indonesia, Malaysia and Australia.

The research aims to derive land-water management strategies for solving the conflicts among agriculture-fisheries-aquaculture and improving the livelihood of the poor in the coastal zones.

The project will provide (1) an analytical system that comprises a new version of water model with the refined acidity module and the linkage between water quality and fisheries-water regression functions; (2) a set of scenarios focusing on an assessment of the impacts of water management on livelihoods of poor people and on the environment inside and outside the protected area; and (3) the proceedings of an international workshop on "Effective land-water interface management for solving agriculture - fishery - aquaculture conflicts " which synthesize findings of the proposed project and other case studies.

Key activities of the project are (i) survey and collect additional data on water quality and fisheries resources and refine the water model to develop the linkage between water model and fisheries analysis; (ii) build land use scenarios, apply the analytical system to determine alternatives of water control and transfer the alternatives to stakeholders; and (iii) organize and provide the proceedings of an international workshop dealing with effective land-water management for solving agriculture-fishery-aquaculture conflicts.

The project will have impacts on three *groups of beneficiaries*: (i) poor rural households whose livelihoods will be improved by minimizing the negative impacts on fisheries resources due to proper resource management in the region; (ii) decision makers and managers who will be provided with the land-water management alternatives and the impact assessment; and (iii) researchers and planners who will receive the analytical system to apply for planning and studies in the coastal zones. Additionally, the international workshop will present the findings to researchers and stakeholders in other South and Southeast Asian countries.

Key stakeholders are the Department of Agriculture and Rural Development (DARD) and Department of Fisheries (DOF) of Bac Lieu province, Sub-Institute of Water Resources Planning (SIWRP), Can Tho University (CTU) and University of Agriculture and Forestry (UAF), Vietnam. A participatory approach will be applied in the project to make use as much as possible of local expertise and also to guarantee that the findings will be useful to stakeholders.

TOTAL COST OF PROJECT (total and donor contribution required)

Total: 352,554US$

Deleted: 356,759

Donor contribution required: 199,590 US$

Deleted: 199,627

DURATION OF PROJECT

2 years (2003-2004)

LOCATION OF PROJECT

Bac Lieu province, Mekong River Delta, Vietnam

BACKGROUND

The tidal saline sub-ecosystem accounts for more than 2 million hectares of rice land in South and South East Asia. People living in this sub-ecosystem are among the poorest and the most food-insecure farmers. Agricultural production is often hindered by flooding and salinity intrusion due to tidal fluctuations. One strategy for improving agricultural production is to install saline water intrusion sluices to reduce incursions of seawater during the dry season and extend the period of fresh water availability at the end of the rainy season.

The design of the sluices has been principally based on engineering criteria to reduce incursions of seawater, and for the benefit of agricultural production. However, there are other types of producers in the coastal lands, for example those who rely on aquaculture and fishery for their livelihood, especially the landless laborers and small farm holders. Salinity protection may lead to changes in water chemistry (less saline, more acidic) reduce aquatic biodiversity in the canals, i.e. fish, crustaceans, mollusks (Chairuddin et al., 1990; Grimas, 1998). It could be thus detrimental to fishers, shrimp and fish farmers and to aquatic biodiversity. It is possible that the brackish water resource, which normally provides benefits particularly to poorer people, may exceed the benefits they obtain from alternative farming strategies after salinity intrusion is prevented.

Salinity protection thus can have both positive and negative impact on people's livelihood, depending on their location, soil type, resource use types (e.g. agriculture vs. fisheries and aquaculture), and the change in market value of their products. A clear understanding of the land and water interface and opportunities in resource management that may arise from salinity protection will benefit effective and sustainable resource management strategies in coastal lands.

Lessons, conclusions drawn from past and on going work

Experiences in eastern Australia have shown that saline water sluices deteriorated water quality and their impact on aquatic communities were massive (White et al., 1996). In areas with acid sulphate soils (ASS) as in the Ca Mau peninsula, Mekong River Delta, Vietnam, the protection against saline tidal water in the dry season may lead to lower water tables and increased acidification of ASS (van den Eelaart, 1981). Contaminants coming from acidified products pollute the canal water (Minh et al., 1997).

In depth analysis of the effects of salinity control on farmer livelihood and resource-use strategies was carried out in the project R7467C "Accelerating poverty elimination through sustainable resource management in coastal lands protected from salinity intrusion: a case study in Vietnam"[1] funded by the U.K. Department for International

[1]The principal objective of the project is to improve the livelihoods of poor people by developing an effective and sustainable land and water resource management strategy in coastal lands protected from salinity intrusion. It has been implemented in Bac Lieu province, Vietnam from April 2000 by the International Rice Research Institute (IRRI), in collaboration with University of Newcastle upon Tyne UK, the World Fish Center (ICLARM), Can Tho University (CTU), University of Agriculture and Forestry of Ho Chi Minh City (UAF), Sub-Institute for Water Resources Planning (SIWRP) and Sub-Institute for

Development (DfID) in the southern part of the Mekong River Delta of Vietnam. Previously, the area was annually affected by salinity intrusion for a period more than 6-months per year. Since 1993, following a study of various water management options, which were aimed at improving the situation of the rural population (ESSA et al, 1992), a plan was implemented for promoting the intensification of rice production. This was achieved by improving the supply of fresh water from the Bassac River and by building a series of embankments and tidal sluices (Hoanh, 1996) to gradually expand the area protected from salinity intrusion to 300,000 ha in 2000.

Using an integrated natural resource management (INRM) approach (Kam et al, 2001), added by the hydraulic and water quality VRSAP model[2] (Hoanh et al, 2001), the DfID funded project confirmed that in salinity-protected areas, farmers can intensify their rice cropping and, thereby improve their livelihood. The double cropped area in the protected region in Bac Lieu province increased from 18,000 ha in 1994 to 75,000 ha in 2000.

The freshening also increased the abundance and biomass of fresh water fish species, and brought benefits to farmers in the areas with permanent fresh water (east of study area). On the other hand, the brackish and saline species declined significantly, i.e. freshening caused negative effects on livelihood of people who relied on artisanal capture fisheries. Salinity protection also forced farmers at the west of the study area to abandon their shrimp ponds, which had relied on brackish water for shrimp raising. In summary, salinity protection benefited the eastern part with more rice and upland crops at the expense of the western part that had more rice-shrimp integration or shrimp monoculture. The research findings prompted the local government to re-examine the land use policy of maximizing rice production. In 2001, at the request of stakeholders in the province, the project used the VRSAP model to identify suitable sluice operation options that allowed salt-water intake during certain periods in the year for shrimp production in the west of the area, while maintaining the areas of intensive rice production in the eastern part. These options were adopted by the provincial authorities who turned around the land use policy from monoculture rice production to diversification with shrimp-rice systems (Tuong, 2002).

At the project review meeting in June 2002 all stakeholders at different levels in the region, from farmers to provincial and central Government recognized the success of the DfID-funded project. They proposed that the study should be extended to surrounding provinces, which are in the same salinity control system, since sluice operation in one province will affect other provinces. They were also concerned about the "downstream effects" in that the water management of the system may affect fishery resources of the coastal areas outside the protected areas. This is particularly important for the acid

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Agriculture Planning and Projection (Sub-NIAPP) and the Department of Agriculture and Rural Development (DARD) of Bac Lieu province, Vietnam.

[2] VRSAP (Vietnam River System and Plains) is a one-dimensional model using the implicit finite difference scheme [Delft Hydraulics, 1989] to compute water level and salinity for each node and each field, and discharge in each segment of the canal network. It has been extensively applied to the Mekong River Delta [Khue, 1986, NEDECO, 1991; ESSA et al., 1992].

pollution, which has been shown to be associated with the conversion of lands with acid sulphate soils to agriculture and aquaculture production (Tuong et al. 2002). There is an urgent need to quantify the effect of acidity pollution on fish in the river and canal system and to identify land-water management to allow productive use of these acid sulphate soils without causing negative off-site impacts, thereby minimizing the impact of acid pollution on the poor, who rely on capture fish.

To do this, we need to refine the water model so that it can simulate the acidity generation (from soil) and transportation in the canal network and link it with the analysis of fisheries-relevant water quality conditions, and incorporate the socio-economic and livelihood analysis into scenario setting. These subjects could not yet be studied in the DfID funded project because many data and information were only collected in the second and the last year of the three-year project, and after the changes in policy and water management that allow saline water intake for shrimp production were decided and implemented. The effects of such changes on land use and production are only significant from the last year of that project.

Finally there is a need to synthesize the findings such that effective management strategies can be disseminated to other similar coastal areas, not only in Vietnam but also in other countries such as Thailand (Rönnbäck, 2001), Indonesia and Australia (Sammut and Hanafi, 2000), and Malaysia (Oseko, 2002).

Research hypothesis/proposition

Based on the findings and conclusions from the above project, the current proposal puts forward the following hypotheses:

- The canal systems are interlinked, therefore acid water from the acid sulphate soil area can be spread over a large area that affects both agricultural and aquacultural land use, and natural fishery resources that are important to the poor. Proper operation of sluice systems can minimize the negative impacts of acid water on production and the environment
- Water modeling, including salinity and acidity, can help in analyzing sluice operation scenarios and identifying the best options that enhance both fisheries and agricultural production.
- The project findings, together with those of similar studies (e.g. van Mensvoort and Tri, 2000, Sammut and Hanafi, 2000, Rönnbäck, 2001) can be synthesized to derive land-water interface use strategies for sustainable improvement in food and environmental security.

Knowlege and data for modelling the dynamics of acid water have been collected and the development of an acidity module in the water model has been started in the DfID project. The effort in this proposed project is to refine this module and apply the model for analyzing the land and water interface for both fisheries and agricultural production.

Linkages and contributions to CA's objectives

The proposed project will contribute to the following CA themes:

- *The options and their consequences for improving water productivity in agriculture:* The proposed project will assess the impact of water management on crops and fish abundance and catch, and on environmental quality.

- *Water management to sustain and enhance capture fisheries and aquaculture systems:* Building on the success of the DfID-project, the proposed project will focus on land-water interface management that benefits fisheries and aquaculture, instead of only on agriculture as in the past. The project will improve knowledge on water requirements in terms of quality, quantity, and timing of sluice gate operation needed to sustain fisheries and aquaculture, as these are important sources of food and income to people, in particular the poor, in the coastal zones.

- *The consequences of land and water degradation on the multiple users of water:* By concentrating on the acidity problem in the acid sulphate soil areas of the delta, the proposed project will help to minimize the land and water degradation, the effect on water productivity and food security, and will propose the suitable land-water interface management to reverse the trends of degradation.

How will this deal with cross-cutting issues of food security, poverty, gender, and environmental security?

The project aims at a win-win situation to benefit both rice farmers and shrimp (and other types of aquaculture) farmers while improving the environmental conditions to a level that is conducive to enhanced and sustained fishery resources. One of the possible farming systems that we will study is the integrated shrimp-rice system. Rice is an important component to reduce the disease occurrence in shrimp, and to act as "insurance" to the more lucrative but risky shrimp raising component. The project is expected to increase rice, aquaculture production, and canal fishery catch, thereby contributing to food security of the coastal zone.

The previous project showed that converting lands with acid sulphate soils to agriculture and aquaculture production pollutes the surface water, which is detrimental to aquatic biodiversity and diminishes the fishery. Reducing acid pollution will not only improve the environment but also enhance the source of food and income to the poor. Output 1 will contribute to the resource management that will minimize acid pollution. Output 2 of the project specifically addresses the impact of water management on the poor who rely to great deal on fishery resources.

GOAL

The ultimate goal of the study is to improve the livelihoods of poor people living in coastal lands.

PROJECT PURPOSE

The research aims to derive at land-water management strategies for solving the conflicts among agriculture-fisheries-aquaculture and improving the livelihood of the poor in the

coastal zones. This will be achieved through a detailed investigation at the proposed study site and a multi-site synthesis of other case studies with similar conditions and problems.

OUTPUTS

Output 1 will be an analytical system that comprises a refined version of the VRSAP water model that was used in the DfID funded project (the VRSAP: Vietnam River System And Plains, Khue, 1986, NEDECO, 1991, ESSA et al., 1992, Hoanh et al., 2001). New components will include (i) an acidity module that relates acidity generation to land uses and simulates acid transport within the canal network; and (ii) linkage between water quality and fisheries-water regression functions such as the variations of important species in relation to water quality and the flow velocity in different segments of the canal system. These will be mainly in form of a PhD thesis to be prepared by Mr. Phong of UAF, who in the earlier project was a key person in the monitoring and modeling work.

Output 2 will be a set of scenarios focusing on an assessment of the impacts of water management (particularly salinity and acidity control) on livelihoods of poor people and on the environment inside and outside the protected area. This will provide the necessary base for better-informed decision making, particularly in relation to protection of estuarine fisheries which is the concern of the management authorities.

Output 3 will be the proceedings of an international workshop on “Effective land-water interface management for solving agriculture-fishery-aquaculture conflicts" which synthesize the findings of the proposed project and other case studies such as the DfID funded project, and from other countries with similar conditions.

ACTIVITIES AND METHODOLOGY

The following activities will be implemented to achieve the outputs of the project:

Output 1: *An analytical system that comprises water model linked to fisheries resources analysis.*
Activities:
1.1 Survey and collect additional data on water quality and fisheries resources

- Under the DfID funded project, water quality (salinity and acidity) monitoring was carried out from 2000 to 2002 at 76 locations in the river and canal network of Bac Lieu province. Data from the water monitoring were linked to a GIS to show the variations of salinity and acidity in half-month intervals. This water monitoring will be continued and the network will be expanded into surrounding provinces to take into account the effects of water management in the whole water control system. Hydrological measurement campaigns will be carried out to collect data on water level, flow and water quality data in some parts of the canal network where acidity leaching is dominant.

- Canal fisheries assessment by sample trawling and recording of the fish catch at the traps were also implemented in the second and last year of the DfID funded project. Since it would take some years to have significant effects of changes in water management on fisheries resources, the sampling and production recording will be continued under this project.

1.2 Refine the VRSAP model

The VRSAP (Vietnam River System and Plains) model is a one-dimensional model using Saint-Venant equations for solving complex flow and mass transport problems in a complex network of interconnecting open channels. Using the implicit finite difference scheme [Delft Hydraulics, 1989], presently the VRSAP model can compute the water level and salinity for each node and each field, and the discharge for each segment of the river and canal network. Water level, flow and salinity modules were calibrated and validated with data in 1996. Under the DfID funded project, an acidity module is being developed and tested with water quality data collected at the beginning of the rainy season 2002 at several representative locations with different soil types, land use systems and field water management. However, for the acidity module, data taken in only one rainy season are not adequate for validation. Therefore, with new data collected in the first year of this proposed project at larger scale than in 2002, this module will be recalibrated and validated, and the computation will be refined.

1.3 Analyze water-fisheries relations

Since water management strongly affects water quality and subsequently the fisheries resources and aquaculture in the coastal areas, the relationships between fisheries resources and water conditions will be established. Regression functions to describe the variations in fisheries species and population due to changes in water level, salinity, acidity and flow velocity will be identified. Effects of sluice operation and fish catching will also be analysed.

1.4 Develop and test the linkage between water model and fisheries analysis

With the regression functions from Activity 1.3, the fisheries resources can be identified from water conditions outputted from the model. First, the surveyed data will be used to evaluate these estimates. Then this method will be applied for different scenarios of water management to identify fisheries resources.

Output 2: *A set of scenarios for assessing the impacts of water management on livelihoods of poor people and on the environment*.

Activities:

2.1 Build land use scenarios in consultation with stakeholders

Under the DfID funded project, land use zoning based on soil and water conditions was carried out and various scenarios with different rice or shrimp production systems in each zone were formulated. The resource management domains[3] (RDM) were also identified

[3] A Resource Management Domain (RMD) is a spatial (landscape) unit that offers opportunities for identification and application of resource management options to address specific issues. It is derived from geo-referenced biophysical and socio-economic information, and it is dynamic and multi-scale in that it reflects human interventions in the landscape (Craswell et al., 1998).

in each zone, and the socio-economic conditions were also monitored through several surveys. The RMD characteristics and variations in socio-economic conditions, and other aspects such as the mangrove ecology and naturally-resourced mangrove-shrimp systems studied under the project MHO-8 IMCR (van Mensvoort and Tri, 2000) will be synthesized and incorporated into the land use scenarios. This activity will be done by consultation with stakeholders to make sure that they can refer to land use scenarios to identify the development objectives and suitable and necessary interventions in management of land and water resources.

2.2 Apply the analytical system (Output 1) to determine alternatives of water control by operating the sluices and improving the canal system to support both rice and shrimp production, and to analyse the impacts of land-water management on water quality and fisheries resources. Conflicts among agriculture, fisheries and aquaculture are then identified, and trade-offs between water control alternatives and effects on livelihood of local people, in particular the poor, will be studied.

2.3 Present and discuss the land use scenarios and water management alternatives with stakeholders.
The results of the analyses, including land use scenarios, corresponding water management alternatives will be presented to stakeholders for determining the most suitable alternatives that maintain aquatic diversity and biomass, and minimize the negative effects on the environment and livelihood of local people. Options for mitigation and necessary policy changes will be also identified through the consultations with stakeholders.

Output 3: *Proceedings of an international workshop on "Effective water control for solving agriculture-fishery-aquaculture conflicts"*
Activities:
3.1 Organize the international workshop
An international workshop dealing with land-water management and effective water control for solving agriculture-fishery-aquaculture conflicts will be organized in the second year of the project period to synthesize the findings from the case study in the Ca Mau peninsular and to exchange the experiences among research projects and case studies such as the Shrimp aquaculture study by Swedish EIA Centre (Rönnbäck, P. 2001), the Development of technology for the diagnosis and prevention of shrimp viral diseases in Malaysia by JIRCAS (Oseko, 2002), the ACIAR Project FIS/97/22 on Remediation and management of degraded shrimp ponds in Indonesia and Australia (Sammut and Hanafi, 2000) and the study on coastal shrimp aquaculture in Thailand (Smith ed., 1999a and 1999b).

3.2 Prepare and publish the workshop proceedings
Papers presented at the workshop will be edited and published in the workshop proceedings as a basic reference for other research and management activities in the coastal zone.

BENEFICIARIES AND IMPACT

Target beneficiaries are three groups:

- *Poor rural households living in the coastal zones.* Exploitation of previously unused areas of acid sulphate soils has caused severe acidification of water, which impacts particularly on poorer households who depend on fishing as an important livelihood activity. Alternatives for land-water management from the proposed project will minimize the negative impacts on fisheries resources that occurred due to the development of forms of agriculture and aquaculture that were more favorable to wealthy households.

- *Decision makers and managers* at the provincial authorities such as the Department of Agriculture and Rural Development (DARD) or Department of Fisheries (DOF) who will receive the land-water management alternatives and the impact assessment that can be incorporated into their policy and management strategies for the multi-purpose development of their provinces.

- *Researchers and planners* at the universities and planning institutes will receive the analytical system comprising a water model and the analysis procedure that can be applied for the planning exercise in other regions, or other studies in the coastal zones.

The international workshop will explore the wider relevance of findings to the coastal zones in South and Southeast Asia countries, and provide the opportunities of sharing experiences, in particular learning the mistakes of other sites in solving conflicts between development, food security and environmental protection.

IMPLEMENTATION AND MANAGEMENT

The lead coordination agency

ICLARM – The World Fish Center has high expertise in both inland aquatic (mainly ponds and rice floodwaters) and marine and coastal systems - in which research is carried out on their dynamics, on investigating alternative management schemes, and on improving the productivity of key species. This type of expertise is essential for the proposed project.

Collaborating institutes

IRRI – The International Rice Research Institute is the leading agency of the DfID funded project (2000-2003) on "Accelerating poverty elimination through sustainable resource management in coastal lands protected from salinity intrusion" with expertise on the rice-based production system, integrated natural resource management, hydraulic and water quality modeling.

CLUWRR - The Centre for Land Use and Water Resources Research, University of Newcastle upon Tyne, UK has expertise for development of integrating methodologies for linking ecology, hydrology, land-water interface and economics, taking account of issues of sustainability, equity, socio-economics and stakeholder participation. The staff of the Center has experiences on the proposed study site because they played a major role in survey, data analysis, modeling and reporting of the DfID funded project.

CTU - Can Tho University, Vietnam is the key education and research institution in the Mekong River Delta, Vietnam. CTU scientific contribution is expertise on fisheries resources and aquaculture based on experiences through the survey, data collection and analysis under the DfID funded project and many other studies in the Mekong Delta. CTU also has good facilities and expertise in the water quality laboratory, the closest laboratory to the proposed study area that is most suitable for water testing within the time limit after sampling.

UAF - University of Agriculture and Forestry, Ho Chi Minh City, Vietnam has a water resource modeler who carried out most of the soil-water surveys in the Ca Mau peninsular in the DfID funded project. He is also a candidate for a PhD study at the University of Newcastle upon Tyne, UK, on development of the acidity module for the water model in the delta area. His PhD thesis is expected as an output of the proposed project

SIWRP - Sub-Institute of Water Resources Planning, Vietnam provides the VRSAP water model with all hydrological and topographic data (water level, salinity, climate and configurations of river and canal network) that are required for water modeling, and has expertise in model calibration, validation and applying for scenario analysis.

DARD and DOF - Department of Agriculture and Rural Development and Department of Fisheries of Bac Lieu province, Vietnam are key stakeholders responsible for land use, agriculture, water management, rural development, fisheries and aquaculture of the central province in the Ca Mau peninsular where the conflicts among agriculture-fisheries-aquaculture occur. Most of field works will be implemented by this department, and the scenario analysis will be transferred to DARD for identifying and implementing policy and management measures.

Location, narrate policy and institutional environment

At the Mid-term Review Workshop of the DfID funded project organized in Bac Lieu, Vietnam in June 2002, stakeholders from all provinces in the Ca Mau Peninsular of Vietnam recognized that it is necessary to adjust land use in accordance with salinity control in different zones and periods in a year, and the effects of sluice operation on water quality indicated that operating the sluices for salinity control can serve both rice and shrimp production.

However, researchers from IRRI, ICLARM and University of Newscatle upon Tyne, CTU and UAF, and stakeholders in the region also noticed that effects on fisheries resources are still unclear and tradeoffs between different water users are not well

understood. Therefore all provinces within this coastal zone stressed the importance of studying the whole water control system and of joint effort to manage the system as a whole and further investigation of the impact of acid leachates and their control is urgently required. They also expressed their strong desire to have a new phase of the study that focuses on the land-water interface management and expands to the entire water control system, and confirmed their commitment in participation and strong support to the proposed project.

Therefore, in the proposed project, the Ca Mau peninsular, with Bac Lieu as central province will be selected as study site. The survey and data collection will be implemented in Bac Lieu and surrounding provinces. Stakeholder consultation meetings and workshops, and the international workshop in the second year of the project will be held in Bac Lieu.

Acvitity chart and specific milestones

The activity chart with time lines of the proposed project is presented in Appendix 2.

DISSEMINATION STRATEGY

Outputs from the project will be disseminated to different target groups:

- Outputs 1 and 2 of the project will have a great impact on the livelihood of *the poor rural households living in the coastal zones* of the Ca Mau peninsular through the improvement of land-water interface management that affects the sources of their food and income.

- The project will provide to *the decision makers and managers* of provincial authorities as DARD in the Ca Mau peninsula, the land-water interface management alternatives and strategies through the consultation meetings and workshops, and also the experiences from research projects and case studies from other countries at the international workshop hold in the region. The project documents, including database, reports and research papers, will be provided to them for reference. The Ministry of Agriculture and Rural Development (MARD) also indicated that MARD will mobilize its network of the provincial DARDs to transfer the knowledge gained from the study in this region to other coastal areas of Vietnam. Other coastal provincial DARDs will be invited to the project workshops.

- We will work closely with *researchers and planners* at the universities and planning institutes during the development of the analytical system comprising a water model and the analysis procedure, and provide training for application. Through this collaborative work, staff of CTU, UAF and SIWRP will become familiar with the methodologies and tools developed (Output 1) by the project and know how to apply these tools (Output 2) either for ex-ante evaluation of the impact of salinity protection intervention or for identifying land-water management strategies and practices to

enhance the resource productivity of those areas which are going through the process of salinity protection.

- In a wider context, the proceedings of the international workshop that contain all important research findings relevant to the management of the land-water interface will be provided to *researchers and stakeholders in other countries* such as Thailand, Indonesia, Malaysia, Philippines, Bangladesh, Sri Lanka. Cantho University, IRRI, and ICLARM are active members of the Flood Prone and Coastal Land Research Consortium (IRRI, 1998). They will ensure maximum linkages to other ongoing research activities in the coastal areas of other members of the consortium (Bangladesh, India, Sri Lanka, Thailand). Farmers in the consortium member countries will also benefit from the technologies and information developed by the project.

MONITORING

The log frame in Appendix 3 describes concrete measures and verifiable indicators and milestones to monitor the achievement of outputs. The progress of the project will be monitored through regular project team meetings and reporting.

BUDGET

Please see Appendix 4 for full financial details**.**

APPENDIX 1: LOG FRAME

Project Title: Increasing water productivity by managing land-water interface: effective water control for solving conflicts among agriculture-fisheries-aquaculture in coastal zones.

Narrative Summary	Miles Stones with Measurable Indicators	Means of Verification	Important Assumptions
Goal: Improved sustainable food production and livelihood of the poor in the coastal lands	Increased rice, fishery production and measured favorable change and the capabilities, assets, access to assets, and vulnerability of poor people.		
Purpose Improved land-water management strategies for solving the conflicts among agriculture-fisheries-aquaculture and improving livelihood of the poor in the coastal zones.	By the end of year 2, evidence of application of research products to benefit target communities by achieving one or more of: -Improved land and water management adapted -sustainable production increase - less conflict among different producers and areas	Project review Reports of Vietnamese and international in-country institutions. National statistic Scientific papers and synthesis at the end of the project	Continuing support of local government and their willingness to adapt proposed land and water management strategies.
Output 1: An analytical system that comprises a refined version of the water model linked to an analysis process on fisheries resources.	<u>End of month 9</u>: -Report of data and knowledge arising from monitoring and surveys of water quality and fishery resources -Acidity module included in the refined version of VRSAP model <u>End of month 12</u> -Relationship between water	Databases and summary analysis reported Production of user's guide describing the use of the models Conferences and	Knowledge and data are adequate to develop the acidity water module and link with fisheries analysis. Data are enough for model

Narrative Summary	Miles Stones with Measurable Indicators	Means of Verification	Important Assumptions
	parameters and fishery established and incorporated in the VRSAP model	journal papers	calibration and validation
Output 2: set of scenarios assessing the impacts of water management on livelihoods of poor people and on the environment inside and outside the protected area	End of month 13: Land use scenarios of different production systems built in consultation with stakeholders End of month 17: - Alternative water management schemes enabling land use scenarios tested (using tool in output 1) - Land use and water management strategies presented to stakeholders	Reports of stakeholders meetings Conference and journal papers	Close collaboration of stakeholders at different management levels
Output 3: Documents synthesizing improved land-water interface management	End of month 18: An international workshop with participants from study area and other projects on land and water interface management End of month 24: Proceedings of the workshop published	The physical existence of the Proceedings.	Other projects show interest and have funds to attend the workshop. Authors are timely with their submission.
Activities: Please see Appendix 2 for detailed activities and their schedule			

APPENDIX 2: ACTIVITY CHART

	Months after start of project																							
Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Output 1: An analytical system that comprises a refined version of the water model linked to an analysis process on fisheries resources.																								
1.1 Survey and collect water and fisheries data	x	x	x	x	x	x	x	x																
1.2 Refine water model			x	x	x	x	x	x	x															
1.3 Analyze water-fisheries relations						x	x	x	x															
1.4 Develop/test linkage water – fisheries								x	x	x	x	x												
Output 2: Aset of scenarios assessing the impacts of water management on livelihoods of poor people and on the environment																								
2.1 Develop land use scenarios									x	x	x	x	x											
2.2 Apply model/analyse water management alternatives												x	x	x	x	x	x							
2.3 Present/discuss scenarios with stakeholders													x				x							
Output 3: Documents synthesizing improved land-water interface management																								
3.1 Organize international workshop																		x						
3.2 Prepare/publish proceedings																		x	x	x	x	x	x	x

APPENDIX 4: BUDGET SHEET

Name of Project				
Project Leader				
Theme				
Line Item (in US$)		**Year 1**	**Year 2**	**Year 3**
Researchers:				
International	CG Center NARES ARI			
National	CG Center NARES ARI			
Consultants				
Nat'l Staff Salaries & Benefits				
Office & Research Supplies				
International Travel				
Workshops				
Fellowships				
Publications & Disseminations				
Contract Research				
Contingency				
Vehicles & Equipment				
Total				
Requested by				

Important: Clearly indicate how funding is allocated for each of the collaborating partners. Under each line item specify collaborator.
Please indicate "contributed funds" from the various organizations (i.e. funds your organization will contribute to implement the project).

[PLEASE SEE EXCEL FILE FOR BUDGET]

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Name of Project				
Project Leader				
Theme				
Line Item (in US$)		**Year 1**	**Year 2**	**Total**
Researchers:				
International				
	CG Center	19,022	19,403	38,425
	NARES			
	ARI	6,888	7,026	13,914
National				
	CG Center	2,640	2,693	5,333
	NARES	8,400	8,400	16,800
	ARI			
Consultants				
Nat'l Staff Salaries & Benefits				
Office & Research Supplies		4,200	4,200	8,400
International Travel		14,285	14,285	28,570
Workshops		1,000	16,500	17,500
Fellowships		5,772	5,772	11,544
Publications & Disseminations		-	15,000	15,000
Contract Research (Field surveys)		20,000	-	20,000
Contingency		8,221	9,328	17,549
Indirect cost		3,255	3,300	6,555
Vehicles & Equipment				
Total		93,684	105,906	199,590
Requested by				

Budget requested from SWM2	199,590
Budget contributed by participating institutions	152965
Total budget	352,554