

# Annexures: Case Study Formats



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# Case Study Format

## Region – West Asia

### Country – Iran

### Lessons from actual case

#### Focused on sustainable agriculture and irrigation and drainage

Group of Case Studies: (please check one)	<input checked="" type="checkbox"/> "Science& Technology" <input type="checkbox"/> "Peoples Recognition or Social Movement" <input type="checkbox"/> "Governance" <input type="checkbox"/> "Local Practices" <input type="checkbox"/> "Others"
Field of Case Studies: (please check one)	(If you check "Science& Technology" in the Group) <input type="checkbox"/> "Strategy" <input type="checkbox"/> "Investigation" <input type="checkbox"/> "Research" <input checked="" type="checkbox"/> "Analysis" (If you check "Peoples Recognition or Social Movement" in the Group) <input type="checkbox"/> "Symposium" <input type="checkbox"/> "Media" <input type="checkbox"/> "Campaign" (If you check "Governance" in the Group) <input type="checkbox"/> "Law & Regulation" <input type="checkbox"/> "Organization" <input type="checkbox"/> "Budget" <input type="checkbox"/> "Political Will" (If you check "Local Practices" in the Group) <input type="checkbox"/> "People participation" <input type="checkbox"/> "NGO activities"
Country:	Iran

### I. Outline of the activity

Title of Case Studies	Climate Change impacts on irrigation water requirement: A case study in Zayandeh Rud Irrigation Scheme
Implementing Organization	Ministry of Energy; Iran Water Resources Management Co., Office of Applied Researches:
Operating members	Team of expertise: Dr. Morid, Dr. Massah, Dr. Fahmi and Eng. Shah Karami
Active term of this Case Study	To manage and allocate irrigation water demand in the basin through prediction of impacts of climate change at different time horizon (up to 2080).
Contact person	www.wrm.ir/Research wat_Res_OAR@wrm.ir Project Code:WRE1-83072
Background	<p>One of the most conspicuous impacts of climate change on agriculture is its effects on water requirement of agricultural crops. This impact should be taken into account in preparing the Integrated Water Resources Management Plan (IWRM), which is under development for water basins in Iran. The objective of such a plan is to determine the sustainable water allocation to each sector.</p> <p>Many researches in this field have been carried out in some countries namely, San Joaquin Basin, Sacramento valley in California (California Water Resources and Climate change: The big 5 impacts (M. Roos, 2009), in Seyhan basin in Turkey (Impact of climate change on agricultural production system in arid areas by ICCAP (2006-2011) and/or in Mekong River Basin (Impact assessment of climate change on agricultural water use: A challenge of NIRE, 2010).</p> <p>Encouraged by the results of the preceding researches, and in line with the Iran's National Climate Change Policy (under the auspices of the Department of Environment), the Ministry of Energy of Iran took initiative to conduct researches to study impacts of climate change on water resources and agricultural water use and mitigation measures to cope with them for a reasonable agricultural water allocation in the future. In Iran, the Ministry of Energy and the Ministry of Agricultural Jihad are responsible for water supply and agricultural water use, respectively.</p>

## Purpose and Goal

**Goal:** To propose possible adaptation measures to deal with impacts of climate change on agricultural water sector in future in Zayandeh Rud River Basin in Central part of Iran in future.

**Step 1:** To investigate rainfall and temperature changes that may occur due to climate change in three time period : 2010-39, 2040-2069 and 2070-99.

along with different climate change scenario by using the Atmospheric Ocean General Circulation Model (AOGCM), Intergovernmental Panel on Climate Change (IPCC) report and NCAR-DOEPCM.

**Step 2:** To predict the impacts of climate change on flow of the river up to the year 2080 in Zayandeh Rud River Basin.

Using the long-term monthly temperature and rainfall data rather than yearly data.

**Step 3:** To predict water requirement of four crops (Wheat, Barley, Sugarcane and Potato) up to the year 2080 in the mentioned basin.

Using crop water requirement guideline (FAO, 1984) and doing risk analysis (Probability of Occurrence) the water requirement of four crops at different time horizon (up to 2080).

**Step 4:** To consider possible adaptation measures for crop production to deal with climate change impacts based on the result of Step 1 to 3.

## Present situation

The first finding of the research has been published as a paper and submitted on workshop entitled "Climate change impacts on water resources management" which was organized by the Iranian National Committee on Irrigation and Drainage (IRNCID) in Feb.2008 in Tehran. ([www.irncid.org](http://www.irncid.org))

## Effect and Result

The findings show a meaningful increase in crop water requirement in the basin due to impact of climate change as well as high probability for reduction in water resources of the basin.

The results show that the crop water requirement increases as one moves toward the end of 21st century. While the increase in the year 2040 (with 50 % probability) is 8%; it reaches 22% in the year 2100. This is corresponding to an increase of 35 MCM water requirement in the first period (till the year 2040) and 110 MCM in the second period (2040 to 2080) in the irrigation scheme.

The situation is more critical if we also consider the reduction of Zayandeh Rud River flow due to impact of climate change in the basin. The research shows high probability for reduction in water resources of the basin. For the emission Scenario A2 there is between 40 - 75% probability for 10% reduction in seasonal flow of the Zayandeh Rud River in the future (41-44% in the year 2010-2039, 52-54% for the year 2040-2069 and 70-75% for the year 2070-2099).

The most important finding was sensitivity of different crops to climate change where, among the four crops wheat shows the highest response and the carbohydrate-rich potato shows the lowest response to the climate change.

### Crop water requirement of the crops at different time horizon(%50 probability)

Crop	V base (MCM)	V2020s (MCM)	V2080s (MCM)	Δ V2020(MCM)	Δ 2080(MCM)
Wheat	547.43	583.06	658.66	35.63	111.23
Barley	198.11	213.79	241.57	15.68	43.46
Sugar beet	93.00	96.78	106.27	3.78	13.26
Potato	30.46	32.12	35.50	1.67	5.04

The results show that changing the cropping pattern is an important adaptation measure to deal with impacts of climate change on agricultural water sector in future. (See the Diagram 1)

## II. Keys for Success

### i(a) Application of proper methodology 1

#### Experienced problem → How to overcome

- In order to find out probable crop water requirement, possible risks should be considered; simulation analysis using yearly data was considered insufficient judged from the nature of crop growth. We had to seek a proper methodology.
- Due to the uncertainty in using the AOGCM (IPCC) models, where we should use the probability of occurrence in the estimated climatological parameters by AOGCM, we decided to use risk analysis to calculate the predicted crop water requirement and also use long-term monthly climatological data instead of yearly ones.

#### Key points or requirements for success

Use of risk analysis and monthly data are the outstanding features of this research, as compared to the others. The climatic parameters (average temperature, evaporation and evapo-transpiration) for future period have been calculated with 50 and 75 percent probability of occurrence.

### i(b) Application of proper methodology 2

#### Experienced problem → How to overcome

- In this research the conventional guideline for predicted crop water requirement (FAO, 1984) has been used. But, as the recent research on impact of climate change on crop water requirement in California (Joice, 2009) shows the climate change will increase the dew point which causes a decrease in crop water consumption and/or an increase in CO<sub>2</sub> emission, which will slightly reduce water consumption by many crops. These effects have not been considered in this recent research.
- For more realistic prediction of consumptions, the present finding should be compared and reconciled with the other findings at different regions. The most outstanding on-going researches are carried out in Sacramento Valley in California, in Seyhan Basin in Turkey and by NIRE for Mekong Basin.

It has been planned to start a new research project in the Zayandeh Rud Basin will use the recent outcomes in other countries, especially the findings of Sacramento Valley in California and the Seyhan basin in Turkey.

#### Key points or requirements for success

Collaborative researches results in valuable finding in this subject.

### ii) Dissemination to other country/region

#### Experienced problem → How to overcome

- The findings indicate that agricultural water sector is highly vulnerable to climate change. Arid & semi-arid areas are more sensitive to climate change. The recent research among 12 geographical regions (Science Magazine, 2007) shows South Asia & South Africa are the region with the high impact of climate change on agricultural and food production. The major problem is that in the mentioned regions less effort and finance are allocated to the research on this issue.
- The finding of this research and others in different regions (especially in Asia & Oceania) should be compared and a position paper by ICID should be disseminated globally. The countries should be motivated to invest more on research in this field.

#### Key points or requirements for success

Regional Cooperation and collaborative projects.

## III. Key findings from failure

Research is on-going. The next phase of the research will focus on other adaptation measures such as development of new crop varieties (early maturing varieties) and seasonal changes and sowing dates.

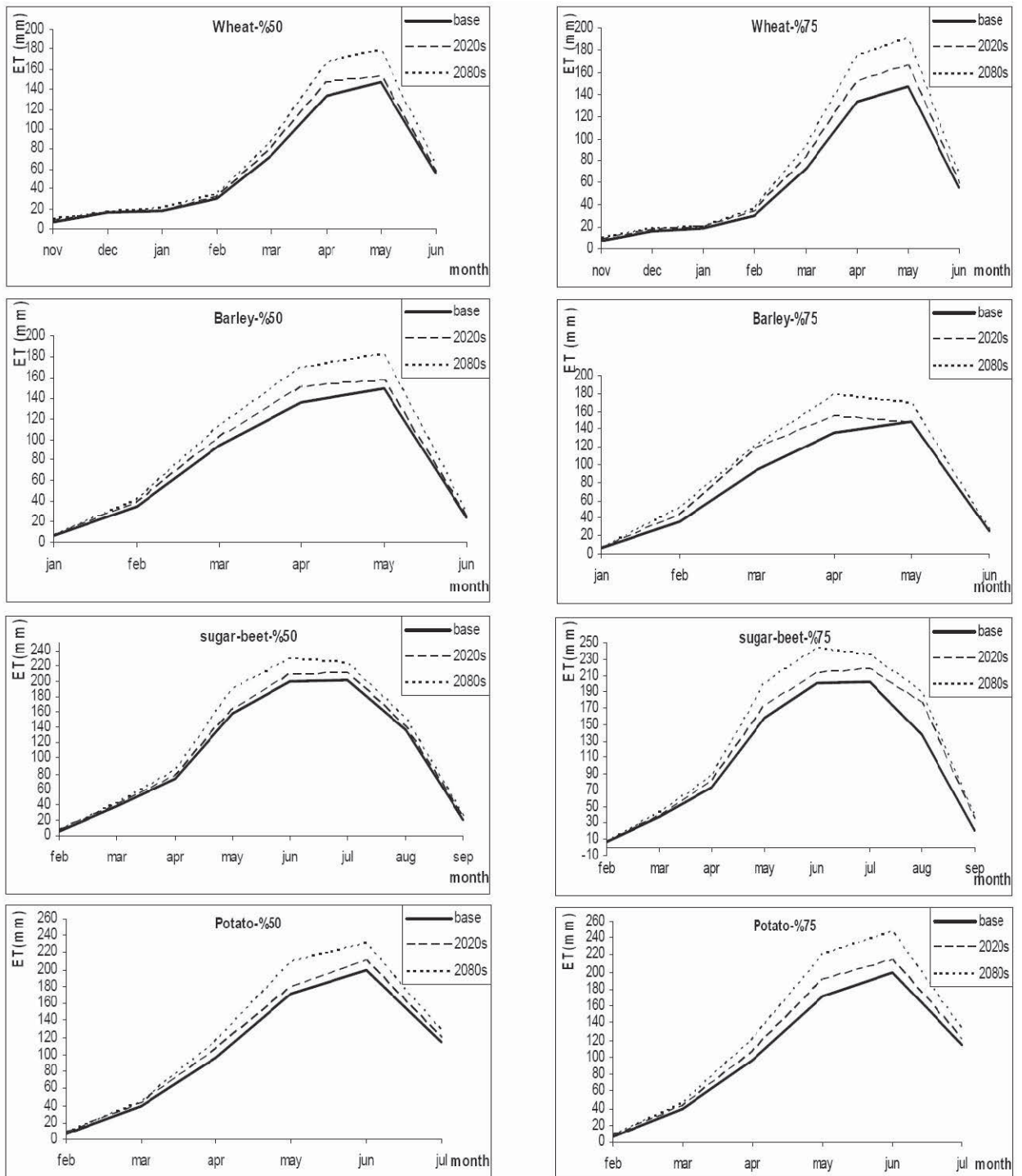


Diagram 1 Water requirement of four major crops with (50% and 75% probability) at the different time horizons.

# Case Study Format

## Region – West Asia

### Country – Turkey (1)

## Annexure 2

### Lessons from actual case

#### Focused on sustainable agriculture and irrigation and drainage

Group of Case Studies: (please check one)	<input checked="" type="checkbox"/> "Science& Technology" <input type="checkbox"/> "Peoples Recognition or Social Movement" <input type="checkbox"/> "Governance" <input type="checkbox"/> "Local Practices" <input type="checkbox"/> "Others"
Field of Case Studies: (please check one)	(If you check "Science& Technology" in the Group) <input type="checkbox"/> "Strategy" <input type="checkbox"/> "Investigation" <input type="checkbox"/> "Research" <input checked="" type="checkbox"/> "Analysis" (If you check "Peoples Recognition or Social Movement" in the Group) <input type="checkbox"/> "Symposium" <input type="checkbox"/> "Media" <input type="checkbox"/> "Campaign" (If you check "Governance" in the Group) <input type="checkbox"/> "Law & Regulation" <input type="checkbox"/> "Organization" <input type="checkbox"/> "Budget" <input type="checkbox"/> "Political Will" (If you check "Local Practices" in the Group) <input type="checkbox"/> "People participation" <input type="checkbox"/> "NGO activities"
Country:	Turkey

### I. Outline of the activity

Title of Case Studies	Increasing Public Awareness and Support for Climate Change
Implementing Organization	Ministry of Environment and Forestry
Operating members	Department of Climate Change Training and Publication Department Other Ministries, Organizations, NGOs, Universities
Active term of this Case Study	On going
Contact person	Muhammet ECEL/ Head of Climate Change Department / Ministry of Environment and Urbanization (mecel@cob.gov.tr)
<b>Background:</b> Turkey became a party to UNFCCC on May 24, 2004 after having taken decision of Turkey's situation in the context of Annex –I and Annex-II countries in the 7th Conference of Parties (COP7) held in Marrakech. "The Coordination Board on Climate Change" consisting of the relevant Ministries and organizations was reestablished and reorganized pursuant to the Prime Ministerial Circular regarding the climate change policy. The Board has 11 Technical Working Groups in different areas. Turkey ratified the Kyoto Protocol on 13 May 2009 and became an official party to the protocol on 26 August 2009. Climate Change Department was established and the specialized staff working under the Air Management Department was appointed to this department in the Ministry of Environment and Forestry (rearranged as Ministry of Environment and Urbanization in July, 2011) in 2009.	



During this period, both governmental organizations and civil society (NGOs, universities, companies, etc.) have started to work on climate change and related topics individually or together.

In 2007 and 2008, extreme droughts occurred and in 2004, 2005, and 2009 there were severe floods. Therefore, lots of citizens felt adverse effects of climate change directly or indirectly during those phenomena.

In terms of legislative arrangements; in May 2006, the Environmental Law was amended to incorporate new and important provisions regarding the expansion of environmental training and raising awareness.

Between December 2005 and January 2007, Regional Environment Center (REC) carried out “Capacity Building on Climate Change for Governmental Institutions and Stakeholders” project focused on training of related staff and academics.

“1st National Communication on Climate Change” under the UNFCCC including national circumstances, inventory of greenhouse gas emissions, policies and measures, projections and assessment of measures, finance, research and systematic observations, education, training and public awareness was prepared in January 2007.

1st Turkey Climate Change Congress was held with broad participation of academics and researchers in Istanbul in April, 2007.

“Enhancing the Capacity of Turkey to Adapt to Climate Change” project aiming at developing capacity for managing climate change risks to rural and coastal development in Turkey has been carried out by United Nations Development Programme (UNDP) between June 2008 – June 2011.

As of being main responsible ministry, Ministry of Food, Agriculture and Livestock has carried out continuously training activities for farmers in terms of best product pattern, modern irrigation technologies, fertilizers and pesticides, horticulture, animal husbandry, etc.

In this context, “Development of Agricultural Publication Project (TAR-GEL)” was started on 1st of January 2007 in 81 Provincial Agricultural Directorate in Turkey.

Another project, namely “Good Agricultural Practices - GAP”, is under way in line with the “By-law on Good Agricultural Practices” enacted in 2004.

Due to being most likely effected country from climate change, “Strategy on Combating Agricultural Drought and Action Plan for Turkey” was prepared by Ministry of Food, Agriculture and Livestock, related ministries, universities and NGOs for the period of 2008-2012.

Under the heading of “Priority 4.2.” in this strategy document, it is stated that training and publication activities intended for farmers and other stakeholders will be increased by Ministry of National Education, Ministry of Environment and Urbanization, DG for State Hydraulic Works (DSI), Universities, Turkish Radio and Television Company, other press companies, NGOs, etc.

Within this context, Ministry of Food, Agriculture and Livestock started preparation studies a new TV channel named “Agriculture TV” on every aspects of the agriculture.

As for irrigation facilities, introduction of pressurized irrigation system has been encouraged in Turkey as a solution to cope with climate change. Technical guidance by General Directorate of State Hydraulic Works (DSI) and the financial support to the farmers for introducing the pressurized system were given.

One of the main themes of the 5th World Water Forum (16-22 March 2009, Istanbul, Turkey) was climate change, disaster, and migration.

Until now, many international, national, regional and local seminars, courses, campaigns, activities have been executed to increase awareness and support of all related stakeholders on the climate change issues. The trend seems that those activities will become dense naturally.

#### **Purpose and Goal**

**Goal:** To realize the concrete countermeasures through increasing awareness of public and stakeholders on climate change

**Step 1:** To gather the academics and researchers working on climate change

**Step 2:** To define effects and to make prioritization of activities and exchanging the experiences

**Step 3:** To define the policy and strategy including measures to mitigate the adverse effects of climate change

**Step 4:** To prepare legal arrangements, technical works, and visibility materials for good agricultural practices with staff, universities, NGOs.

**Step 5:** To work on establishment of the new TV channel related with agriculture,

**Step 6:** To start organizational arrangements, hire technical staff, complete certification program of staff and companies,

**Step 7:** To start training and demonstration activities in the field by visiting farmers and their unions by staff,

**Step 8:** To register all kind of agricultural activities of farmers from preparation of the field till harvesting of the crops

### Present situation

- Updating of the report “1st National Communication on Climate Change” has been continued and is planned to be completed in 2011.
- In some Regional Directorates of State Hydraulic Works (DSI), the meeting is held annually with irrigation unions and cooperatives with the agenda of selection of the best crop pattern, irrigation schemes for that agricultural season, water saving activities, etc.
- 2500 staff is in the field and thousands of farmers and their unions were visited and both practical and technical trainings have been carried out by them without any charge to the farmers.
- Authorized companies in the context of “Good Agricultural Practices” have registered all kind of information including water consumption and irrigation techniques from preparation of the field till harvesting of the crop.
- Informative television programs on modern agricultural methods have been broadcast in both the state and the private national channels,
- Establishment of the new TV channel related with agriculture has been carried out by Ministry of Food, Agriculture and Livestock,
- Afforestation campaign has been in progress since December 2007, approximately 1 000 000 hectares area was afforested in 2008 and 2009.
- A new campaign for afforestation has been started in this year with the name of “Every baby is one sapling”. With this campaign, each one sapling is planted for every new born baby.
- Similar campaigns related with environment, water saving, pollution prevention, forestry, etc. have been carried out intensively.

### Effect and Result

With the help of those activities;

- water consumption for agriculture, the most demanding sector, decreases,
- society becomes reactive and responsive,
- habits and way of life changes,
- erosion decreases, and hydrologic cycle is protected by increasing the forest area
- After completion of the afforestation action plan in 2012, 181.4 million ton Carbone will be absorbed by these forests in the first 20 years.

## II. Keys for Success

### i(a) Definition of strategy and goal, as it relates with the activities of organizations

#### Experienced problem → How to overcome

- Various ministries and organizations had been tackling to mitigate and adapt the climate change effects. But their activities were dispersed and independent.
- With the enacting of the Prime Ministerial Circular, all main responsible Ministries have started to work together in the “Coordination Board on Climate Change”, therefore official activities became more effective and organized.
- Due to the occurrence of severe droughts and floods in the recent times, lots of citizens felt adverse effects of climate change directly or indirectly. But their intensity in the future and unknown effects of the climate change in Turkey have not been clarified and this information has not reached the citizens.
- The central government have been collecting the research results and disseminating these to the all related staff, academics and researchers in order to define the climate change effects to Turkey. The government also amended the Environmental Law in May 2006, to incorporate new and important provisions regarding the expansion of environmental training and raising awareness; Environmental issues should be incorporated into the curriculum of educational institutions, Radio and TV channels should broadcast environmental programmes for a minimum of two hours a month for training purposes.

#### Key points or requirements for success

- The political decision and support
- Willingness to work together as governmental organizations, universities, companies and NGOs, etc.
- Effective use of mass media

## i(b) Definition of strategy and goal, as it relates with agricultural water management

### Experienced problem → How to overcome

- Improper agricultural activities in terms of water consumption, irrigation techniques, registration of water consumption and operation & maintenance of irrigation network would increase vulnerability to the more variable water resources caused by climate change. But, most of the farmers in Turkey are conservative and often reluctant to use new techniques sticking to the conventional farming practices.

→ “Development of Agricultural Publication Project (TAR-GEL)” was started on 1st of January 2007 in 81 Provincial Agricultural Directorate in Turkey and training and visit approach of farmers and farmers union and cooperatives in the field and their offices have been actively implemented.

Ministry of Food, Agriculture and Livestock introduced “Good Agricultural Practices” and have been implementing it. The Ministry has been producing films, such as “Eco-Agriculture”, including good agricultural practices, and Turkish Radio and Television Company has been broadcasting them in one of the national channels.

### Key points or requirements for success

- Identification of the agricultural problems in the country
- Preparation of brochure, leaflet, flyer and TV programs

## i(c) Definition of strategy and goal, as it relates with pressurized irrigation system

### Experienced problem → How to overcome

- Introduction of pressurized irrigation system has been encouraged in Turkey as a solution to cope with climate change. But the farmers' economy does not allow them to transfer their conventional open channel irrigation systems to the closed ones. Moreover, this technology is not familiar to the persons in charge and the farmers, and therefore, its proper operation and maintenance is the key factor to make the effect realized.

→ For switching over from the open channel irrigation systems to the closed ones, the government decided to give interest-free financial support to the farmers and/or their unions in 2006 including 50% grants and 50% credits.

As the responsible agency, the General Directorate of State Hydraulic Works (DSİ) held 3 meetings on operation and maintenance techniques for pressurized irrigation systems with participation of DSİ regional staff, farmers and representatives of water user associations (irrigation unions and irrigation cooperatives).

### Key points or requirements for success

- Identification of the agricultural problems in the country
- Preparation of brochure, leaflet, flyer and TV programs

## III. Key findings from failure

There is not enough data to evaluate the activities, as most of them are new and have been practiced for a few years only. But, it is estimated that appropriate agricultural activities will contribute to water saving and will mitigate the adverse effects of climate change.

## Remarks

### 1. “The Coordination Board on Climate Change”

“The Coordination Board on Climate Change” consists of Ministry of Environment and Urbanization, Ministry of Forestry and Water Affairs, Ministry of Foreign Affairs, Ministry of Public Works and Settlements, Ministry of Transportation, Ministry of Food, Agriculture and Livestock, Ministry of Science, Industry and

Technology, Ministry of Energy and Natural Resources, Ministry of Economics, Ministry of Health, Ministry of Development, Turkish Industrialists' and Businessmen's Association and the Union of Chambers and Commodity Exchanges of Turkey. It was reestablished pursuant to the Prime Ministerial Circular numbered as 2004/13 and was reorganized pursuant to the Prime Ministerial Circular regarding the climate change policy numbered as 2010/18. The Board has 11 Technical Working Groups in different areas.

## 2. Amendment of the Environmental Law

In terms of legislative arrangements; in May 2006, the Environmental Law was amended to incorporate new and important provisions regarding the expansion of environmental training and raising awareness;

- i) Environmental issues should be incorporated into the curriculum of educational institutions affiliated to the Ministry of National Education. Relevant issues should be reflected in the curriculum of school, starting from pre-school level, to protect the environment as well as to raise environmental awareness among the public.
- ii) Radio and TV channels should broadcast environmental programmes for a minimum of two hours a month for training purposes in order to highlight the importance of the environment as well as to raise environmental awareness among the public. Both Public Service Broadcaster (The Turkish Radio and Television Corporation – TRT) and private television and radio are compelled to broadcast educational programmes.

## 3. “Enhancing the Capacity of Turkey to Adapt to Climate Change” project

This project aiming at developing capacity for managing climate change risks to rural and coastal development in Turkey has been carried out by United Nations Development Programme (UNDP) between June 2008 – June 2011. This will be achieved by mainstreaming climate change adaptation into the national development framework, building capacity in national and regional institutions, piloting community-based adaptation projects in the Seyhan River Basin, and integrating climate change adaptation into all UN agencies in Turkey.

## 4. Activities by the Ministry of Food, Agriculture and Livestock

Being the main responsible institution, this Ministry has continuously carried out training activities for farmers in terms of best product pattern, modern irrigation technologies, fertilizers and pesticides, horticulture, animal husbandry, etc.

In this context, “Development of Agricultural Publication Project (TAR-GEL)” was started on 1st of January 2007 in 81 Provincial Agricultural Directorate in Turkey. The main idea of the project is implementation of training and visit approach of farmers and farmers union and cooperatives in the field and their offices through hiring experienced staff (especially agricultural engineers and vets) in the provinces. Within 3 years, 2500 staff has been recruited and thousands of farmers and their unions were visited and both practical and technical trainings have been carried out by staff without any charge to the farmers. The total number of the staff will be increased to 10000.

Another project, namely “Good Agricultural Practices - GAP”, is under way in line with the “By-law on Good Agricultural Practices” enacted in 2004. In the framework of the by-law, good agricultural practices have been adapted to Turkey's circumstances and 7th heading of GAP document is related with irrigation issue including water consumption, irrigation techniques, registration of water consumption, operation and maintenance of irrigation network, etc. Authorized companies have implemented the by-law GAP by registering all kind information including water consumption and irrigation techniques from preparation of the field till harvesting of the crop.

Also, the Ministry has produced films, namely “Eco-Agriculture”, including good agricultural practices, and Turkish Radio and Television Company has broadcast them in one of the national channels.

As a country most likely to be affected due to climate change, “Strategy on Combating Agricultural Drought and Action Plan for Turkey” was prepared by Ministry, related ministries, university and NGOs for the period of 2008-2012. In the strategy document, main issues are drought, drought forecasting, drought risk management, sustainable water supply, effective management of agricultural water demand, R&D, institutional capacity building, setting up of working groups as well as increasing training and publication studies. Under the heading of “Priority 4.2.” in this document, it is stated that training and publication activities intended for farmers and other stakeholders will be increased by Ministry of National Education, Ministry of Environment and Urbanization, Ministry of Forestry and Water Works, DG for State Hydraulic Works (DSI), Universities, Turkish Radio and Television Company, other press companies, NGOs, etc.

Within this context, Ministry started preparation studies to constitute a new TV channel named “Agriculture TV” broadcasting on every aspect of agriculture.

## 5. The 5th World Water Forum

One of the main themes of the 5th World Water Forum (16-22 March 2009, İstanbul, Turkey) was climate change, disaster, and migration. During the sessions and side events of the forum, climate change, disaster, and migration were discussed by participants and the experience was disseminated through all stakeholders. Joint reflection on these issues at the 5th World Water Forum concluded that good adaptation measures implemented for climate change and disaster will, in fact, assist in arresting migration.

# Case Study Format

## Region – West Asia

### Country – Turkey (2)

## Lessons from actual case

### Focused on sustainable agriculture and irrigation and drainage

Group of Case Studies: (please check one)	<input checked="" type="checkbox"/> "Science& Technology" <input type="checkbox"/> "Peoples Recognition or Social Movement" <input type="checkbox"/> "Governance" <input type="checkbox"/> "Local Practices" <input type="checkbox"/> "Others"
Field of Case Studies: (please check one)	(If you check "Science& Technology" in the Group) <input type="checkbox"/> "Strategy" <input type="checkbox"/> "Investigation" <input type="checkbox"/> "Research" <input checked="" type="checkbox"/> "Analysis"
	(If you check "Peoples Recognition or Social Movement" in the Group) <input type="checkbox"/> "Symposium" <input type="checkbox"/> "Media" <input type="checkbox"/> "Campaign"
	(If you check "Governance" in the Group) <input type="checkbox"/> "Law & Regulation" <input type="checkbox"/> "Organization" <input type="checkbox"/> "Budget" <input type="checkbox"/> "Political Will"
	(If you check "Local Practices" in the Group) <input type="checkbox"/> "People participation" <input type="checkbox"/> "NGO activities"
Country:	Turkey

## I. Outline of the activity

Title of Case Studies	Research of impact of Climate Change in Seyhan River in Turkey
Implementing Organization	<ul style="list-style-type: none"> <li>Research Institute for Humanity and Nature, Japan(RIHN)</li> <li>Scientific and Technical Research Council of Turkey (TÜBİTAK)</li> <li>Faculty of Agriculture, Çukurova University, Adana, Turkey</li> <li>Regional directorate of State Hydraulic Works, Adana, Turkey</li> <li>Faculty of Agriculture, Mustafa Kemal University, Antakya, Turkey</li> </ul>
Operating members	<ul style="list-style-type: none"> <li>The project team with 6 sub-groups, a. Climate b. Hydrogy and Water Resource, c. Vegetation, d. Crop Production, e. Irrigation and Drainage and f. Socio-Economics</li> <li>Total 103 persons (58 Turkish, 41 Japanese etc)</li> </ul>
Active term of this Case Study	2002-2007
Contact person	Prof. Dr. Riza KANBER (kanber@mail.cu.edu.tr) Dr. Nurettin PELEN (npelen@dsi.gov.tr) Dr. Takanori NAGANO(naganot@ruby.kobe-u.ac.jp) Dr. Tsuguhiro WATANABE(nabe@chikyu.ac.jp)

## Background

The Mediterranean region is recognized as the place sensitive to global warming.

The Seyhan River Basin is located in the Mediterranean region in Turkey. There are different types of agriculture including rain-fed cultivation in the upper basin, irrigated cultivation in the lower delta, and livestock farming or pasturage in the whole basin. (See the Photo 1)

The Lower Seyhan Irrigation Project is one of the largest irrigation areas in Turkey, with a total irrigated area of 123,170 ha. Major products are maize, wheat, fruits and other economic crops. Runoff of precipitation and snow-melt in winter and spring is stored in the large reservoirs and released in summer time for power generation and irrigation use.

It is widely recognized that the Seyhan River Basin is one of the vulnerable areas mainly affected by climate change in Turkey. Therefore, Research Institute for Humanity and Nature, Japan (RIHN) has implemented the research project named "the Impact of Climate Changes on Agricultural Production System in Arid Areas" in cooperation with Scientific and Technical Research Council of Turkey (TÜBİTAK) as five years from 2002.

## Purpose and Goal

**Goal:** To assess the vulnerability of agricultural production systems against climate change and to suggest possible and effective measures for enhancing sustainability of agriculture.

**Step 1:** Establishment of Study Team with Turkey institutes and RIHN

**Step 2:** Data collection and analysis of climate change prediction in Seyhan River Basin.

**Step 3:** Integrated impact and adaptation assessment of climate changes in Seyhan River Basin.

## Present situation

The project was conducted from 2002 to 2007.

## Effect and Result

According to the pseudo-warming experiment's scenario, Turkey in the 2070's is likely to face increase of 2.0 to 3.5 degree C in surface air temperature in all season. Also, total precipitation in Turkey may decrease about 20% except summer.

In the project, two crop growth simulation models were developed. Wheat and maize yields may increase at most by 15% of the current yield in the 2070s with the changed climate conditions in the generated scenarios, although wheat yields decrease by 10% if CO<sub>2</sub> concentration is not incorporated for the estimation.

Moreover, decreasing snow or rain in winter will result in the decrease of water resource in the basin. Production of fruits or vegetables in the irrigated area may face shortage of water.

## [Necessary Future Work]

- 1) To assess the response of the regional climate to change in land and water use before evaluating the impact of climate change because land use and water use have large influence on regional climate system.
- 2) A systematic model for projecting possible adaptations of farmers or the region towards climate change should be developed
- 3) As consciousness, value and behavior of farmers toward land and water management have large influence, this human aspect should be studied.



## II. Keys for Success

### i) Research system

Experienced problem → How to overcome

(Assumed risks → possible solution :In case of on-going case)

- Establishment of doable environment for study activities

Although we have tried to launch a project in collaboration with Çukurova University in Adana and other organizations, we failed to start it smoothly. This was because necessary budget was not prepared by the Turkish government, support from government organizations was not obtained, and guidance of Japanese researchers during field works was not assured.

→ We explained the importance of the project to The Scientific and Technological Research Council of Turkey (TUBITAK), which is put into place not only for establishment of a cooperation system at local level but also implementation of scientific research at national level. As a result, TUBITAK and a counterpart organization of Japanese side signed a MOU.

This enabled to secure counterpart's fund subsidized by the government.

TUBITAK, which has a mandate to request cooperation to related organizations, made contacts with General Directorate of State Hydraulic Works (DSI) and ministries in charge of guidance in the study area.

As the result, we received cooperation of DSI local office and ensured the guidance at the same time.

Key points or requirements for success

- Existence of national institution promoting research and development.
- Good human relationship can be build between organizations concerned (A person from Çukurova University was personally acquainted with one of the TUBITAK advisory board member).

### ii) Sharing the aim of research and incentive

Experienced problem → How to overcome

(Assumed risks → possible solution :In case of on-going case)

- Sharing the aim of research and incentive

Adana is an advanced region of irrigated agriculture in Turkey. The researcher of various fields who participated in this project had common view that Adana is one of the areas vulnerable to the climate change in terms of decreasing amount of rainfall. However, it was difficult to have a common understanding of project aim because each researcher has respective research field. This did not give much incentive to each researcher.

→ All of us had common interest for climate change, so we held small meetings (5 to 6 times a year) in addition to annual meeting (once or twice a year). At the meetings, the leader from Japanese side qualitatively explained what the project aimed at, and each participant made presentation about the signification of climate change in his field and what he should focus on in his research for the future. Through discussions, we promoted better understanding and the project aim came to be recognized clearly. Each researcher recognized the role of his field and the aim to be achieved. Thus, their incentive to research was enhanced.

Key points or requirements for success

No specific information available.



### III. Key findings from failure

- Delay in the development of simulation model

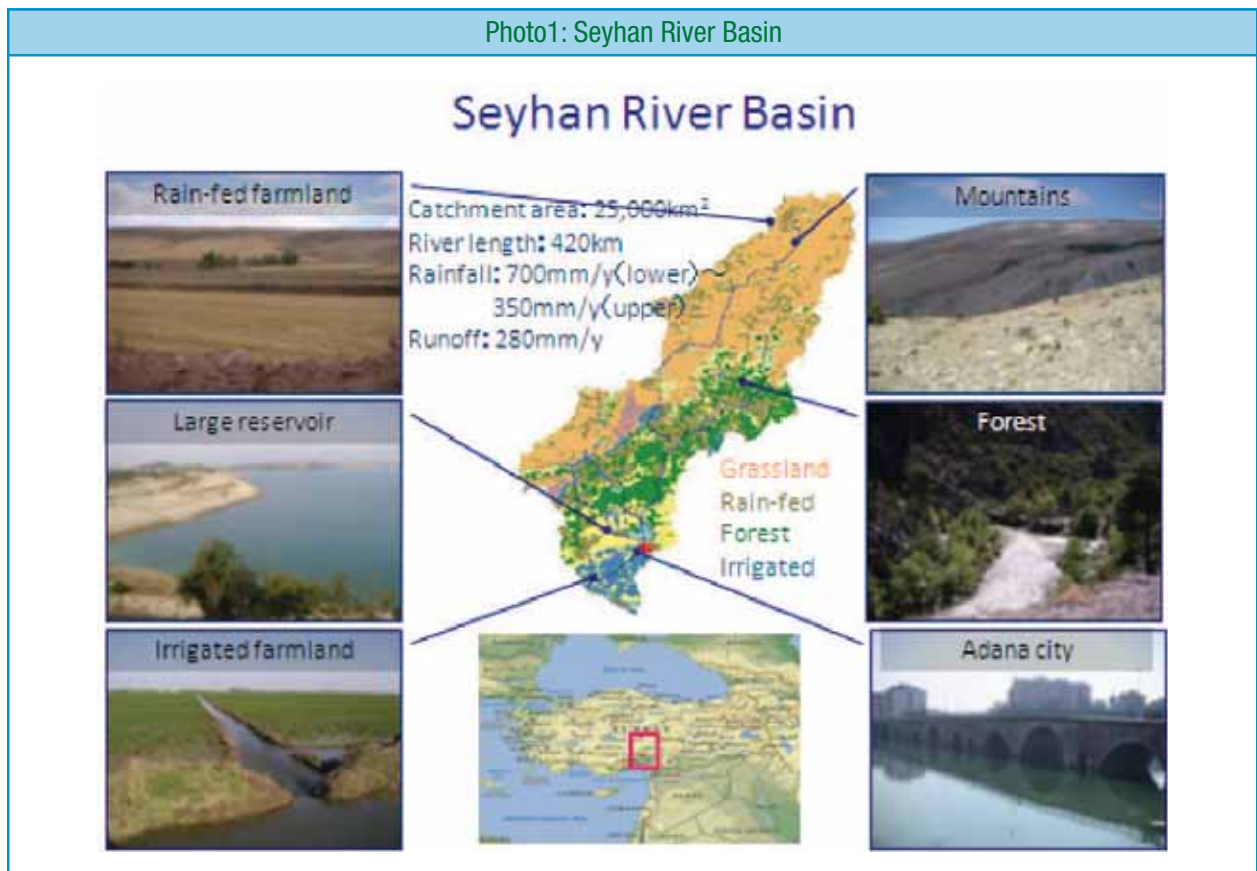
In addition to the delay in the launch of the project, it took time until ensuring repeatability of the model by using hydrological/crop data and others, though we had built simulation model from global climate model. As the result, we did not have enough time to study many envisioned scenarios.

→ We should have set time-affordable schedule.

When the delay was recognized clearly, we discussed what kinds of scenario should be selected and studied on completion of modeling while we waited for its completion.

As the result, we could carry out the study smoothly after the model was built and could find out some tendency of the influence to this area due to climate change.

Photo1: Seyhan River Basin



# Case Study Format

## Region – South Asia

### Country – India

## Lessons from actual case

### Focused on sustainable agriculture and irrigation and drainage

Group of Case Studies: (please check one)	<input type="checkbox"/> "Science& Technology" <input checked="" type="checkbox"/> "Peoples Recognition or Social Movement" <input type="checkbox"/> "Governance" <input type="checkbox"/> "Local Practices" <input type="checkbox"/> "Others"
Field of Case Studies: (please check one)	(If you check "Science& Technology" in the Group) <input type="checkbox"/> "Strategy" <input type="checkbox"/> "Investigation" <input type="checkbox"/> "Research" <input type="checkbox"/> "Analysis" (If you check "Peoples Recognition or Social Movement" in the Group) <input type="checkbox"/> "Symposium" <input type="checkbox"/> "Media" <input checked="" type="checkbox"/> "Campaign" (If you check "Governance" in the Group) <input type="checkbox"/> "Law & Regulation" <input type="checkbox"/> "Organization" <input type="checkbox"/> "Budget" <input type="checkbox"/> "Political Will" (If you check "Local Practices" in the Group) <input type="checkbox"/> "People participation" <input type="checkbox"/> "NGO activities"
Country:	INDIA

## I. Outline of the activity

Title of Case Studies	Farmers Participatory Action Research Programme (FPARP) –1st Phase
Implementing Organization	Central Water Commission (CWC) – Project Implementation Team (PIT) for FPARP
Operating members	Researchers / Scientists of Agricultural Universities, ICAR Research Institutes, ICRISAT and WALMIs
Active term of this Case Study	2007-2010
Contact person	Mr. B.C. VISHWAKARMA (ipdte@nic.in)
<b>Background</b> <p>One thousand and one hundred million people live in India, and it will increase to more than 500 million people by 2050. So, India has to produce more crops to adapt to this population growth.</p> <p>Prime Minister Dr. Manmohan Singh said in his speech in the 60th IEC, in 2009, New Delhi, "The spectre of climate change will also have an unpredictable consequence on the water regime. Various studies point towards its adverse impact on the hydrologic cycle that could result in the intensification of both temporal and spatial variations in precipitation."</p> <p>Prime Minister Dr. Singh also pointed, "The challenge of managing our water resources in a rational and sustainable manner will thus require action on many fronts and coordination across different sectors of the economy. In India, we have tried to address these complex inter-relationships through the formulation of a National Water Mission, which is one of the eight national missions that are part of our National Action Plan on Climate Change launched recently by the Government of India."</p>	

The National Water Mission has been formulated by the Ministry of Water Resources (MoWR) with the main objective of conservation of water, minimizing wastage and ensuring its more equitable distribution both across and within States through integrated water resources development and management.

The Sub Committee on "More Crop and Income per Drop of Water" under the Chairmanship of Dr. M. S. Swaminathan, constituted by the Ministry of Water Resources, recommended implementation of 5,000 Farmer Participatory Action Research Programmes (FPARP) throughout the country with the help of appropriate Agricultural Universities, ICAR Research Institutes, ICRISAT and WALMIs etc. for demonstrating the efficient water use technologies available on shelf to the farmers for increasing the productivity and profitability of agriculture through generating synergy among water, crop, agronomic practices, soil nutrients, crop variety and implements etc.

#### Purpose and Goal

**Goal:** Demonstrations of the technologies available on shelf to the farmers for increasing the productivity and profitability of agriculture through generating synergy among water, crop, agronomic practices, soil nutrients, crop variety and implements etc.

**Step 1:** Award of work to 60 identified institutes for 5,000 demonstrations.

**Step 2:** Monitoring of work by the Regional Offices of Central Water Commission (CWC) and Central Ground Water Board (CGWB).

**Step 3:** Impact assessment of the work of FPARP.

#### Present situation

The programme started in *Rabi* (Winter cultivation season) 2007-08. The demonstrations as proposed are near completion.

#### Effect and Result

Preliminary assessment based on completed demonstrations shows that the saving of water ranges between 10 to 30 % (wheat from 5 to 33%, vegetables from 23 to 40 % and paddy from 25 to 54 %) and yield improvement of the crops ranges between 10 to 40 % (wheat ranging from 16 to 43 %, vegetables from 10 to 23 %, paddy from 10 to 62 %). Farmers also shown their interest to support the programme and have positive view in respect of water saving and increase in yield by such demonstrations.

## II. Keys for Success

### i) Political Leadership

#### Experienced problem → How to overcome

Lack of irrigation water is severe problem in India. Especially for poor people, that problem is crucial and to be solved immediately.

→ Various programme solving lack of irrigation water are being carried out by the government under the political leadership.

#### Key points or requirements for success

Prime Minister Dr. Manmohan Singh made his speech and comments stressing importance of securing irrigation water on various occasions, as mentioned in the back ground. His leadership promotes various programmes tackling lack of irrigation water.

### ii) Dissemination of research outcomes of water saving methods

#### Experienced problem → How to overcome

Many water saving methods are developed by researchers. However, many research outcomes are not used by famers, since farmers did not have chance to see those outcomes.

→ In order to disseminate the research outcomes of water saving methods, the project on demonstrating the technologies available on shelf to the farmers for increasing the productivity and profitability of agriculture was implemented by the government. In order to enable participation in this programme by many researchers, the application guideline for this programme was prepared as shown in Attachment 1

#### Key points or requirements for success

No specific information available.

### iii) Modification of water saving method to be easily used by farmers

#### Experienced problem → How to overcome

At the beginning stage of the programme, the researchers found the difference between suitable condition applying their water saving method and actual condition of demonstration farm operated by farmers.

→ The researchers modified their methods to be easily used by farmers.

#### Key points or requirements for success

No specific information available.

### iv) Sharing outcomes of this programme

#### Experienced problem → How to overcome

In order to modify water saving methods developed by researchers effectively to be suitable under actual farmers' condition, researchers need the occasion to share their experience in the field.

→ The government provide the occasion for sharing researchers' experience in the field, by holding "National Ground Water Congress", as shown in Attachment 2.

#### Key points or requirements for success

No specific information available.

## III. Key findings from failure

No specific information available.

## Attachment 1

### MINISTRY OF WATER RESOURCES

### GUIDELINES TO OPERATIONALISE THE FARMER'S PARTICIPATORY ACTION RESEARCH PROGRAMME (FPARP)

#### 1. Objective of Farmers Action Research Programme

The programme involves field demonstration of technologies developed by the institutes that will increase agriculture productivity and profitability or in other words will enhance yield and income per drop of water. The nature and activities will include soil and water management practices, crops and varieties, agronomic cultural practices, macro- and micro nutrient management, use of appropriate implements such as drip, sprinkler, seed drills and other soil and water conservation implements etc.

#### 2. Award of the programme

The Member Co-ordinator will submit the proposals approved by the PIT indicating inter-alia their cost, period of implementation and the funds to be released to the Commissioner (GW), MoWR for taking necessary action for award of work and release of funds. Commissioner (GW) as Subject Matter Division (SMD) will issue administrative order and separate order for release of funds.

### 3. Pattern for release of funds

- Funds will be provided by sending DD in favour of A. O. or similar appropriate authority.
- MoWR will be providing funds @ Rs.50,000/- (as recommended by the Sub Committee on “More Crop and Income per Drop of Water”) or the approved cost per demonstration whichever is less, limited to 100 demonstration per institute. Expenditure incurred above the approved cost will be borne by the Institutes themselves. However, PIT can waive the ceiling on the number of demonstrations for reputed institutions which have developed more technologies and have capacity for their demonstration.
- 70% of the cost of the proposal will be released at the time of award of the work once the proposal is accepted by PIT. The balance 30% will be released on submission of utilization certificate along with the completion report & acceptance thereof by PIT.
- Accounts of the grant are open to test check by the Comptroller and Auditor General of India under Government of India decision No. 2 below Rule 149 of G.F.R. 1963.
- The organization will devise the system of accounting, reporting & auditing of expenditure in respect of this grant.
- Unutilized funds will be returned through crossed Demand Draft in favour of PAO, MoWR on completion of the programme or if work is terminated by PIT.
- No expenses will be allowed for purchase of vehicles, computers & office furniture/ modification of office.
- The expenditure will be allowed to be incurred under the subheads of Salary, Travel expenses (TE), Infrastructure/ Equipment and Demonstration cost as per the enclosed MoWR’s guidelines for implementation of R&D schemes. Similarly, the expenditure under Contingency and Overhead charges will be allowed to be incurred in accordance with these guidelines. Accordingly, the Institutes will have to submit cost estimate as per enclosed format **CE**
- In accordance with the provisions of Rule 149(4)(i) of the GFR, NGOs/ Private Institutes will be required to execute a bond with two sureties to the president before releasing of funds.

### 4. Time frame

The programme shall be completed in maximum three crop seasons after the release of first installment of fund. However, the PIT may consider granting of more time, if demonstration of technology so warrant (such as drought, flood as well as seasonality and duration of particular technology. The number of seasons will also depend upon the type of crop and technology used.) or on the request of the institutes giving full justification.

### 5. Termination of Programme

The award of work can be terminated at any stage if PIT is satisfied that the work is not progressing well after reviewing the progress reports or after physical checking by Member(s) of PIT. Based upon the recommendation of PIT, the Institute may have to refund the amount released on termination along with the interest at prevailing rate as fixed by the Ministry.

### 6. Completion report

The Institutes will have to implement the FPARPs within the stipulated time period or extended period as approved by PIT and submit the completion report (in hard & soft copy) to Member Coordinator. The completion report should inter-alia highlight the benefits accrued due to implementation of the programme and the beneficiary villages/ farmer families, increase in agricultural production/ livestock,

resultant increase in income of farmers and/ or improvement in ecology, quantum of water saved/ conserved, Training/ education programme to promote proposed technology (ies). Institutes will also furnish the list of equipments procured with the completion report duly signed by Head of the Department.

## 7. Utilisation certificate

- The demand & expenditure will have to be indicated as per format **UC** enclosed.
- The institutes have to furnish a certificate from the Auditors to the effect that the grant-in –aid has been utilized for the purpose for which it was sanctioned.
- The utilization certificate should be duly certified by the Principal/ V.C./ Head/ Director of the institutes (Agricultural Universities & Account Officer/ Registrar.

## 8. Monitoring of the programme

- The institutes will furnish Action Plan for each crop season on the enclosed proforma **AP** on award of work.
- The institutes will furnish the progress (both physical and financial) report in the month following the end of each crop season, on the enclosed proforma **PP & FP**.
- Physical monitoring of FPARPs will be done by the regional offices of CWC and CGWB. They will be submitting the monitoring report containing both physical and financial progress in the proforma **PP&FP** to Member Coordinator of PIT in the month following the end of a crop season. The institutes will extend full cooperation to the monitoring team.
- PIT, if feel necessary, can also make random checking of programme implementation by the Institutes or call meeting(s) of the implementing institute(s).

## 9. Impact Evaluation

- As suggested by the Project Steering Committee, impact analysis in terms of physical and financial gains of all FPARPs shall be done on completion by the following four regional institutes:
  1. Madras Institutes for Development studies, Chennai for Southern region
  2. Indian Statistical Institute, Kolakata for Eastern & North Eastern Regions
  3. Tata Institute for Social Science Research, Mumbai for Western Region
  4. National Institute for Applied Economic Research, Delhi for Northern Region (NCAER).
- MoWR may consider impact evaluation of work by these Regional Institutes at later stage after completion of the FPAR Programme.
- The assessment of FPARP by the regional Institutes will be put on website of MoWR for wider dissemination by SMD.



# FARMERS PARTICIPATORY ACTION RESEARCH PROGRAMME (FPARP)

## Background

The Ministry of Water Resources had constituted an Advisory Council on Artificial Recharge of Ground Water under the Chairmanship of Prof. Saifuddin Soz, Hon'ble Minister of Water Resources. The first meeting of the Council was held on 22nd July, 2006 at Vigyan Bhavan, New Delhi and was inaugurated by Dr. Manmohan Singh, Hon'ble Prime Minister of India. In his inaugural address, the Prime Minister mentioned **“We have to minimize our water use – invest in science and technology to ensure that we can grow crops which use less water. In other words, find ways of valuing the crop per drop”**. To implement the suggestions of Prime Minister, the Council in its first meeting constituted a Sub-Committee under the Chairmanship of Dr. M.S. Swaminathan to prepare a report on **“More Crop and Income per Drop of Water”**. The Sub-Committee consists of representatives of Ministry of Agriculture, Ministry of Rural Development, National Fishery Development Board, CGWB, CWC, Confederation of Indian Industry and Agricultural Scientists from IARI, CRIDA, CAZRI, ICRISAT and State/Central Agriculture Universities/Institutes. The Sub-Committee held two meetings on 9th and 29th Sept., 2006 in a brain-storming mode to analyze the available data and offer concrete recommendations.

The report by the sub-committee was submitted on 2nd October, 2006 to Hon'ble Minister of Water Resources. The Sub Committee had, inter-alia, recommended to initiate 5000 Farmers Participatory Action Research Programme (FPARP) through out the country with the help of Agricultural Universities/ ICAR institutes/ Engineering colleges/ WALMIs etc. for demonstrating the technologies available on shelf to the farmers for increasing the productivity and profitability of agriculture through generating synergy among water, crop, agronomic practices, soil nutrients, crop variety and implements etc.

To implement the above recommendation of the Sub Committee, the MoWR set up PAN Govt. of India Project Steering Committee again under the Chairmanship of Dr. Swaminathan with Chief Engineer (IMO) as Member Secretary.

- The Steering Committee in its meeting held in Feb, 2007 devised the proforma to invite proposals from the Institutes for FPARP. It also decided to set up a small group under the banner of *“Project Implementation Team (PIT)”*.
- MoWR constituted PIT on 09.04.07 with Dr. K. Palanisami, Director, CARDS, TNAU as Chairman and Chief Engineer (IMO), as Member Coordinator for evaluation of the proposals received for FPARP and to formulate of guidelines to operationalize the programme.
- MS (PIT) invited proposals from various Institutes (ICAR Research Institutes/ Agricultural Universities/ Engineering Colleges/ WALMIs/ NGOs etc.) on the proforma finalized by the Steering Committee. In response, 85 proposals were received.
- The PIT shortlisted 63 proposals by 60 institutes for conducting 5000 demonstrations and submitted proposals for release of funds in July/ August, 2007 to the Ministry. It included four proposals by International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad to be implemented in four states of Andhra Pradesh, Chattisgarh, Madhya Pradesh and Rajasthan. PIT also evolved guidelines for implementation of programme which were approved by the Ministry in July, 2007.
- MoWR issued sanction order for conducting 2060 demonstrations by 21 Institutes on 10.09.2007 and for 2940 demonstrations by 39 Institutes on 31.12.2007. 21 Institutes were released advance payment of 1st Installment (35% of the cost) in November 2007 and the balance 35% in March, 08. Remaining 39 Institutes were released advance payment of 1st installment (35% of the cost) in March, 2008. As on 30th May, 2008 all the 60 Institutes have been provided with 70% of the cost of their programme.

- Para 8 of the guidelines provides for physical monitoring of the programme by the Regional offices of CWC and CGWB. Necessary instructions to Regional offices in this regard, have since been issued on 28.01.2008. Provision for random checking of implementation of the programme by PIT Members also exists in the guidelines.
- The programme is to be implemented in maximum 2-3 crop seasons after release of 1st installment. As per the guidelines, the monitoring reports by the Regional Offices are to be submitted in the month following the end of each crop season and the completion report at the end of the programme. Based on information presented during meeting of PIT held on 8th April, 2008, due to mismatch in release of the funds and agriculture season, many institutes could not start the work during *Rabi* season 2007-08 and will be starting their work from *Kharif* 2008-09. Therefore major part of the programme would be completed by *Rabi* season 09. However, a few institutes may be in position to complete their work during *Kharif* season, 08. (*Kharif* and *Rabi* are, respectively, the local names of the monsoon and the winter cultivation seasons).
- The MOWR had organized a “National Ground Water Congress” in September, 2008. It is proposed to have an exclusive session for FPARP wherein each participating institute will make a presentation of 7-10 minute duration on the activities being undertaken by them. Besides, each institute will submit one-two page leaflet with photographs exhibiting various activities of FPARP for distribution during the Congress. To maintain uniformity of information by Institutes a proforma has been devised and sent to all the participating Institutes for submitting the data/information by end of June, 2008. Dr K Palanisami, Chairman of PIT in the Congress, would also make an overall presentation on FPARP.
- As on date, 2001 villages in 366 districts and 25 states are covered under the programme. As per information available, 10,600 farmers are participating in the programme and the number will increase on the receipt of complete information.
- 17 out of 21 Institutes, to whom funds were released in November, 2007 and March, 2008 have reported that they have completed 1072 demonstrations. Details are available in Institute-wise progress report.



# Case Study Format

## Region – South Asia

### Country – Nepal

## Lessons from and on-going case study in Nepal

### Focused on sustainable agriculture and irrigation and drainage

Group of Case Studies: (please check one)	<input checked="" type="checkbox"/> "Science& Technology" <input type="checkbox"/> "Peoples Recognition or Social Movement" <input type="checkbox"/> "Governance" <input type="checkbox"/> "Local Practices" <input type="checkbox"/> "Others"
Field of Case Studies: (please check one)	(If you check "Science& Technology" in the Group) <input type="checkbox"/> "Strategy" <input type="checkbox"/> "Investigation" <input checked="" type="checkbox"/> "Research" <input type="checkbox"/> "Analysis" (If you check "Peoples Recognition or Social Movement" in the Group) <input type="checkbox"/> "Symposium" <input type="checkbox"/> "Media" <input type="checkbox"/> "Campaign" (If you check "Governance" in the Group) <input type="checkbox"/> "Law & Regulation" <input type="checkbox"/> "Organization" <input type="checkbox"/> "Budget" <input type="checkbox"/> "Political Will" (If you check "Local Practices" in the Group) <input type="checkbox"/> "People participation" <input type="checkbox"/> "NGO activities"
Country:	Nepal

## I. Outline of the activity

Title of Case Studies	Adaptation to Global Change in Agricultural Practices: A Case Study of Indrawati Basin, Nepal.
Implementing Organization	Department of Irrigation in collaboration with Nepal National Committee for ICID (NENCID) and technical support from UNESCO-IHE and AIT
Operating members	Uttam Raj Timilsina (Team Leader, Superintending Irrigation Engineer) Suman Sijapati (Contact Person and report writing, Senior Irrigation Engineer) Ramesh Bandu Aryal (local and technical support, Senior Irrigation Engineer) Pradeep Manandhar (financial management and technical support ,Senior Irrigation Engineer) Mr. Dev Raj Niraula (supervise field activities, Senior Irrigation Engineer) Mr. Prem Lasiwa (data collection and compilation, Irrigation Engineer)
Active term of this Case Study	March 2010 to Dec 2013.
Contact person	Suman Sijapati Senior Divisional Engineer, Department of Irrigation Email: sijapati@wlink.com.np

## Background

“Adaptation to Global Change in Agricultural Practices” is an on-going research project being implemented by Department of Irrigation, Nepal in collaboration with Nepal National Committee for ICID (NENCID) and technical support from UNESCO-IHE Institute for Water Education, Delft, The Netherlands and Asian Institute of Technology (AIT), Bangkok, Thailand.

The project has selected Indrawati Basin located in the central region of Nepal as its study area. This study has special significance as the Himalayan river basins are considered to be one of the “hot-spots” in terms of climate change and the agriculture based population living in this area are strongly vulnerable to changes in land use, climate, rainfall patterns, river flow regimes, and seasons.

## Purpose and Goal

**Goal:** The main aim of the project is to develop adaptation strategies through the documentation and analysis of the agricultural practices of the farmers together with integrated hydrological and crop-water-yield models based on well validated database and scientifically translated basin scale climate change predictions.

**Step 1:** Translate global scale climate change to a river basin scale

**Step 2:** Assess impacts of climate change in water resources availability for agriculture

**Step 3:** Develop crop-water-yield database and couple with hydrological model and evaluate alternative farming scenario

**Step 4:** Develop guidelines for adaptation

(See the Figure 1)

## Present situation

This research project commenced in March 2010 and is on-going. Till date the project has started collecting data of agricultural practices in the study area (See the Photo 1 and Figure2) and already started analyzing them to get the preliminary results. Simultaneously, work is underway for the development of crop-water-yield database and for downscaling global scale climate data to river basin scale.

Once all these information are collected and analyzed, the project will start developing guidelines for adaptation from climate change for the area.

## Effect and Result

Preliminary analysis of the data from Indrawati basin has revealed some interesting findings. Settlement pattern in the basin was also observed to be closely related to water availability. Close correlation was observed between education level of the people and their dependency on agriculture and migration trends from the village.

- In terms of water availability, different sites can be divided into three categories: those receiving water from major (perennial) rivers, those depending on local sources and those with no sources (rainfed).
- Those areas that extracted water from major perennial rivers seem to be unaffected in terms of water availability through time.
- Irrigated areas depending on local water sources have experienced decreasing water availability, while, rainfed areas remain in status-quo

## II. Keys for Success

### i) Data Collection

#### Experienced problem → How to overcome

- **Research team has to be of sufficient size:**

The research team has to be able to cover all the aspects and research tasks hence, sufficient and qualified human resources and equipment is necessary. Originally, the team contained a team leader (Superintending Irrigation Engineer) and two supporting members both Senior Irrigation Engineers. We experienced in the course of the research was that the original size of the team was too small to cope with the broad and multi-disciplinary nature of the data requirement for the research.

→ Soon after the work started, the need for a younger member who would carry out the field work of data collection and compilation was realized. Similarly, need of a member who would take care of the financial aspect was also soon felt. Therefore, the research team was expanded from originally three members to six members in order to cover all the aspects and tasks required for the research. Professionally, the additional members also are Senior Irrigation Engineer and Engineer.

- **Sample Data collection sites and data template:**

In the course of the preliminary research it became clear that some of the sample data collection sites and the templates originally developed for data collection were not suitable in view of purpose of measurement.

→ Sample Data collection sites and data template were adjusted on the basis of preliminary results. The changes were aimed at making the data collection process more precise and comprehensive.

**Key points or requirements for success**

Flexibility is essential for broad research topics like the impact of climate change on irrigation and agricultural practices.

A rigid format for data collection may not be appropriate. The research team has to be ready to make adjustments in the collection sites, data collection templates.

## ii) Integrated Approach Needed

Experienced problem → How to overcome

- **Information sources and methodology:**

Because of the complex and multi-disciplinary nature of the topic of climate change, this type of research has to cover a wide spectrum of information sources and methodology.

→ A multidisciplinary and integrated approach was taken for the analysis of the data. All possible sources of information was explored and tapped and all possible methods were used to collect the necessary information.

- **Cross verification of the information from different sources:**

Because the information were collected from different sources, the researcher also felt the need to verify the information from different sources and to adopt the most reliable source.

→ The information collected from different sources need to be cross verified.

**Key points or requirements for success**

An integrated approach for data collection and analysis is essential for researches in the field of climate change and information from all possible sources should be tapped and cross-verified.

## III. Key findings from failure

The research is still on-going so, it is difficult at this point to discuss any failure.

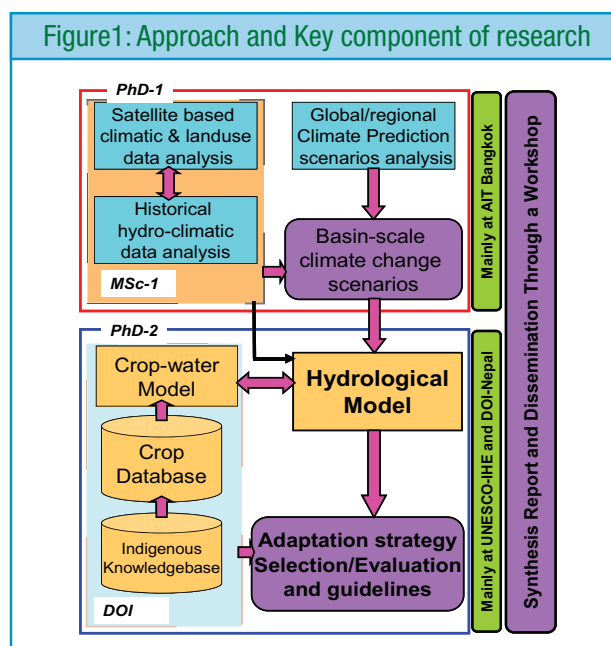
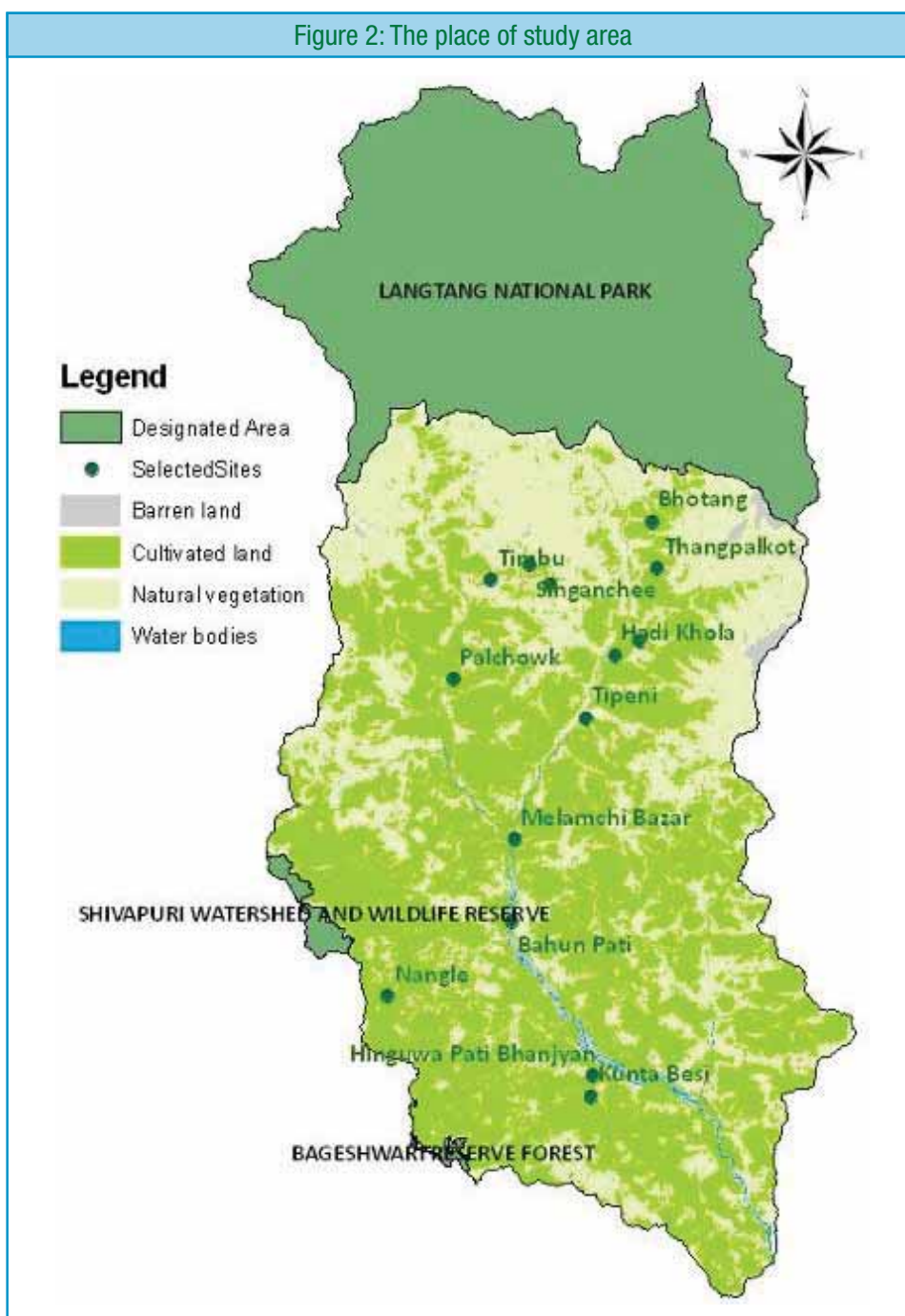


Photo 1: Data collection process



Figure 2: The place of study area



# Case Study Format

## Region – South Asia

### Country – Pakistan (1)

## Annexure

# 6

### Lessons from actual case

#### Focused on sustainable agriculture and irrigation and drainage

Group of Case Studies: (please check one)	<input type="checkbox"/> "Science& Technology" <input type="checkbox"/> "Peoples Recognition or Social Movement" <input type="checkbox"/> "Governance" <input checked="" type="checkbox"/> "Local Practices" <input type="checkbox"/> "Others"
Field of Case Studies: (please check one)	(If you check "Science& Technology" in the Group) <input type="checkbox"/> "Strategy" <input type="checkbox"/> "Investigation" <input type="checkbox"/> "Research" <input type="checkbox"/> "Analysis" (If you check "Peoples Recognition or Social Movement" in the Group) <input type="checkbox"/> "Symposium" <input type="checkbox"/> "Media" <input type="checkbox"/> "Campaign" (If you check "Governance" in the Group) <input type="checkbox"/> "Law & Regulation" <input type="checkbox"/> "Organization" <input type="checkbox"/> "Budget" <input type="checkbox"/> "Political Will" (If you check "Local Practices" in the Group) <input checked="" type="checkbox"/> "People participation" <input type="checkbox"/> "NGO activities"
Country:	Pakistan

### I. Outline of the activity

Title of Case Studies	Lower Bari Doab Canal Improvement Project (LBDC)
Implementing Organization	Irrigation and Power Department, Government of Punjab Lower Bari Doab Canal Consultants.
Operating members	Irrigation staff, Farmers Organization / Punjab Irrigation and Drainage Authority (PIDA)
Active term of this Case Study	2008-2013
Contact person	Ch. Iqbal 14-B/1 Model Town Extension Lahore Pakistan
<b>Background</b> (1) Utilization of existing irrigation facilities as adaptation measures to climate change The Lower Bari Doab Canal (LBDC) irrigation system was built in 1913 and became operational in 1917. It serves a gross area of 740,674 hectares (1668, 897 acres) in Central Punjab (PMU, 2006). The system feeds non-methane producing crops mainly wheat, cotton and maize. In addition, it supports a variety of orchids and irrigated plantation, which act as carbon sinks and contribute in reducing greenhouse emissions. The strategies on tackling climate change in Pakistan are shown in Attachment 1 The increased drought cycles followed by high floods in the Indus River Basin as a result of climate variability in the catchments will enhance the water requirements and if the system is not rehabilitated, it would result in a disaster for the canal command inhabitants. Rehabilitation of Lower Bari Doab Canal (LBDC) Project is an adaptation measure rather than preventive measure to the climate change. LBDC command area is comparatively less prone to the floods, which cause huge damages to the other parts of the country. Thus, it also serves as a food storage that could feed thousands of people vulnerable to frequent floods caused by climate change in the region.	

(2) The project summary and the importance of formation of farmer's organization

(Source: Web Site of Punjab Irrigation and Drainage Authority)

The LBDC project was loaned by Asian Development Bank. The project summary is as follows;

	(Rs. in Million)
Total cost	17,176
Donor share (ADB)	13,068
GOP share	3,921
Date of effectiveness	24, August, 2007
Loan closing date	September, 2013
Utilization of total cost	202.00
Utilization of loan	152.00

The objectives of the project is as follows:

- 1) Rehabilitation and up-gradation of Balloki barrage;
- 2) Rehabilitation and modernization of LBDC main canal & its system;
- 3) Improvement in irrigation infrastructure to avert:
  - low efficiency in irrigation water delivery;
  - Inequitable water distribution; and
  - low application efficiencies.
- 4) Ground water observations, modeling, monitoring and management;
- 5) Facilitate control and reverse the affects of salinity;
- 6) Mobilization of farmers, formation of farmer's organization (FOs) & their training for institutional strengthening; and
- 7) Facilitate private & public investment in agriculture by farmers training and extension services.

The activities related to objective 6) among the above objectives are introduced in this case study.

#### Purpose and Goal

**Goal:** The FOs at the distributaries' level and water course associations are formed in the project area.

**Step 1:** Approaching strategically to FOs formation and Capacity Building

**Step 2:** Holding consultative meetings with each FOs management committees and local horizontal social capital

**Step 3:** Implementing the rehabilitation and new construction works in parallel with or immediately after the formation of FOs

#### Present situation

More than eighty percent of FOs at the distributary level and 90 percent of water course associations have been formed in the project area. Walk-through surveys in association with consultants and representatives of Punjab Irrigation and Power Department (PIPD), Punjab Irrigation and Drainage Authority (PIDA), FOs / WCAs and local village social capital has already been completed in the entire project areas. In-depth community consultative meetings with each formed FOs management committees and local horizontal (bonding) social capital have been completed in all three irrigation divisions of the project area.

New FO offices are being constructed with modern facilities for each FO close to the main distributary canal. Two pilot projects of 15 – L and Jandraka in 1CB – 04 and 1CB – 05 are being implemented for the last one year. Three 1CBs – 01, 02 and 03 for the main canal (LBDC) have been awarded. The project detailed design is most likely to be completed within next 6 months.

The arrangements for project implementation are close to completion.

#### Effect and Result

The project will result enhancing the water carrying efficiency of the canal by rehabilitating old irrigated facilities and formation of Farmers' Organization for management of rehabilitated irrigated facilities.

Community consultative meetings with each FO's management committees and local horizontal (bonding) social capital were especially an essential component of institutional development to find out community demanded structures. Those meetings are also effective to find out engineering issues to be incorporated into engineering design to make the irrigation system people friendly and socially acceptable, besides being positive on gender issues.

Farmers' Organization will ultimately be responsible for O&M of the minor and distributary canals to enhance the water carrying efficiency particularly at the tail ends.



## II. Keys for Success

### i) Strategic Approach to FOs formation and Capacity Building

#### Experienced problem → How to overcome

The newly established FOs were expected to play key role in this project but the duration for FOs' formulation was limited. Under such condition, difficulties in the formulating substantial FOs were anticipated in the absence of any guideline and related published literature on the subject.

→ Positive / negative checklists are provided as success/ failure factors for FO formation. Positive checklists contain the items of "Conceptual clarity of objectives", "Fair and equal water distribution system", "Having annual / seasonal work plans", and so on. The negative ones contain items of "Fear of novelty", "Traditional rivalry among stakeholders", "Low degree of social acceptance", and so on. Our two and a half years experience of FO formation in LBDCIP confirmed that treating positive and negative checklists as factors related to FO formation were the valid and reliable.

#### Key points or requirements for success

We tried to develop our own guideline for formulating FOs. At the first step, we made positive and negative checklists as shown in Annex 2 to enhance formation of FOs in advance before completion of the guidelines.

Strategic approach to FO formation and capacity building for skill improvement, self reliance, water tax assessment/ collection and O&M arrangement of irrigation channels at distributaries and minor levels.

The major lesson learned from the on going LBDCIP FO formation is that to promote the positive factors and minimize the negative factors or keep the failure factor to the possible minimum level by way of removing the false and vague subjective feelings or primary stakeholders, it is useful to create healthy competition for achieving active cooperation of potential FO office bearers.

### ii) Consideration of conflict resolution mechanism by informal way

#### Experienced problem → How to overcome

Applying strategic approach solely was considered insufficient especially in the case of FO management committee's election, which is positioned as the most important process of FOs' formulation.

→ The FO election was supposed to be synthesis of formal and informal interaction process between the farmers and PIDA / PIPD to make FO management committee socially acceptable.

#### Key points or requirements for success

Keeping in view the socio – cultural environment of the project area, it would be better to select the FO management committee in an informal way based on consensus prior to formal election, which would have social pressure and moral obligations behind the socially accepted FO candidates. These FO office bearers would have "trust" as well as formal mandate of the water course association chairmen, who act as electoral college for FO management committee.

The key to successful formation of FOs is that its entire panel is elected unanimously rather split mandate represented by various pressure groups, castes and ethnic affiliations eventually making the FO tasks difficult and unachievable in a timely manner. Sociologically speaking informal control is far more effective, efficient and lasting as compared to formal law enforcement agencies.

### iii) Strengthen the FOs through implementing small simple works

#### Experienced problem → How to overcome

Newly organized FO members did not share practical objectives of FOs. They also need incentives for strengthening their organization at their initial stage.

→ Small scale projects were provided for the newly organized FOs in order to increase the whole members' participation and involvement and to share successful experience.

#### Key points or requirements for success

The concept of FO participation and active involvement was introduced by awarding a small simple work to FO in the form of "community Contracting" having a part of the main international contract. In all 15 progressive FOs, out of 54 have been given community contracts at the ICB contract rates to start with.

### III. Key findings from failure

No specific information available.

## Annex 1: Activities on countermeasures against climate change

Pakistan signed the United Nations Framework Convention on Climate Change (UNFCCC) in June 1994 and submitted initial National Communication to the UNFCCC in November 2003. Pakistan has made significant progress so far on issues related to climate change and formulated the National Conservation Strategy (NCS), the Pakistan Environmental Protection Act (PEPA), 1997, the National Environmental Action Plan (NEAP), National Water Policy and National Environmental Policy. All these documents recognize the water sector environmental issues and support the management strategies. Climate change impacts on irrigated agriculture in the Indus basin are predicted 20 years increasing flows followed by substantial reductions in surface water and groundwater recharge; changed seasonality of runoff and peak flows; more rainfall in place of snow; increased peak flows and flooding; increased salinity; and declining productivity in places (FAO, 2008).

## Annex 2: Positive and negative Check lists for FOs

At the first step, we made positive and negative checklists as follows to enhance formation of FO in advance before completion of the guidelines.

### [Positive Checklist]

Items below from A to k are important elements to formulate genuine FOs in the project area.

- a. Quality social mobilization
- b. Genuineness of FO
- c. Conceptual clarity of objectives
- d. Fair and equal water distribution system
- e. Having annual / seasonal work plans
- f. Timely assessment and collection of “ Water Charges” (Abiana)
- g. Proper O&M arrangements
- h. Honest and competent FO staff
- i. Efficient coordination with high level organization
- j. Consideration of FO as way of life by water users for agricultural community, and
- k. Dynamic FO leadership

Positive / negative checklists are provided as success/ failure factors for FO formation. Our two and a half years experience of FO formation in LBDCIP confirmed that treating positive and negative checklists as factors related to FO formation were the valid and reliable variables for the success / semi-success and failure of FO dynamics with significant statistical variation of relevant factor both in ascending and descending order for FOs success, semi-success and failure categories. These FOs could be termed as “semi-successful” having the following relevant characteristics.



## Semi-Successful FO

The semi-successful category of FO was characterized by having:

1. Vested interests of local powerful big landlord located at head of the irrigation channel being FO office holder.
2. Minimum degree of social acceptance of new water distribution system.
3. Improper social mobilization.
4. Undemocratic FO election below the standard fixed by the Area Water Board/ government.
5. Ethnic disharmony among stakeholders
6. Vague concept of irrigation reform process.
7. Lack of faith in new water distribution system.
8. Trust deficit between the winning and defeated groups during post election period.
9. Acceptance of FO elections unconditionally.

The above success, semi-success and failure factors are valid and applicable local socioeconomic and socio-cultural environment. The social mobilizers (social change agents) had to critically understand the specific, social, cultural and psychological dynamics before initiating and FO formation processes and other extension activities in the project area.

## [Negative Checklist]

Items below from 'a' to 'k' are considered obstacles to formulate FOs.

- a. Marking FO as political football game.
- b. Vested interest of powerful big land holders especially located at head reach of irrigation channel.
- c. Fear of novelty (social change)
- d. Low degree of social acceptance
- e. Inappropriate social mobilization
- f. Higher proportion of proxy / inactive water course association (WCA)
- g. Ethnic disharmony among stakeholders
- h. Traditional rivalry among stakeholders
- i. Traditionally trained project proponents assuming role of development agents.
- j. Lack of backup support (follow up) by project implementation agents, and
- k. Unpreparedness on the part of all stakeholders for assuming new role for positive social change.

## Prerequisite Conditions

The following are the prerequisite conditions prior to the process of FO elections. The preconditions were generally followed under LBDCIP before elections were held.

- i. Geo-technical survey of distributaries / minors.
- ii. Socio-economic survey of all water courses.
- iii. Identification of dynamic social capital dynamic horizontal (bonding) at village watercourse levels and vertical (bridging) at minor level.
- iv. List of eligible voters of watercourse and distributary levels.

- v. Elections of chairmen of watercourses and the executive committees.
- vi. Formation of watercourse association.
- vii. Election of president and management committees of FO.
- viii. Notification of FO office bearers
- ix. Field officer (social organizer) in place.
- x. Training of field officer.
- xi. Registration of watercourse association
- xii. Registration of FO
- xiii. Opening of bank account of WCA
- xiv. Opening bank account of FO.

# Case Study Format

## Region – South Asia

### Country – Pakistan (2)

#### Lessons from actual case

#### Focused on sustainable agriculture and irrigation and drainage

Group of Case Studies: (please check one)	<input type="checkbox"/> "Science& Technology" <input type="checkbox"/> "Peoples Recognition or Social Movement" <input checked="" type="checkbox"/> "Governance" <input type="checkbox"/> "Local Practices" <input type="checkbox"/> "Others"
Field of Case Studies: (please check one)	(If you check "Science& Technology" in the Group) <input type="checkbox"/> "Strategy" <input type="checkbox"/> "Investigation" <input type="checkbox"/> "Research" <input type="checkbox"/> "Analysis" (If you check "Peoples Recognition or Social Movement" in the Group) <input type="checkbox"/> "Symposium" <input type="checkbox"/> "Media" <input type="checkbox"/> "Campaign" (If you check "Governance" in the Group) <input checked="" type="checkbox"/> "Law & Regulation" <input type="checkbox"/> "Organization" <input type="checkbox"/> "Budget" <input type="checkbox"/> "Political Will" (If you check "Local Practices" in the Group) <input type="checkbox"/> "People participation" <input type="checkbox"/> "NGO activities"
Country:	Pakistan

#### I. Outline of the activity

Title of Case Studies	Water Sector Environmental Management Planning in Pakistan
Implementing Organization	National Drainage Program (NDP), Government of Pakistan (GOP)
Operating members	(i) Chief Engineering Advisor, Ministry of Water and Power (ii) General Manager (NDP)
Active term of this Case Study	2004-2006
Contact person	Dr. M. Ashraf Bodla, Environmentalist 277 E-1, Wapda Town, Lahore, Pakistan

## Background

### (1) Water sector environmental issues and Climate Change

Pakistan signed the United Nations Framework Convention on Climate Change (UNFCCC) in June 1994 and submitted Initial National Communication to the UNFCCC in November 2003. Pakistan has made significant progress so far on issues related to climate change and formulated the National Conservation Strategy (NCS), the Pakistan Environmental Protection Act (PEPA), 1997, the National Environmental Action Plan (NEAP), National Water Policy and National Environmental Policy. All these documents recognize the water sector environmental issues and support the management strategies. In case of water sector, Pakistan government made Environmental Management Plan, an adaptation measure rather than a preventive measure primarily covering:

#### a. Wetlands management (Remark 1)

Water-saturated environments, wetlands play important roles in flood protection, groundwater recharge, food production, water quality, wildlife habitat and biogeochemical cycling. Because cultivation and irrigation for agriculture cause bad impacts on wetland, we have some restrictions.

#### b. Control on groundwater extraction (Remark 2)

Because agriculture is a major user of groundwater in Pakistan, we have some restrictions.

#### c. Safe disposal of urban and industrial effluents into water bodies (Remark 3)

Because disposal of urban and industrial effluents cause negative impacts on agricultural production, we have some restrictions for protecting agricultural sector.

### (2) Significance of Water Sector EMP in Agriculture Sector:

Agriculture is the largest sector of the economy, with primary commodities accounting for 25% of GDP and 47% of total employment, and contributes more than 60% of foreign exchange earnings. Out of total agricultural production of Pakistan, 90% is from irrigated agriculture, which mostly depends on the Indus Basin Irrigation System. Out of 145 Million Acre Feet (MAF) of river water inflows, the Indus Basin Integrated Irrigation System directs 105 MAF of water to canals which is delivered to farms through a large network of distributary systems in 43 canal commands.

The water-logging and salinity problem has affected large areas of Pakistan's irrigated agriculture due to poor quality ground water, unregulated groundwater pumping, poor quality irrigation waters, over irrigation, low delivery efficiency of irrigation system, irrigation without drainage and the physical lack of drainage system. The National Drainage Programme (NDP) was launched to alleviate the loss of productive farm land to water logging and salinity. The drainage activities are much related to water quantity and quality issues and the conservation of the threatened wetlands from drainage. Thus, demanding the preparation and implementation of a water sector EMP to ensure the disposal of drainage effluents in environmentally safe manner.

### (3) Evaluation System for Implementation of EMP:

Environmental Monitoring and Evaluation System (EMES) has been included in the Water Sector EMP to act as an early warning system, identifying as soon as possible any sudden environmental deterioration requiring immediate mitigation.

The overall goals of the EMES are to afford effective environmental surveillance and to provide reliable information upon which the continuing environmental management can be updated and refined. Specific objectives of EMES, as shown in detail in Remarks 4)

## Purpose and Goal

**Goal:** Enhancing agricultural products through Implementation of country wide Water Sector Environmental Management Plan (EMP) through:

**Step 1:** Detailed design of EMP for provinces & countrywide

**Step 2:** Interaction with concerned bodies to establish a possible institutional structure in implementing EMP

**Step 3:** Involving agricultural party in implementing EMP

## Present situation

Being partially implemented in Punjab and Sindh through Environmental Management units (EMU); no integrated activity at country level.

### (1) Punjab Province

The Social and Environmental Management Unit (SEMU: Vide Remark 5 later) was established in December 2006 under Punjab Irrigation and Drainage Authority (PIDA).

Social & environmental assessment guidelines for Irrigation Infrastructure have been developed, which are applicable to construction / rehabilitation of canals, drains and small dam projects. Trainings are being regularly given to the representatives of the stakeholders.

Environmental screening of more than 300 schemes has been done so far. Water quality of canals and drains is being monitored.

(2) Sindh Province

The EMU was also established in Sindh Irrigation and Drainage Authority (SIDA) to strengthen its capacity for integrating environment considerations in planning, development and use of water resources.

EMU is responsible for preparation and implementation of environmental management plan (EMP) and/or appropriate social management plans for each canal system according to the Environmental Management Framework (EMF) and the Social Impact Management Framework (SIMF) prepared for the projects. These design reports upon approval would form the basis for preparing the bidding documents for carrying out the construction works and implementing EMP and social management plans, where necessary.

#### Effect and Result

(1) Punjab Province

The newly prepared social & environmental assessment guidelines for Irrigation Infrastructure enable Canal Officers, Area Water Boards (AWBs) and Farmer Organizations (FOs) to identify and mitigate adverse social and environmental impacts caused by the implementation of different irrigation sector projects.

(2) Sindh Province

The SEMU in PIDA and the EMU in Sindh Irrigation and Drainage Authority (SIDA) were established.

The Social & environmental assessment guidelines by PIDA and the environmental management plan by SIDA were developed.

## II. Keys for Success

### i) Enhancing people's interest on environmental issues

#### Experienced problem → How to overcome

During preparation of Water Sector EMP, the persistent weakness in Government's environmental management capability (technical and logistical) in Pakistan, coupled with inadequate environmental institutional organization, particularly regarding the Water Sector outside urban/industrial areas was recognized. Additionally, almost all of people did not have initiative for having environmental awareness.

→ The local governments provided activities for environmental awareness in the rural area through Environmental Education, Media, Economic Instruments, Community Group Involvement, NGOs' activities. For example, in the case of Environmental Education, the curriculum of environment would cover the Basic concepts of Environment; Environmental Impact Assessment; Environment monitoring; Environmental Database. Environmental Management Planning, and so on. Each of them is explained in Remarks 6.

#### Key points or requirements for success

The following conditions are the reason, which people don't have much awareness of environmental issues. When the local governments provide activities for environmental awareness, the following conditions should be carefully considered.

- Widespread poverty, creating more immediate problems of hunger and sickness;
- Relentless excessive population growth which remains incommensurate with the Indus Plains' level of socio-economic development and far outstrips the human carrying capacity of the land, creating both poverty and urban drift;
- High levels of illiteracy, preventing much of the population absorbing or understanding the concept of sustainable development, even at the elementary levels;
- Ignorance of the longer-term implications of everyday acts, such as cutting of trees or killing even inedible wildlife for the sake of it.

## ii) Strengthening the organizational structure at provincial level

### Experienced problem → How to overcome

The implementation of the EMP involves many organizations, such as research institutes and implementation bodies at provincial level. Without a strong commitment from the concerned government authorities, the effective implementation of EMP could not be expected.

→ Each of Punjab and Sindh Provinces established a special unit for smooth implementation of EMP.

The EMP also requires inter-agency cooperation, such as joint programming, joint extension and joint implementation and day-to-day operational coordination. The four-leveled institutional framework was proposed and has been functioning for each of the four Provinces concerned.

### Key points or requirements for success

The capacity as well as capability of various stakeholders in the Water Sector must be enhanced to develop a well-structured and sustainable environmental management system. The improved capacity within the federal and provincial governments to integrate short and long term resource management policies with macro and micro environmental management, capable among other things, of proving clear and stable decisions on resource allocations, resource sharing, and pricing of critical resources.

The four-leveled institutional framework was proposed for each of the four Provinces concerned and also at the Basin-wide (or country-wide) level to address the environmental issues in the irrigated agriculture sector: It can be summarized as follows.

- Environmental Task Force (ETF). A small top-level body of the senior officers of the organizations involved in the EMP, acting chiefly as directors of policy and upper level management, coordination and supervision.
- Environmental Technical Committee (ETC). The EMP's technical secretariat, comprising the senior technical officers of all the organizations with a significant role in the EMP (mainly as the WSESOs – see below).
- Environmental Management Organization (EMO). The conceptual title for the central agency responsible for coordination, supervision and reporting of EMP activities.
- Environmental Supporting Organizations (ESOs). The numerous agencies and organizations that will contribute to the EMP design and implementation, given the huge technical scope of environmental management.

## iii) Strengthening the organizational structure inter-provincial level

### Experienced problem → How to overcome

Both Punjab and Sindh Provinces established units of EMP.

At other provinces, such as (Khyber Pakhtoon Khawa and Balochistan) and Azad Jammu and Kashmir, the Environmental Management Units were established, but were later closed due to lack of funding support from the Federal/Provincial Government and lack of reorganization of environmental issues in the water/agriculture sector. In spite that a basin wide view is essential to cope with climate change impacts on water quality and quantity through EMP, a commitment from the federal government and cooperation among concerned provinces along Indus River Basin are limited for implementation of the EMP.

→ (Possible solution)

While searching funding sources, the federal government could prepare a platform on which the Environmental Management Units established in each province and water sector organizations along Indus River Basin could exchange information and views as well as cooperate on the common issues, mainly thru web.

### Key points or requirements for success

The Environmental Management Units have been established in Punjab and Sindh Provinces and functioning properly. At federal, other provinces (Khyber Pakhtoon Khawa and Balochistan) and Azad Jammu and Kashmir level, the Environmental Management Units were established under NDP with the support of Asian Development Bank, but after concluding of NDP, these units were also close due to non-availability of funding support from the Federal/Provincial Governments and also due to non-reorganization of environmental issues in the water/agriculture sector on the whole.

### III. Key findings from failure

No specific information available.

#### Remark (1) Wetland Management and Food Productivity

Wetlands are the world's important natural resources. These cover approximately 9.7% or 7,800,000 hectares (7,800 km<sup>2</sup>) of the total area of Pakistan (803,941km<sup>2</sup>). This area includes 3,100,000 ha of rivers and major tributaries, 56,000 ha of irrigation canals, 110,000 ha of natural lakes, 92,000 ha of water storage reservoirs, 108,000 ha of ponds, *dhands* and fish farms, 300,000 ha of delta marshes (Indus), and over 4,000,000 ha of waterlogged areas, seasonally flooded plains and saline wastes.

Pakistan's wetlands support a broad spectrum of important plant species and invertebrate and vertebrate animals; the latter includes a range of threatened, endemic and endangered species; five species of mammals, nine bird species, six forms of reptiles, and about six freshwater, estuarine and marine fish types. Several of these animals are world famous such as the Indus Dolphin, Punjab Urial, Marsh Crocodile and Green and Olive Ridley turtles. Many types of migratory birds including white-headed duck, Siberian cranes, sarus cranes, greater flamingoes and spot-billed pelicans use Pakistan's wetlands as wintering grounds.

We can benefit from wetlands by sustenance for agriculture, grazing and fisheries, provision of vital habitat for wildlife, especially waterfowl, maintenance of water quality and abatement of pollution, flood and erosion control, maintenance of both surface and underground water supplies, tourism, outdoor education, sports and recreation; and contribution to global climate control and stability.

Wetlands are a major source of food production in the form of fish. Pakistan's domestic consumption of fish is termed as one of the lowest in the world, at 1.6 kg per person per year (compared to world average of 16.2 kg per person per year). Hence, most of the produce is exported. During the year 2008-09 (Economic Survey of Pakistan) a total of 134,000 million tons of fish and fishery products were exported earning US\$ 236 million.

Wetlands in Pakistan and the biodiversity and natural resources they support, however, are under constant threat of degradation due to direct human disturbances, development impacts, water quality impacts and disruption of natural hydrology (For instance, the current annual fish catch from Manchar Lake, the biggest freshwater lake of the country is 100 tons which was about 3000 tons in 1950). The situation is made worse by issues such as lack of education and awareness, absence of sustainable resource management policies, limited financial resources for management agencies and lack of income/resource alternatives for local wetland-dependent communities. As a result, some 50% of all '*wetlands of international importance*' (as defined under Ramsar Convention criteria) in Pakistan has been rated as being under moderate to high threat.

There is a need for integrated wetland management planning to secure the conservation of biodiversity, natural values and other benefits accruing from Pakistan's remaining globally, nationally and locally significant wetland sites, located within the Indus Basin, the Indus Basin Irrigation System (IBIS), and within the water sector development programmes.

#### Remark (2) Groundwater Extraction for Agriculture

In recent decades groundwater has played a major part in meeting the accelerating demand for water for irrigated agriculture. Groundwater extraction has also been widely used in the Indus Plains as a means of drainage and desalinization. These trends are likely to continue and become stronger.

The total available groundwater resource of the country is estimated as 65 Million Acre Feet but there are widespread problems of groundwater depletion and destabilization of groundwater quality patterns, especially regarding salinity. Legislation is urgently required providing authority for the following critical components of the Groundwater Regulatory Framework for irrigated agriculture in the country:

- identification of Groundwater Management Areas and within them Critical Areas requiring more intensive management and legislation.
- establishment of a Groundwater Monitoring and Evaluation Programme, including water levels and quality.
- field verification of groundwater abstractions;
- determination of safe yield criteria and their regulatory application;
- registration of existing groundwater users and licensing of new users;
- adjustment of canal supplies in coordination with groundwater use;
- restriction of groundwater abstractions;
- modification of private tube-well designs and pumping equipment;
- restriction on certain crops and/or the extent under such crops.

### Remark (3) Influence of urban and industrial effluents on Agriculture

Largely uncontrolled urban and industrial effluents are rapidly becoming major polluters of Pakistan's drainage, irrigation, wetlands and river systems. Accelerating urban/industrial pollution is especially serious in the heavily populated Indus Plains, where much of the effluents are disposed of either directly into the river system; directly or ultimately into the drainage channels; or even directly into the irrigation canals if this is more convenient for the polluters. At present the drainage network in the Indus Plains is uncoordinated, so that effluents mostly end up entering the Indus River system or sometimes just accumulating in local depressions or wetlands. There is an obvious and growing threat to the Indus and its tributaries from urban and industrial effluent pollution.

Groundwater can receive urban/industrial pollutants either directly by percolation from the source sites or by percolation from drains, canals and other collection points (depressions, wetlands, etc) that become badly affected. Slow percolation to the groundwater might help lean the effluent by a sieving effect, although this in turn contaminates the soil and subsoil.

The waste water is widely used to grow a variety of vegetables, cereal crops and orchards. The area under waste water irrigation has increased significantly with about 20 million hectares producing nearly 40% of the food produced worldwide (WHO, 1997). In Pakistan, about 32,500 ha are presently irrigated using urban waste water mostly mixed with industrial effluents.

Farming communities in water-scarce regions increasingly practice the use of waste water for agriculture.

In Pakistan the water is used for irrigation along the length of the drains. The villagers even use water from wells dug close to the drains, which are exposed to the pollution through seepage.

With growing water scarcity for agriculture and increasing waste water volume in drains, farmers around these drains find it convenient to irrigate the fields with easily accessible and free of cost drains water. Untreated water, when used for irrigation, seeps into the soil and facilitates the entry of a number of pathogens and heavy metals like iron, copper, zinc and nickel into the food chain. Vegetables and other crops grown with polluted water may cause diseases when consumed by the people as raw or cooked.



There is need for urban/industrial effluent regulation to improve the quality of such effluent to safe and acceptable standards. In achieving this, regulation must aim to:

- impose real on-site control on industry, pressurizing industry to treat pollution in the right place, i.e., at source;
- establish practical but effective threshold values for effluent discharge from critical sites and discharge points;
- find ways of enforcing such standards through effective legal procedures;
- impose fines of effective magnitude on industries and municipal authorities that cannot realistically meet the standards in the short-term;
- ensure that the “short term” in such cases is acceptably finite;
- encourage municipal authorities in cities and large towns to plan, implement and maintain effective sewage treatment plants;
- establish efficient surface collection systems for industrial effluent and, wherever possible, subsurface pipe systems for sewage;
- create official and public awareness of the nature and seriousness of the problems.

## Remark (4) Specific Objectives of EMES

- identification and prioritization of the issues to be monitored, on the basis of the EA;
- identification and prioritization of the indicators (visible and/or measurable parameters) available for each issue;
- practical design of methods of measuring or estimating values for the selected indicators;
- definition of standards (threshold values) indicating the need for corrective actions;
- establishing means of storing, retrieving, analyzing and presenting the monitored data;
- allocation of technical responsibilities for monitoring and evaluation, including the critical activity of field data collection;
- participation of local people, especially at village and district levels, and possibly NGOs in EMES design and implementation;
- establishment of evaluation and reporting procedures, including “early warning” and retrospective environmental assessment evaluation procedures;
- cost estimation and achieving cost effectiveness;
- sourcing options for the necessary financial inputs.

## Remark (5) Functions of SWMU

- Develop social & environmental assessment guidelines for Irrigation Infrastructure
- Raise awareness & capacity building among Irrigation and Power Department (IPD) and PIDA staff regarding social & environmental impacts of irrigation & drainage sector projects and their mitigations.
- Review Planning Commission Performa (PC-1s) of Irrigation and Drainage sector projects with reference to Social & Environmental Guidelines in the portfolio of Public Sector Development Projects (PSDP) and Annual Development Plan (ADP).
- Monitoring and evaluation of projects through Field visits for ensuring the implementation of S&E Guidelines.

- Conduct social and environmental impact assessment studies of irrigation & drainage sector projects including small dams.
- Review EIA and SEA studies being undertaken within IPD for large projects
- Coordinate to monitor the water quality of Headworks, Rivers, Canals and Drains.

## Remark (6) Activities for increasing environmental awareness in the rural communities

The following activities would extend the environmental awareness in the rural communities:

### *Environmental Education*

Formal education syllabuses should introduce or expand environmental courses in educational institutes. The curriculum would cover the Basic concepts of Environment (What is Environment, Components of Environment); Sources of water, Water cycle; Recognition of good quality water; Concept of water-logging and salinity and their effects (on wetlands, streams, vegetation, soil) ; Soil types; Water pollution and pollutants; Drainage effluent disposal options; Environmental Impact Assessment; Environment monitoring; Environmental Database. Environmental Management Planning; Wetlands Management; Impacts of water pollution on life; Surface and groundwater resources; Sedimentation and erosion.

Farming Community would be trained for: Measuring the depth of water table; Soil and water sampling; Water testing for salinity (use of EC meter); Getting the samples analyzed from the laboratory; Use of Gypsum and other amendments; Biological utilization of salt-affected and waterlogged lands; Water quality monitoring; Maintenance of irrigation and drainage channels, water pollution and its control.

### *Use of the Media*

Radio is probably the most effective medium in rural Pakistan for raising awareness in the general public. Posters and pamphlets are other media forms that can be used as targeted environmental propaganda, focused on one main issue and prepared simplistically for impact.

### *Economic Instruments*

Environmental awareness can be raised by subsidizing environmentally-friendly materials or equipment to targeted groups or individuals, to initiate local interest in them. Other economic tools might include grants and tax reliefs. These may or may not improve environmental behaviour but they might well raise environmental awareness.

### *Community Group Involvement*

The community groups at union council directly related to the Irrigation and Drainage including Water User Associations (WUAs) and Farmers' Organizations (FOs) would be involved in environmental awareness campaigns.

### *Non-Government Organizations (NGOs)*

NGOs have probably to date played the major part in any raising of public environmental awareness that has occurred, in all sectors of society. Local NGOs would function effectively at village levels.

# Case Study Format

## Region – Southeast Asia

### Country – Indonesia

### Lessons from actual case

#### Focused on sustainable agriculture and irrigation and drainage

Group of Case Studies: (please check one)	<input checked="" type="checkbox"/> "Science& Technology" <input type="checkbox"/> "Peoples Recognition or Social Movement" <input type="checkbox"/> "Governance" <input type="checkbox"/> "Local Practices" <input type="checkbox"/> "Others"
Field of Case Studies: (please check one)	(If you check "Science& Technology" in the Group) <input checked="" type="checkbox"/> "Strategy" <input type="checkbox"/> "Investigation" <input type="checkbox"/> "Research" <input type="checkbox"/> "Analysis" (If you check "Peoples Recognition or Social Movement" in the Group) <input type="checkbox"/> "Symposium" <input type="checkbox"/> "Media" <input type="checkbox"/> "Campaign" (If you check "Governance" in the Group) <input type="checkbox"/> "Law & Regulation" <input type="checkbox"/> "Organization" <input type="checkbox"/> "Budget" <input type="checkbox"/> "Political Will" (If you check "Local Practices" in the Group) <input type="checkbox"/> "People participation" <input type="checkbox"/> "NGO activities"
Country:	Indonesia

### I. Outline of the activity

Title of Case Studies	Impact of Climate Change on Water Availability Aspects In Java Island
Implementing Organization	Research Centre for Water Resources (RCWR), Agency for Research and Development, Ministry of Public Works
Operating members	Experimental Station for Hydrology and Water Management and Experimental station for Irrigation
Active term of this Case Study	2010- 2014
Contact person	Dr.Arie Setiadi Moerwanto, Dr.Fransisca Mulyantari, Dr.Wanny Adidarma, Rahmat S. Lubis
<b>Background</b> (1) The problem of Water Resources in Indonesia Indonesia has abundant water resources almost in every region. At present it is estimated 4 million MCM per year or equal to 2110 mm/year. More than 80% of the present water resources are used for agriculture. The average annual availability of water is 14.000 cubic meters per capita is large at a first glance and appears adequate to meet all water needs of the country. But things are very different on a regional basis. Among about 90 major river basins, more than 20 face critical water shortages. Furthermore catchment's degradation threatens food security and rural prosperity. This condition is likely to be attributed to environmental degradation and, consequently, changes in hydrological cycle, as indicated by: <ul style="list-style-type: none"> <li>■ Degradation of carrying capacity of the upstream areas of the water catchments as a result of uncontrolled clearing of forests</li> <li>■ Uncontrolled land clearing within flood plains, catchment areas and river banks that had resulted in reduced infiltration capacity, changes in river morphology and reduced carrying capacity of streams; thus expanding the risk and increasing the frequency of flooding</li> </ul>	

- Riverbed sand exploitation in Java, Bali and West Nusa Tenggara has caused infrastructure and structural damage along the rivers.

The problems arose due to decreasing water supply in the islands of Java, Bali, Nusa Tenggara Timur where demand for water is higher than availability. Issues associated with these problems are population growth, industrial development, urbanization, groundwater overuse and inadequate supply in some regions.

#### (2) Impacts of Climate Change on Water Resources in Indonesia

The global climate is a very complex system and global warming will interact with many other influences; but in Indonesia, it will make many of our existing climatic problems worse. For this reason, most Indonesian water sources are already subject to many climate-related hazards, including floods, droughts, storm and landslides (Figure 1.). Now these will become more frequent or more severe. The detailed analysis is shown in Annex 1.

#### (3) Utilization of research outcomes by implementation units of water resources and rural development

Indonesia has 31 River Basin Organization (RBOs) in the major river basins. They started their operations in 2007 in line with the Water Law 7/2004. The RBOs are the implementation units under the Directorate General of Water Resources, Ministry of Public Works.

Studies and research activities in Research Centre for Water Resources has been supported and budgeted by government. Results and products are used to support government policies in coping with climate change mitigation and adaptation. (Moving from “Key for Success”)

The research results should be used as base of adaptation for RBOs such as: reviewing reservoir operation rule curve for water allocation with the major supply for irrigation.

As mentioned above, various studies have proved that annual runoff has been reducing, intensity of drought has been increasing, and heavy precipitations come more often. In Java, impact of climate change on water resources showed that changes in precipitation and evapotranspiration always have an amplified effect on runoff. RBOs would be required to consider more about adaptation methods to ward off the adverse impacts of climate change based on outcomes of research for implementing water resource development and rural development programmes.

### Purpose and Goal

**Goal:** To promote cooperation and collaboration among institutions in Indonesia through various activities to better understand the phenomenon of climate change and to increase skill to interpret climate change impact to water resources, especially on water availability for irrigation.

**Step 1:** Establishing national systematic observing networks

**Step 2:** Dissemination of research outcomes to implementation units in the Ministry

### Present situation

#### (1) Establishing national systematic observing networks

To understand the climate better and thus be able to predict local climate change, Indonesia must have adequate operational national systematic observing networks, and access to the data available from other global and regional networks (UNFCC, 2007).

Observations and data availability still need to be improved in terms of quantity and also the quality in Indonesia; especially systematic observation networks still are inadequate because there is a lack of stations and lack of maintenance. A comprehensive knowledge base from systematic observation and forecasting services is essential to monitor climate; detect and attribute climate change; improve the understanding of the dynamics of the climate system and its natural variability; provide input for climate models; and thus plan adaptation options.

#### (2) Dissemination of research outcomes to implementation units

RCWR have a program called Dissemination Unit of Water Resources and Technology (DUWRMT) supported by JICA. The overall goal of the DUWRMT is increasing the capacity of RBOs related to implementation of practical water resources management. Through this program, RCWR disseminate the research results about climate change, especially which gives impact to water availability to all RBOs. This dissemination is done through programs as follows:

- Training, workshop, discussion,
- Preparing guidelines and manuals
- Counselling to RBOs of water resources management

Other ways to disseminate the climate change impact are publishing scientific and technical papers in national journals and news papers and presenting research efforts and their outcome in national seminars, which is held by other institutions.

### Effect and Result

(1) Establishing national systematic observing networks

Increasing level of predictive skill for climate change phenomena is done by setting up MOU between RCWR, BMKG (Bureau of Geophysics, Meteorology and Climatology), Indonesia and Deltares & KNMI Netherland to transfer data and knowledge.

(2) Dissemination of research outcomes to implementation units

Training to RBOs staff is done every year and when they have a technical problem, RCWR staff will give technical advices as a home doctor.

## II. Keys for Success

### i) Establishing cooperation and collaboration among research institutes concerned

#### Experienced Problem → How to overcome

Observations and data availability and human resource on climate change are limited. Especially, systematic observation networks still are inadequate because there is a lack of weather monitoring stations and lack of maintenance.

→ RCWR established cooperation and collaboration among research institutions concerned, including BMKG, in Indonesia as well as technical supports from abroad, including Deltares & KNMI Netherland.

#### Key points or requirements for success

In order to increase the length of period of data and increasing the density of hydro-meteorological gauging stations, observations and data availability still need to be improved both in terms of quantity and quality in Indonesia. Presently, they are inadequate and also there is a lack of maintenance of the existing stations. Human resource as researchers on climate change is also limited. Understanding of climate change phenomena to predict local climate change should be improved by local and/or international training.

In response to Indonesian climate change the mitigation measures, which are suitable for immediate adaptation should be promoted through concrete measures. In the short time the efforts leading to successful adaptation have began to appear.

In order to enhance the observation network in Indonesia and to collect necessary data for effective analysis under the condition of limitation of human resource and budget, cooperation and collaboration among government institutions of other countries are necessary.

### ii) Setting up working team composed of implementation bodies and research institutes

#### Experienced problem → How to overcome

The RBOs as implementation unit for climate change adaptation for water resources has limited human resources in the field of climate change. This hinders on-site implementation of measures to cope with climate change.

→ Ministry of Public Works has set up a working team for smooth cooperation among divisions in the Ministry and coordinates various activities for National Action Plan for Mitigation and Adaptation of Climate Change.

RCWR is a part of the team in order to share the outcomes of researches with implementation bodies, and plays an important role in applying them on site through capacity building of RBO staff.

#### Key points or requirements for success

Climate Change Issues attract implementation bodies' attention. The results of simulation of aridity and increasing flood caused by climate change are needed to be shown to them in a clear way. The working team comprising implementation bodies and research institutes provides good occasion for research institutes to understand implementation bodies' demand from research institutes and to make effort to render their research results lucidly.

### III. Key findings from failure

(1) Changing actions required to minimize loss or optimize benefits

The procedure of making national systematic observation system included in planned adaptation category is the process of public policy making and preparation that is based on an awareness of the existing condition and vulnerabilities, the attributes that will change and the actions required to minimize the losses or optimize the benefits.

(2) Necessity of Adaptation Assessment method based on outcomes of research

Spontaneous adaptation is often referred to in the context of business adapting to change, usually triggered by markets or welfare changes and societal preferences. Those who favour deploying “concrete” adaptation measures, such as the creation of reservoirs or development of irrigation systems, have sometimes been reluctant to adopt “softer” adaptation methods such as education, extension services, regulations, penalties and other incentives (Bergkamp et al., 2003).

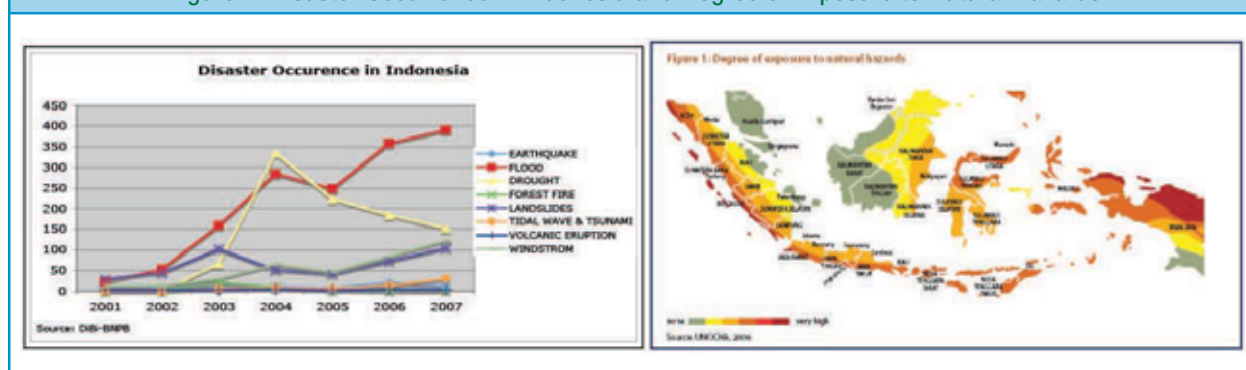
Adaptation assessment should be based more on planned adaptation, which needs improvement in observation network; than on spontaneous adaptation.

## Annex 1: Impact of Global Warming on Water Resources in Indonesia

### The Impact of Global Warming on Water Resources in Indonesia

The global climate is a very complex system and global warming will interact with many other influences, but in Indonesia, it will make many of our existing climatic problems worse. For this reason, most Indonesian sources are already subject to many climatic-related hazards, including floods, droughts, storm and landslides (Figure 1.). Now these will become more frequent or more severe.

Figure 1: Disaster Occurrence in Indonesia and Degree of Exposure to Natural Hazards



#### *Trends of Rainfall*

Temporal rainfall analysis based on more than 100 stations with monthly rainfall data from 1916-2000 has been carried out. To identify the climatic trend in the area, test of absence of trends by using Mann-Kendall test with 95% confidence interval were performed for whole Java (Adidarma et al., 2009a). The study revealed significant negative trends for wet and dry season in most of the areas and only a few number of time series data indicated positive trends. (Figure 2 and Figure 3). The dominant of negative trends occur in Central & East Java.



Figure 2: Significant Trend of Dry Season Rainfall in Java (Adidarma et al, 2009a)

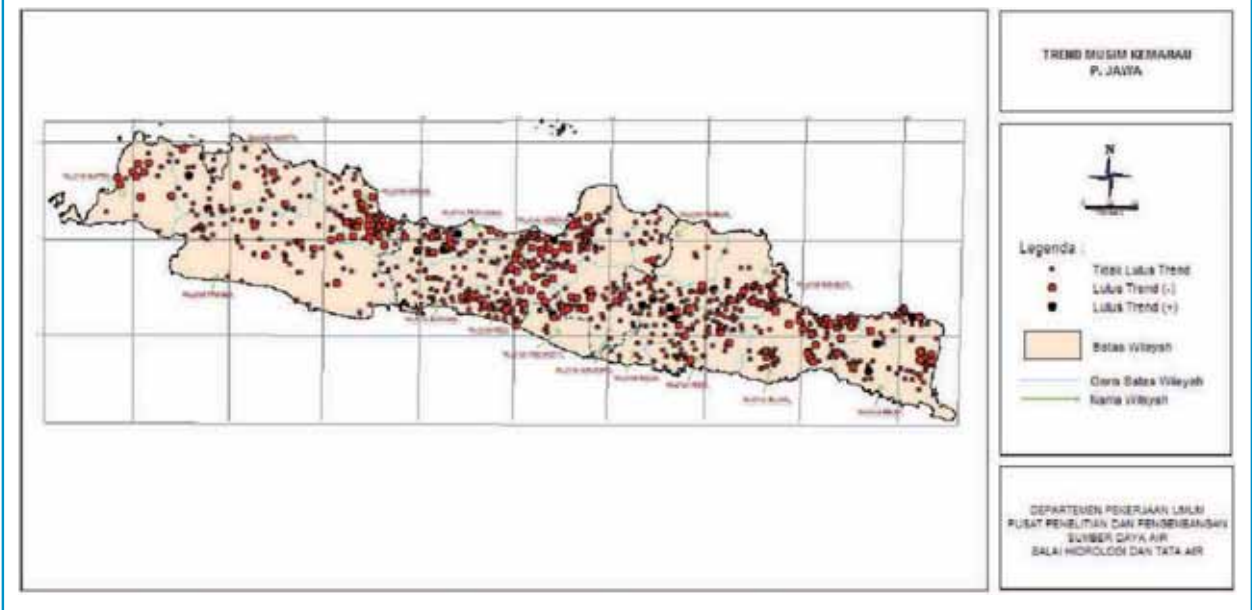
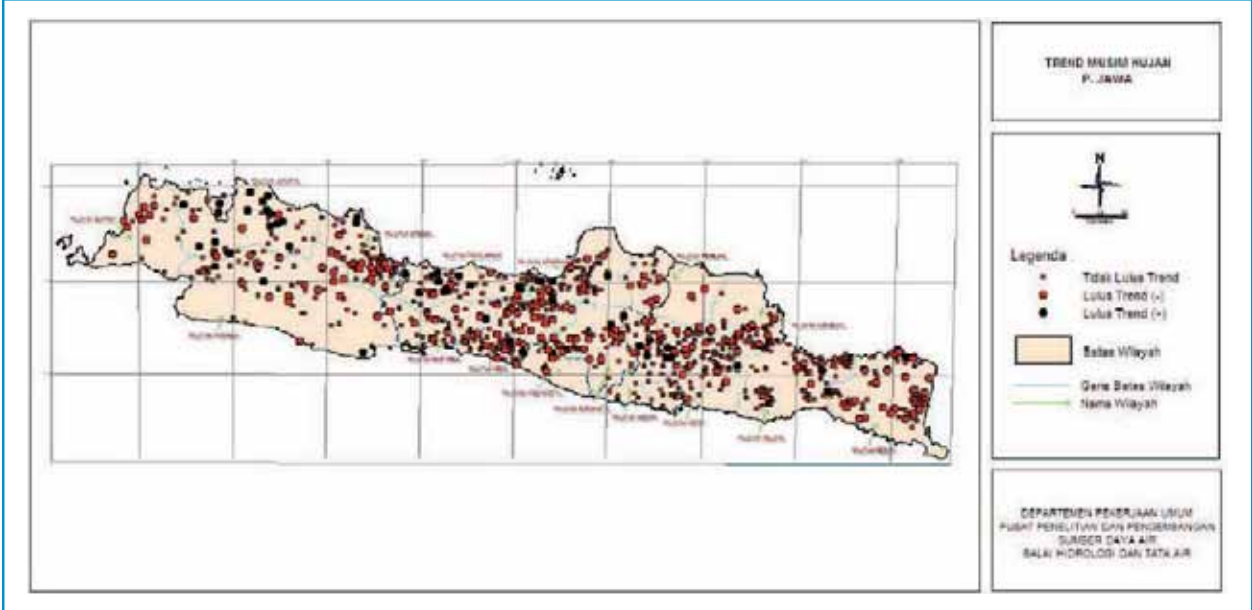


Figure 3: Significant Trend of Rainy Season Rainfall in Java (Adidarma et al., 2009a)

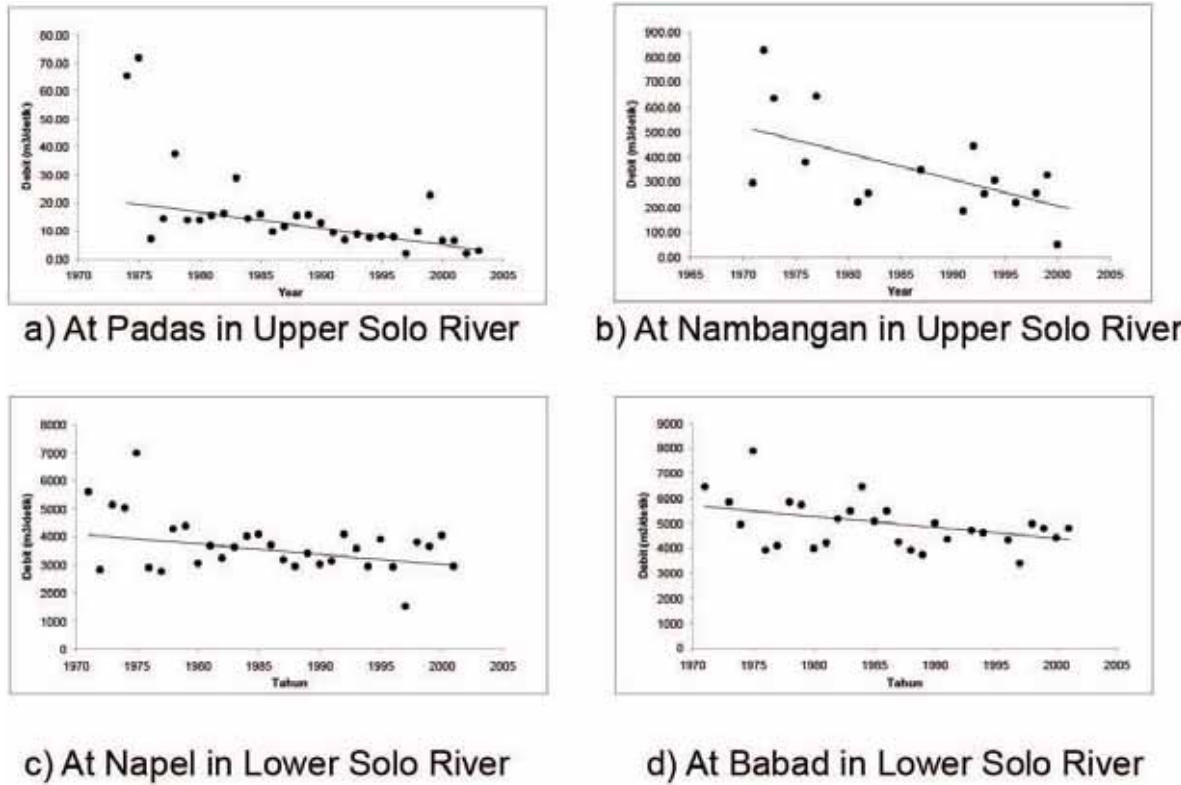


### *Trend of Streamflow*

Character of annual runoff hydrographs in rivers mainly depends on land use and land cover changes besides climate change, as seen in Figure 4. Trend analysis of the annual stream flow series in upper, middle and lower catchments on eight main rivers in Java showed that they had a tendency of reducing flow. The more downstream the river flows the bigger will be the decrease in the linear trend (Sutopo, 2009).



Figure 4: Annual Runoff in the Upper and Lower Solo River, Source:Sutopo, 2009



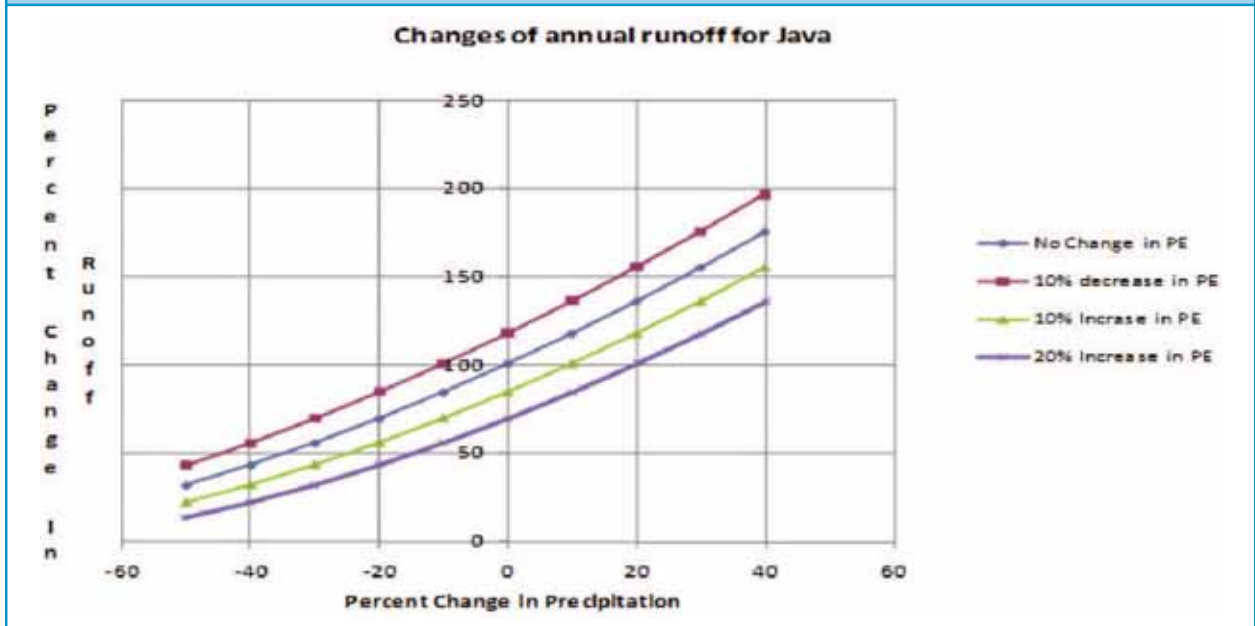
Decreasing of trends in the downstream areas may be caused by some factors such as: a) withdrawal water in the middle catchments for irrigation requirement (Pawitan et al., 2000), b) decreasing annual rainfall in the downstream areas for example in Brantas River Basin during period 1955-2000 (Aldrian dan Djamil, 2008; Pawitan, 2004), c) the effect of the water allocation from dams in the upper areas (Humborg et al., 1997; Admiral et al., 1990; Bennekom et al., 1981; Conley et al., 1993); d) the decrease of base flows in the upper catchments

### *Impact on Water Resources*

Water resources and the hydrologic cycle are largely controlled by climatic factors including precipitation, humidity, temperature, wind speed, and solar radiation. Therefore, any change in any of these climate variables may affect the quantity, quality and spatial distribution of water on land. The scenarios for future climate change indicate the possibility of sharpening of extremes (e.g. droughts, floods etc.) and changes in seasonal and area distribution of water resources (Arnell et al., 2001).

If the change is defined as deviation between annual runoff after and before considering impact of climate change, an 80% annual runoff change means that after climate change the runoff becomes less with magnitude about 0.8 times annual runoff before climate change. Through Continuous Rainfall Runoff Model and the usage of monthly hydrological data from 8 catchments, it is predicted that annual runoff with various rainfall and evapotranspiration changes. The relationship amongst them are shown in Figure 5. A 10% change in precipitation (reduction) over a basin would result in 84% change in runoff, assuming no change in evaporation (Pusat Penelitian dan Pengembangan Sumber Daya Air, 2008).

Figure 5: Changes in Streamflow as a Results of Changes in Precipitation and Evapotranspiration (Puslitbang Air, 2008)



### Impact on Drought

By using the rainfall recorded in meteorological observatories in each region, drought intensity was examined. The data used in this study was obtained from 69 rainfall stations recorded from 1916 to 1999 in Cirebon Region, 23 rainfall stations with period of 1916-2004 in Kedu Region and 34 stations from 1916-2002 in Pekalongan Region (Adidarma et al., 2009b; Adidarma et al., 2009c).

The result showed that the intensity of drought becomes more severe in the latest decade (Figures 6 and 7). Meteorological Drought in Pemali-Comal River Basin which consists of 12 sub-catchments is greater than 1.5 (category severe and extreme), its frequency increases mainly in the last period (Figure 6). Spatially, area with high drought intensity enlarges in Cirebon, Kedu and Pekalongan Region, significant increases occur in Kedu and Pekalongan Region as seen in Figure 7.

Figure 6: Number of Occurrence of Drought Intensity Greater Than 1.5 (Adidarma et al, 2009b)

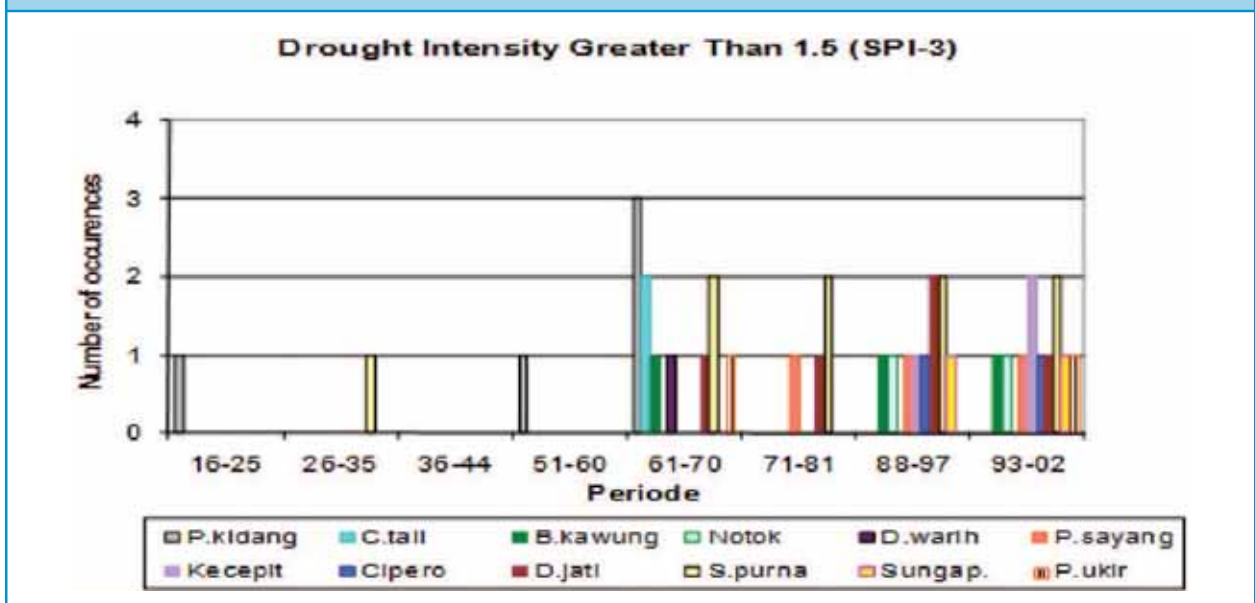
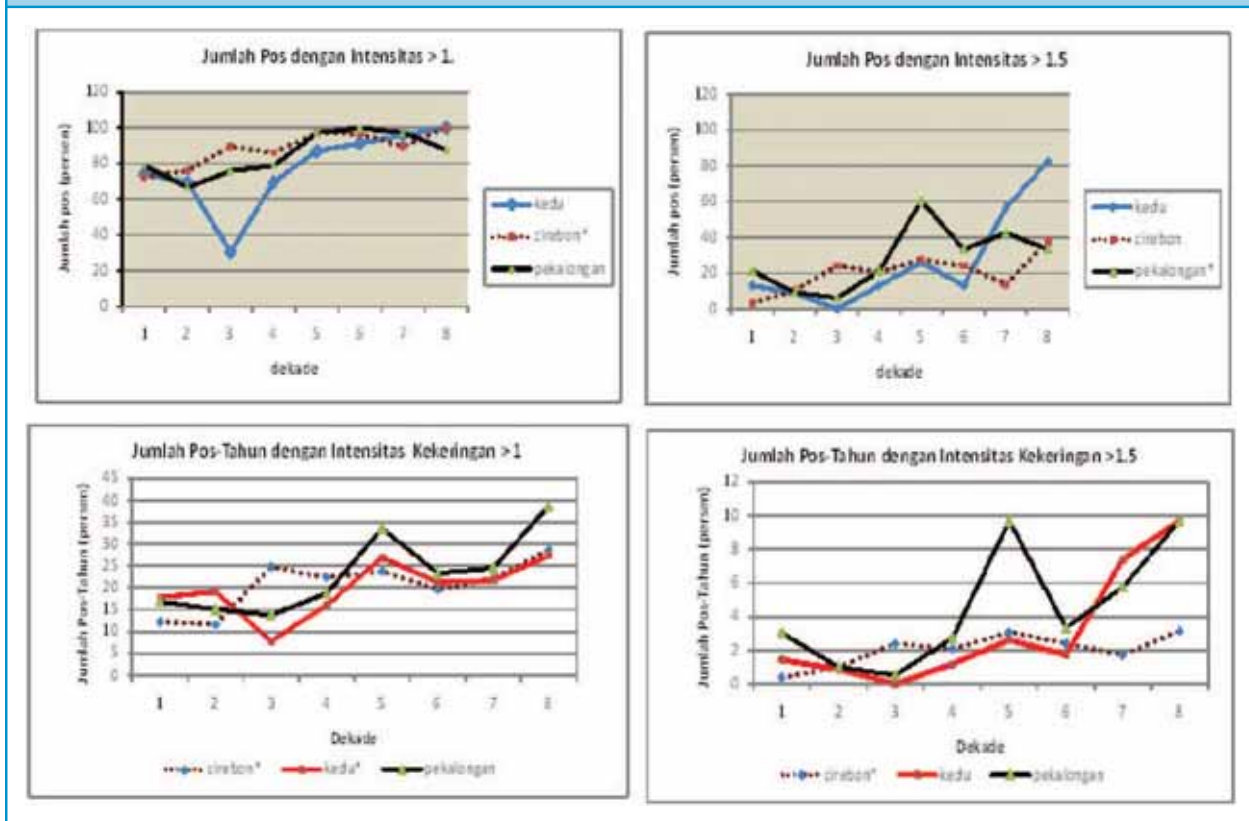


Figure 7: Per cent Number of Rainfall Stations with Drought Intensity Greater Than 1 or 1.5 in Kedu, Pekalongan dan Cirebon Region. (Adidarma et al., 2009c)



### Impact on Water Availability

Water for irrigation, usually is tapped directly from the river, the reservoir, the lake or the groundwater and applied to the paddy field. Water supply for irrigation should fulfill the irrigation water requirement and there should be no dearth of irrigation water. If water availability is not enough for irrigation during irrigation season, crop production will drop off.

The water availability for irrigation can be categorized into the three scenarios described below:

- The water availability is sufficient to meet the irrigation water requirement, but water shortages do occur when the flow is low during dry season of the year and during dry years.
- The water availability is plentiful as compared to the irrigation water requirement even during dry season, but water shortages do occur in dry years.
- The water availability is always much greater than the irrigation water requirement over the irrigation season. Therefore, there is no a problem for the irrigation system as regards water availability.

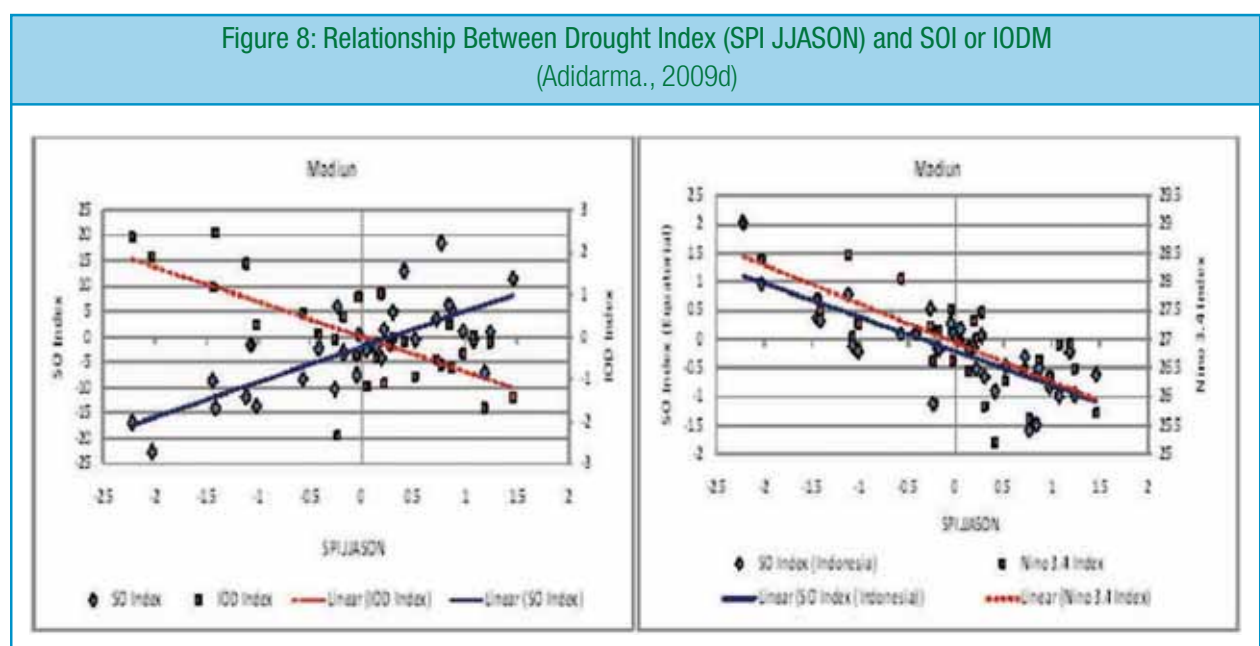
The water source of river is mainly the rainfall over the catchment. The negative trend of rainfall causes the intensity of drought to become more severe and the frequency of drought increases in the latest decade. All these will adversely impact the water availability, which will reduce. In fact, since more than 80% of the available water is used for agriculture, an adverse impact on water availability will cause a reduction in crop production. The reliability of water supply is an essential factor in the success of the irrigation scheme.

Reservoirs are formed by building a dam across the rivers to store runoff from the catchments. Storage depends on dam height and width of the valley behind the dam. Since river water availability may vary a lot within and among years, reservoir storage during wet season can meet the irrigation water demand during the dry season.

Usually, multipurpose reservoirs were built in Java Island with the main purpose of irrigation water supply. It is reported that water shortages in reservoir occur almost every year during dry season. This condition may be caused due to reduction in rainfall and the consequent reduction of runoff, and also due to increased drought intensity. This will bring us to the first scenario that water availability does not guarantee fulfilling the water requirement during dry season and also in dry year.

### *Effect of ENSO Phenomenon*

El-Nino Southern Oscillation (ENSO) phenomenon has been found to be one of the important factors that affect rainfall variability in Indonesia. Recent studies indicated that Indian Ocean Dipole Mode (IODM) also has significant influence on rainfall variability in Indonesia. Yamagata et al. (2001) and Kumar et al. (1999) stated that if IODM occurred at the same time with El-Nino (IODM is strongly positive and South Oscillation Index - SOI strongly positive), it would counteract the reducing effect of El-Nino on rainfall. Analysis of averaged drought index for sub-catchment's Madiun in Bengawan Solo River Basin suggested that this type of relationship were true only for dry season rainfall in monsoonal type region (Figure 8).



The coefficient of correlation between SOI or IODM and dry season drought index could reach level more than 0.7 (strong correlation) for Pemali-Comal River Basin in North Central Java (Figure 9) and also for sub-catchment's Madiun in Bengawan Solo River Basin, Central Java and East Java (Figure 9).

When there is an El-Nino, Indonesia usually, have more droughts. When there is a La Nina, Indonesia have more floods. Over the period 1844-2006, out of 43 droughts, 37 were associated with an El Nino. The ENSO with SOI is also one of the main factors in the creation of larger frequency and greater magnitude of drought intensity for the whole River Basin Pemali-Comal and for several Sub-basins in Bengawan Solo River Basin. It has been proven by the existence of strong correlation between Drought Index and SOI in Pemali-Comal River Basin (Figure 9 and Figure 10).

Figure 9: Correlation Coefficient of Drought Index (dry season: JJASON; wet season : DJFMAM) and SOI and IODM (Adidarma . 2009 d)

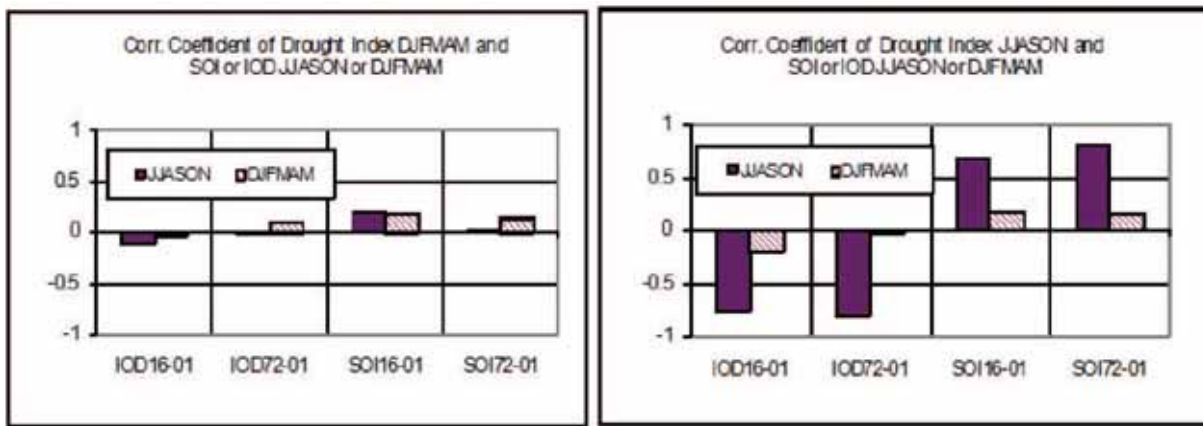
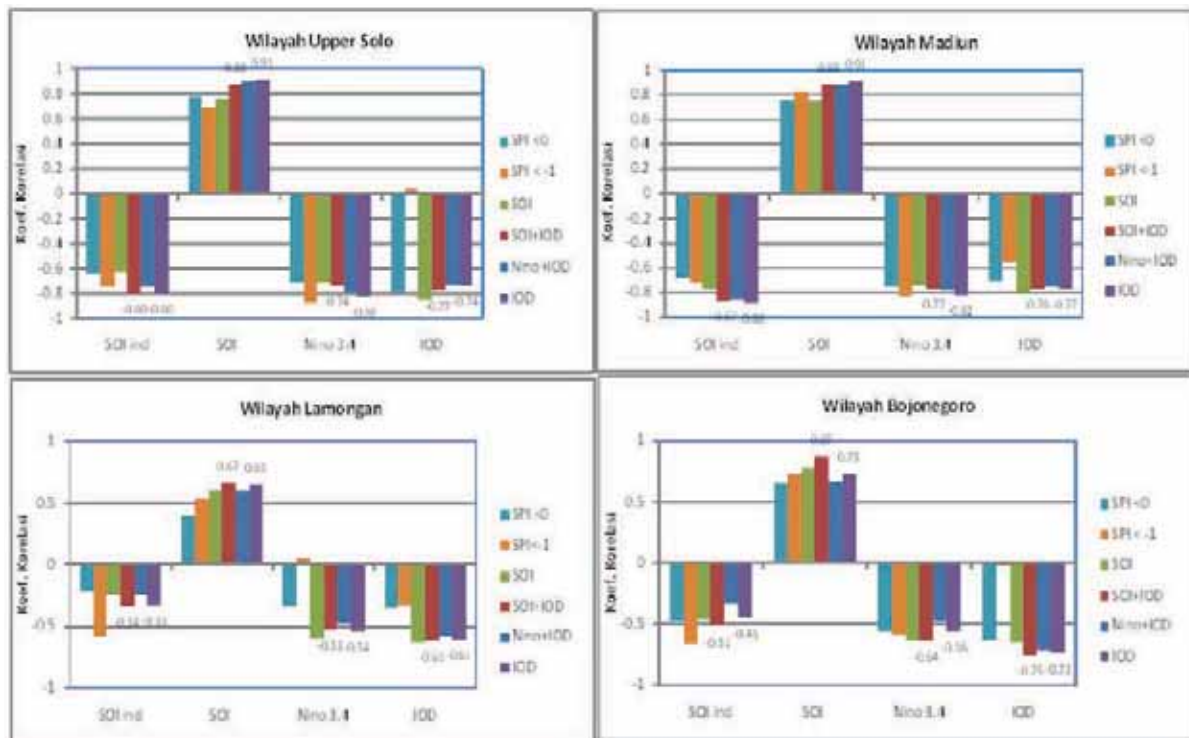


Figure 10: Coefficient Correlation of Drought Index (dry season: June July August September October November) and SOI and IODM for Sub-Catachments in Bengawan Solo River Basin (Adidarma, 2009d)



Relationship between global climate forcing factors (SOI and IODM) and rainfall variability in the four stations (Jakarta, Kupang, Meulaboh and Ambon) was assessed using regression analysis, (Lasco et al., 2006). The correlations between IODM and dry season were not as strong as those between SOI and dry season rainfall and in a few stations the correlations were not significant (Boer and Faqih, 2005). In equatorial type (Meulaboh), these two global climate forcing factors showed no significant correlation with the rainfall variability of all seasons, while in Ambon (local type) only SOI showed significant correlation with April-September rainfall (Adidarma., 2009d).



# Case Study Format

## Region – Southeast Asia

### Country – Malaysia

### Lessons from actual case

#### Focused on sustainable agriculture and irrigation and drainage

Group of Case Studies: (please check one)	<input type="checkbox"/> "Science& Technology" <input type="checkbox"/> "Peoples Recognition or Social Movement" <input type="checkbox"/> "Governance" <input checked="" type="checkbox"/> "Local Practices" <input type="checkbox"/> "Others"
Field of Case Studies: (please check one)	(If you check "Science& Technology" in the Group) <input type="checkbox"/> "Strategy" <input type="checkbox"/> "Investigation" <input type="checkbox"/> "Research" <input type="checkbox"/> "Analysis" (If you check "Peoples Recognition or Social Movement" in the Group) <input type="checkbox"/> "Symposium" <input type="checkbox"/> "Media" <input type="checkbox"/> "Campaign" (If you check "Governance" in the Group) <input type="checkbox"/> "Law & Regulation" <input type="checkbox"/> "Organization" <input type="checkbox"/> "Budget" <input type="checkbox"/> "Political Will" (If you check "Local Practices" in the Group) <input type="checkbox"/> "People participation" <input type="checkbox"/> "NGO activities"
Country:	MALAYSIA

### I. Outline of the activity

Title of Case Studies	A Conceptual Framework for the Preparation of Guidelines for Climate Change Vulnerability and Adaptation Strategies
Implementing Organization	RPM Engineers Sdn Bhd
Operating members	NAHRIM
Active term of this Case Study	No specified
Contact person	Mohd. Adnan (mdadnan@rpm-engineers.com.my)
<b>Background</b> Vulnerability and Adaptation (V&A) due to the impact of climate change is now one of the main subjects of interest and concern of all countries around the world. Many related studies by the respective countries have begun and are in various stages of progress. There are however a number of concerns expressed at recent Climate Change related conferences and workshops as well as publications in the Asian region. Among the areas of concern are: (1) The need to encourage downscaling of V&A efforts and increased participation, and, (2) The need for quantified and "valued" V&A assessments. Also, as Climate Change related program gathers momentum and volume, there appears to be a need to have some form of uniformity of approach for a meaningful comparison of results of those programs. A strategy to resolve those concerns and produce suitable guidelines is needed. .	

At the moment the problem is that efforts by some to undertake vulnerability and adaptation studies are much varied and mostly very subjective and unquantified. The approaches are also diverse and therefore do not allow for easy evaluation for further support for in-depth study and development of action plans. The speed of taking up of studies by the various sectors and communities are also slow because there is little encouragement, if any, to make it easy for a wide-spread participation by all stakeholders.

The necessity for a guideline is recognized by the NAHRIM and Asian Development Bank as well as by many who were involved in the recent preparation of the National Communications 2 report. Following this NAHRIM and RPM Engineers decided to take the initiative to begin the development of the V&A Guidelines with some practical examples. Whilst the initial V&A is very simplified, it does provide a sequence of action to consider. At the same time it is also not restrictive in terms of the steps to be taken. It encourages interested parties to start the V&A in any of their areas of interest. NAHRIM and RPM Engineers are the lead organizations to continue developing, testing and promoting the V&A Guidelines.

Irrigation and drainage are related to this project in a number of situations. For agriculture areas installed with irrigation and drainage systems, there will be certain adaptations required. These could include changing in the timing of planting seasons, change of crops, developing new varieties, review of the irrigation and drainage operations and maintenance activities, review of systems and components design.

Rain-fed agriculture is the largest agriculture area and may be more vulnerable economically for the farmers and also the nation. For areas that are rain-fed (such as for oil palm), installing irrigation system may be the adaptation strategy. This is not just to meet crop water requirement in the dry season but also for cooling the plant during the periods of high temperature. The drainage system will need to be re-designed to have function for removal of excess water as well as for irrigation and groundwater recharge. There may be a need for better surface water management, storage system that include more refined water-table management. In the coastal zones where sea-level rise maybe significant, salt water intrusion will have to be controlled and managed.

#### Purpose and Goal

**Goal:** To develop guidelines for Climate Change V&A for several reference

**Step 1:** Develop framework for guidelines for Climate Change

**Step 2:** Test the guidelines

**Step 3:** Improve the guidelines

#### Present situation

The guideline has been tested by RPM Engineers for a Climate Change Vulnerability Assessment and Adaptation Study for Carey Island, Sime Darby Plantation (oil palm estate).

#### Effect and Result

The simple guideline is useful and easily adopted by technical persons. Need to show more examples on its applications.

## II. Keys for Success

### i) Understanding the meaning of V&A

#### Experienced problem → How to overcome

Poor appreciation of risks. There is a need to explain risks and risks management.

Inadequate data on impact on biodiversity.

During the study on Climate Change impact and V&A for an oil palm plantation, the difficulty was in explaining to the oil palm managers to prioritize areas of concern based on risk assessment. If this is not done then, the areas of concern are just too many to consider and therefore become impractical. For example, as a commercial enterprise, the concern should be on the impact of climate change on yields and production activities and therefore profitability.

There are many components of these and one way to prioritize is to evaluate which is the most at risk and critical.

This was finally solved by having a session to explain risk management and to have a common agreement on what would be the priority for V&A.

On the issue of inadequate data on impact on biodiversity, the recommendation is to encourage more research on this.

See the attached tables after the Format-

#### Key points or requirements for success

More simple explanation on risk and risk management.



## ii) Understanding Vulnerability and Adaptation

Experienced problem → How to overcome

- Lack of data and understanding of “vulnerability” was a serious problem to promote V&A and good examples are needed.

Lack of data can only be overcome through network with knowledge centres and active professionals. On understanding “vulnerability”, this can be overcome through a series of capacity building program and also good examples. In this case, some examples were given as a guide to develop ideas for local issues. For example, coastal plantation would be more vulnerable to sea level rise than plantations on higher lands. The same for temperature rise. There are also flood issues on the lowlands.

To promote more participants to undertake V&A, there need to be examples that could be used as illustrations to facilitate the use of the guidelines. Under this study, some examples were given based on actual studies performed by active professionals. These can be considered as initial collections that hopefully will lead to more examples on the use of the guideline as well as for improving the basic guideline initiated. In the long term, these will form a good database for reference not only by active professionals, but the community as a whole.

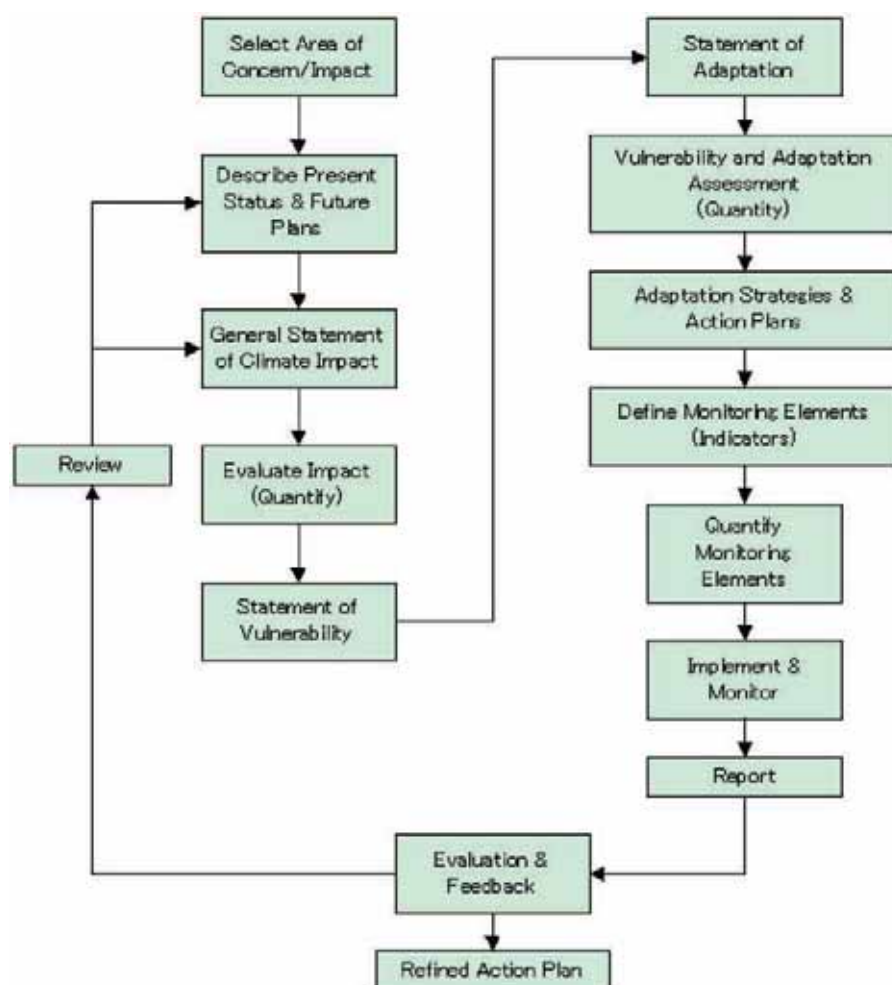
Key points or requirements for success

Need for more participation by the community.

## III. Key findings from failure

Need to have more quantifiable data and examples on vulnerability and adaptation.

Remarks: Tables related with “Experienced trouble → How to overcome” of “Understanding the meaning of V&A”



**Accompanying figure 1: Example of Developing V&A Strategies and Action Plan  
Guidelines for Climate Change Adaptation Monitoring**

Step	Action	Description	Example
1	Select Area of Concern/Impact e.g. Dam Flood Structure Residential Area Water Supply	Explain its country -To the country -Population -Community -Individual -Sector -Subsector	-Flood mitigation System -Dams -Structures
2	Describe Present Status & Future Plans	Descriptions of present Status and future plans. List assumptions (parameters)	-Master-plan Flood Events -Flood Mitigation Project
3	General Statement of Climate Impact	Listing of General Impacts anticipated	-Loss due to floods -Loss due to drought -Loss of income, business
4	Evaluate Impacts (Quantify)	Use climate projections to evaluate impacts	-Reg. HCM –PM -Rainfall, river flow -Time series
5	Statements of Vulnerability	Describe the elements of vulnerability	-Sensitivity to floods -Exposure to floods -Exposure to droughts
6	Statements of Adaptation	Describe general adaptation options potential	-Flood Protection -Intensity -Flood area, depths, frequency
7	Vulnerability and Adaptation Assessment (Quantify)	List of monitoring elements in relation to Vulnerability elements and adaptation options	-Rainfall -Intensity -Flood area, depths, frequency -Damages
8	Adaptation Strategies and Action Plans	Put a value to the elements and the targets	-Population increase -Damage Assessment
9	Define Monitoring Elements (Indicators)	Compare target units with actual achievements	
10	Quantify Monitoring Elements	Reasons for achieving targets Reasons for not achieving targets Recommendations	-Relate to CC
11	Implement & Monitor		
12	Report		
13	Evaluation & Feedback		
14	Review		
15	Refined Action Plan		

# Case Study Format

## Region – Southeast Asia

### Country – Thailand

### Lessons from actual case

#### Focused on sustainable agriculture and irrigation and drainage

Group of Case Studies: (please check one)	<input type="checkbox"/> "Science& Technology" <input type="checkbox"/> "Peoples Recognition or Social Movement" <input checked="" type="checkbox"/> "Governance" <input type="checkbox"/> "Local Practices" <input type="checkbox"/> "Others"
Field of Case Studies: (please check one)	(If you check "Science& Technology" in the Group) <input type="checkbox"/> "Strategy" <input type="checkbox"/> "Investigation" <input type="checkbox"/> "Research" <input type="checkbox"/> "Analysis" (If you check "Peoples Recognition or Social Movement" in the Group) <input type="checkbox"/> "Symposium" <input type="checkbox"/> "Media" <input type="checkbox"/> "Campaign" (If you check "Governance" in the Group) <input checked="" type="checkbox"/> "Law & Regulation" <input type="checkbox"/> "Organization" <input type="checkbox"/> "Budget" <input checked="" type="checkbox"/> "Political Will" (If you check "Local Practices" in the Group) <input type="checkbox"/> "People participation" <input type="checkbox"/> "NGO activities"
Country:	Thailand

### I. Outline of the activity

Title of Case Studies	Study of Using Agricultural Land in the Chao Phraya Delta for Mitigating Flood caused by Climate Change.
Implementing Organization	Office of Project Management, Royal Irrigation Department, Ministry of Agriculture and Cooperatives
Operating members	Arthon Suttigarn, Ph.D. Mr. Phonchai klinkhachorn
Active term of this Case Study	October 2009-December 2010
Contact person	Arthon Suttigarn, Ph.D. (asut1030@gmail.com)
<b>Background</b> <p>The Chao Phraya River basin has experienced so many floods, and the 1983, 1995, and 2010 floods were the most serious. The inundation area is broadly divided into four regions in this basin: Upper Central Plain, Nakhon Swan Area, Higher Delta (between Chainat and Ayuttaya Province), and Lower Delta (downstream of Ayuttaya).</p> <p>The consequences mentioned might correspond to the Study of the Climate Change Impact in Chao Phraya River basin conducted by Panya Consultant Company in 2009. The Climate Change Impact and Adaptation Study for Bangkok Metropolitan Region (Final Report 2009) reveals that in 2050, the temperature, rainfall intensity, and sea level will increase 1.2-1.9 °C, 9.8-15%, and 19-29 cm, respectively. The studied model also shows the cumulated volume in Chao Phraya River at C2 station at Nakhorn Swan from July to December, will increase from 39,960 million m<sup>3</sup> to 41,150 million m<sup>3</sup> (return period 100 years) in 2050 or maximum flow will increase from 6,853 to 7,146 m<sup>3</sup>/s. Therefore, Climate Change has been expected to increase flood in Chao Phraya river basin in the Future. (See the Photo 1)</p>	

In 2010, it was observed that there were huge floods in many parts of Thailand, i.e. the North, North-East, Central Plain and South. The effect of 2010 Floods in those areas was severe. It is believed that Climate Change plays a role in the change of period and intensity of rainfalls in many parts of the country. As a result, it causes excess flows in river channels. Like in the Lower Central Plain, the main causes of flooding are the running water overflows banks of Chao Phraya river and its tributaries. In the 2010 flood, dike breaching and overtopping occurred in lots of reach of the Chao Phraya river, its tributaries and distributaries.

The report of JICA (August 1999) on the Study on Integrated Plan for Flood Mitigation in Chao Phraya River Basin described the features flooding in the basin into 5 categories: extensive inundation, river flood, inland flood, influence of Tide, and influence of Land Development and Embankment in Flood Plain. The Land Development in existing natural flooding areas and Embankments such as roads, railways, irrigation canal dikes, including self-protected areas make such natural basins along the river course of Chao Phraya River reducedecrease. As a result, flooding appears to occur into the urban areas and Bangkok Metropolitan Areas.

Royal Irrigation Department has attempted to study several measures to mitigate and prevent such disasters in Chao Phraya River basin. One of those measures is the study of using agricultural areas, which are low lands and always inundated when flooding, of Chao Phraya River basin as temporarily water retarding basins.

#### Purpose and Goal

**Goal:** To study of using low-land agricultural areas in Chao Phraya Delta as temporary retarding basins to mitigate floods caused by the Climate Change.

**Step 1:** Studying the Feasibility, Initial Environmental Examination, Social Impact Assessment, and People Participation.

**Step 2:** Select a Pilot Project to implement and evaluate(See Remarks"1").

**Step 3:** Using as information for Government Decision Making.

#### Present Situation

Eight low lands in the Chao Phraya Delta have been proposed as Master Plan areas for temporary water storages when inundation occurs. Four of 8 low lands, which are agricultural areas, have already been studied at the Feasibility level, meanwhile, the rest will be studied in the recent years. One of the studied areas has been selected for implementation of a Pilot Project. . Now, that project is under progress. The project evaluation is being carried out simultaneously.

#### Effect and Result

The Master Plan study shows that low lands are necessary for using as retarding basins for flooding in Chao Phraya River basin. The total of 884 km<sup>2</sup> of proposed agricultural areas, mostly paddy fields, in 8 areas along Chao Phraya River at downstream of Chainat Province, are able to store about 1.661 billion m<sup>3</sup> of water, or about 17% of inundation of 9.5 billion m<sup>3</sup> of Chao Phraya Delta in 1995 Flood.

The Feasibility study of 4 studied areas shows no protest from people who own the lands if government has fair compensation and use their lands temporarily. Whereas economic and financial considerations reveal that the project will be feasible if all 8 proposed areas are implemented.

## II. Keys for Success

### i) Win-Win Strategy

#### Experienced problem → How to overcome

The proposed project areas are Paddy Fields and low lands. Therefore, the areas have always been inundated when flooding occurs in the rainy season every year. People (mainly farmers) realize that the land is left uncultivated when inundation occurs and no benefit accrues to them from the land. The flood damages not only the agricultural lands, but also urban areas and infrastructures. Therefore, Climate Change has been expected to increasing flood in Chao Phraya river basin in the Future.

- One of the measures considered is a project using the above agricultural areas as temporary water retarding basins. If the project could be done, the Lower Chao Phraya River Basin area, including Bangkok and its vicinity, will be secured. In order to get approval of the project from the peoples' consideration, the Government considers making acceptable compensations of the utilized lands for low land people and creating "Win-Win strategy" for both urban areas and low land people. (See the Figure1 and Remarks"2".)

#### Key points or requirements for success

- Acceptable compensation, regulation, and law for stakeholders
- Establishment of Flood Fund and Flood Management Organization (See Remarks"3").
- Land Development Control or issuing laws to sustainable land development

## ii) Information and People Participation

### Experienced problem → How to overcome

- Feasibility Study clarified people's concerns including operation body for inundation control and condition of inundation (e.g duration of inundation, water level, relation to cultivation calendar, the term of drainage and water quality) as well as the amount of compensation and time of payment. Unless the Government grasps these concerns in detail and the farmers' doubts are clarified, the project cannot be successful.

→ The Government on various occasions should explain the contents of the project, hear from the people concerned and answer the questions such as participation in water management or advanced announcement raised by the people;

, "Site-visit" with both official and unofficial community leaders as well as local authority officers

, "Consultation" with community leaders

, "Seminars" at the provincial level for public relations

, "Community forum" for people and related people at the area level of every district (See Remarks"4&5").

### Key points or requirements for success

- People's participation in all steps of the project from study to implementation.
- Cooperation of all concerned parties.
- Providing accurate information or public relations for people or stakeholders in all steps of the project.
- Updating and disseminating information to the stakeholders

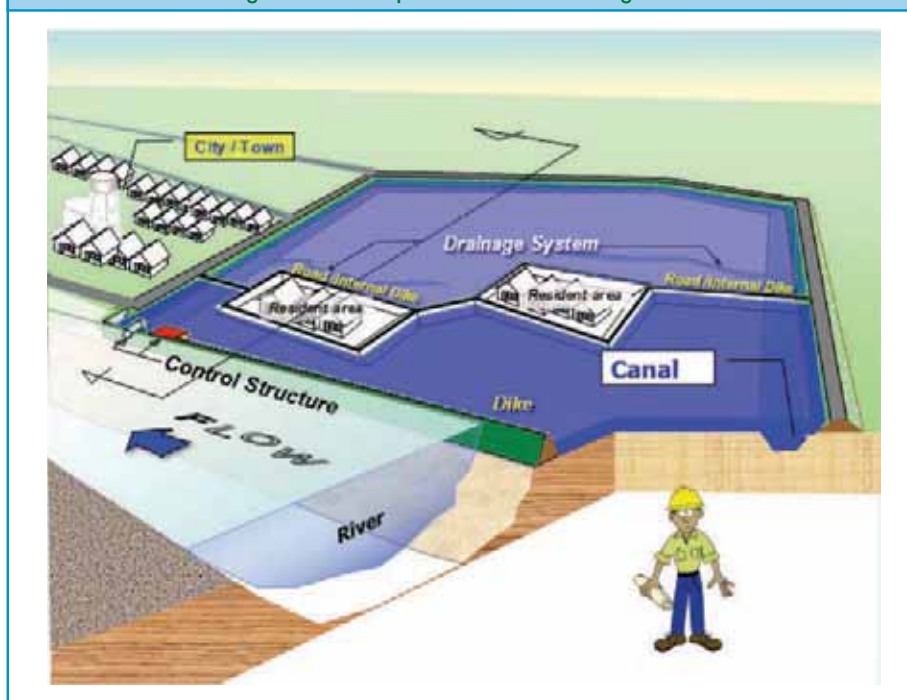
## III. Key findings from failure

Land has continuously been developed with no direction from agricultural areas to household and industrial areas. No study has been done to optimize the land use in this kind of geography. Hence, in this study, people have realized that they will receive more benefits from their lands if the projects proceed. (See Remarks"6").

Photo 1: 2011 Flood in Thailand



Figure 1: Concept for Lowland Management



## [Remarks]

### Remark 1: Pilot Project

In the case where the areas function to retain flood water, the compensation will be paid to people who live in project area (Bang Ban 1). The 5 options are stipulated by the researcher as follows.

- 1) There is no compensation to be paid.
- 2) The compensation shall be paid as prescribed by the Second Finance Ministry's regulation on advanced payment to support disaster emergency victim B.E. 2549 (2006).
- 3) The compensation is determined from the agriculture cost.
- 4) The calculated compensation from the agriculture cost combined with 50% of appropriate benefits.
- 5) The compensation shall be paid based on the income appropriately.

If the payment are to be made under items 4) and 5), the compensation shall be commensurate to the price of rice. The affected people shall receive compensation in accordance with damaged areas.

### Remark 2: The Government explanation to various concerns of the people

- People's concern 1; The Government will store water permanently and keep water higher than a studied water level.  
→ Informing People that they will participate in water management to make sure that water will be kept in the areas temporarily and won't be stored at higher than the proposed level.
- People's concern 2; When the government will begin to store water and how the project will affect their cultivation calendars.  
→ Informing people that Government must announce for using those flood retarding areas in advance and must suggest suitable crop calendars or introduce a new crop pattern for farmers.



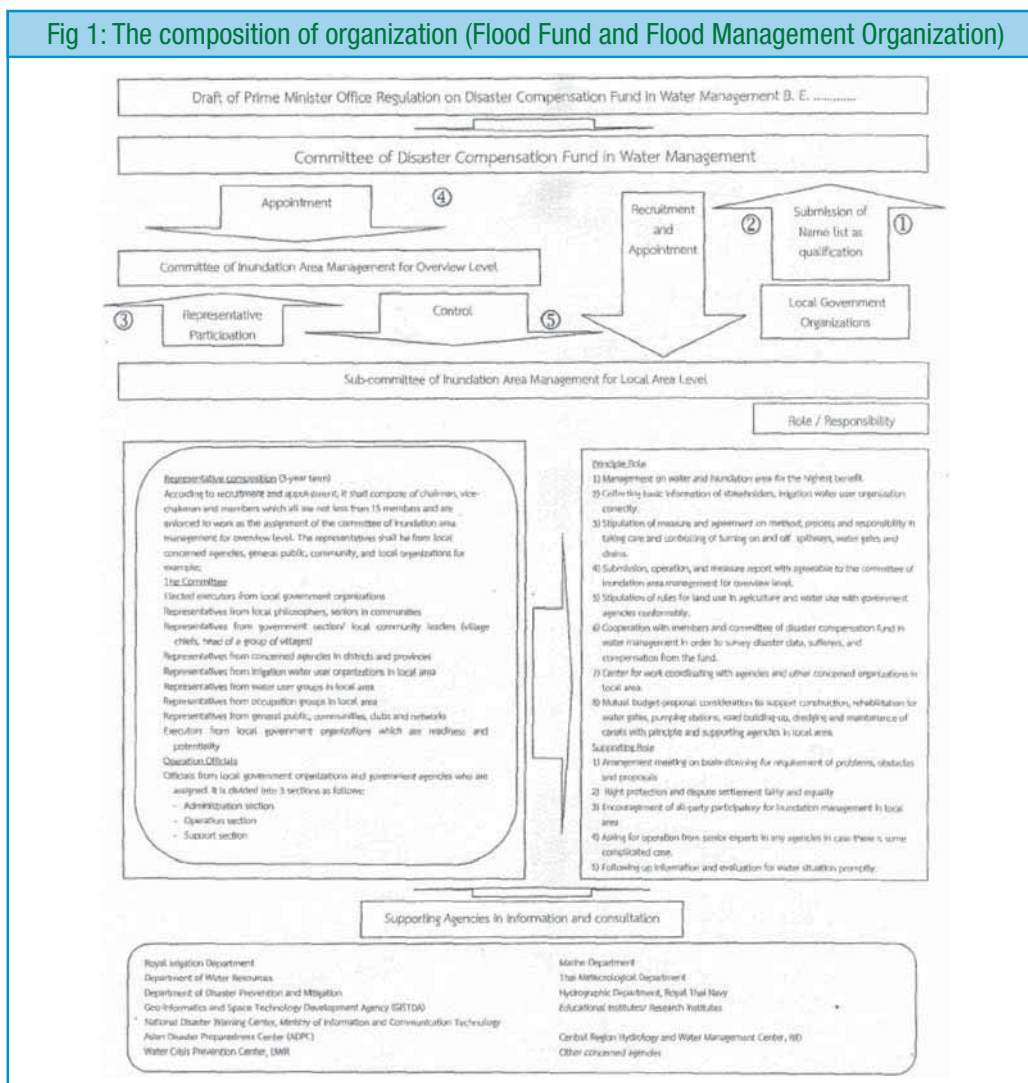
- People's concern 3; How long will be the storage of water (“Water quality” become worse if the water is stored for long duration such as two – three months in agricultural areas .
- Informing people that the stored water will be circulated or drained by pumping or gravity within a stipulated time to prevent deterioration of water quality.
- People's concern4; The amount of compensation, and time of payment.
- Informing people that it needs to issue specific laws and regulations for these projects, to identify acceptable compensation, and to appoint stakeholders’ representatives with central and rural officers in the compensation committee.

### Remark 3: Establishment of management organizations

The flood retarding area management (low land) shall attract public participation by establishing suitable organization with its objective as water and compensation management. Informing people that it needs to issue specific laws and regulations for these projects, to identify acceptable compensation, and to appoint stakeholders’ representatives with central and rural officers in the compensation committee.

To manage flood plain areas, new rules, regulations or laws shall be enacted because the existing ones do not cover project implementation. People living in the flood plain areas will participate in enacting them through flood plain management organizations.

(The composition of organization is shown in fig 1.)





## Remark 4: Method of informing people

### (a) Form of participation

All farmers participated or representatives can participate.

### (b) Method of publicity of the meetings

Method of publicity to people is undertaken by various ways as follows:

- Site visit with both official and unofficial community leaders as well as local authority officers by making an appointment for interview and group conversation as well as explanation on the project background at the monthly meeting of local and regional agencies, local media, e.g. sound linking system, local magazines for project public relations and public hearing about information, opinions, recommendations of people and different agencies at the area level. Site visits are made continuously through the study duration.
- Seminars at the provincial level for public relations about the project implementation plan to the representatives of basin, provincial, district levels and representatives of people at the district level to acknowledge the information, opinions and recommendation.
- Consultation with community leaders to inform people and representatives of concerned agencies in the study area about the progress of project development continuously, to participate in consultation for actual project development. The study team consequently selects the community leaders both official and unofficial leaders, representatives of local agencies, different groups in the community, local private organizations and knowledgeable people about irrigation system as well as experts from the locality and the study team, to join in the working group. This is the forum for the representatives of every sector to analyze, suggest and identify the problems that may occur due to the project implementation as well as the solutions related the area context condition. Consultation with the community leaders is specified for 3 intervals during the study duration.
- Community forum aims to hold the activities for people and related people at the area level of every district (38 forums) for participatory learning of project implementation, sharing opinions, recommendation as well as informing the problems that may occur in the families, community residents, so as to find their solutions.

\*Such process is for public relations and information dissemination of work performance under the project and also the forum for people and stakeholders to participate in the project development (from the project commencement), and giving recommendation for actual project development.

### (c) Percentage of participation and others

(Target of the dissemination and Response for quarry from farmers)

Target of the dissemination was local people, local organizations, district organizations, provincial organizations and central organizations so that they would all be informed of the project progress steadily.

The discussions which involved community leaders, representatives of related local government agencies and other concerned persons reveals that there are some people who disagree with the development of their land for storing excess flood. They study team then excluded such area from the plan. Impact of project development was further studied by the study team and concerned persons to find suitable solutions and be criteria used in project development plan to be further considered by concerned agencies.

## Remark 5: Method of gathering opinions and request from farmers

### (a) Hearing in the meetings

In public hearing, all suggestions were taken into consideration under rational reasons and concerned conditions. The agreements were made by consensus (not by voting); people of 34 public hearing venues

agreed with project implementation while those of 4 venues disagreed and preferred to live outside the project area. The consultant, then, modified project boundary to suit the people's need. However, those disagreeing opinions would be summarized for further solution findings, or as optional choices to reduce conflicts or negative impacts.

(b) Questionnaire

After all guidelines and elements of the project development have been found, 807 questionnaires were distributed to find the opinions of the people residing there about issues that may be the problems caused from project implementation and be database for impact assessment. These questionnaires also helped finding out the people's opinions in several aspects especially about the benefits and disadvantages of project implementation and measures that should be taken to reduce impacts. About 80% of the questionnaires showed the people's agreement with the project concept

(c) Request to each village for gathering opinions and others

People's opinions gathered from seminars, public hearings and meetings were recorded by activities and by area and be further processed, analyzed and disseminated to the public.

### **Remark 6: How to incorporate the farmers' opinions and request in the actual project**

People's opinions and requests were recorded in reports to be used as RID's guidance for project implementation. If the requests are not granted, the project may be resisted.

# Case Study Format

## Region – East Asia

### Country – China

### Lessons from actual case

#### Focused on sustainable agriculture and irrigation and drainage

Group of Case Studies: (please check one)	<input checked="" type="checkbox"/> "Science& Technology" <input type="checkbox"/> "Peoples Recognition or Social Movement" <input type="checkbox"/> "Governance" <input type="checkbox"/> "Local Practices" <input type="checkbox"/> "Others"
Field of Case Studies: (please check one)	(If you check "Science& Technology" in the Group) <input type="checkbox"/> "Strategy" <input type="checkbox"/> "Investigation" <input checked="" type="checkbox"/> "Research" <input type="checkbox"/> "Analysis" (If you check "Peoples Recognition or Social Movement" in the Group) <input type="checkbox"/> "Symposium" <input type="checkbox"/> "Media" <input type="checkbox"/> "Campaign" (If you check "Governance" in the Group) <input type="checkbox"/> "Law & Regulation" <input type="checkbox"/> "Organization" <input type="checkbox"/> "Budget" <input type="checkbox"/> "Political Will" (If you check "Local Practices" in the Group) <input type="checkbox"/> "People participation" <input type="checkbox"/> "NGO activities"
Country:	CHINA

### I. Outline of the activity

Title of Case Studies	Managing Climate Change Effect on Groundwater through Monitoring Groundwater
Implementing Organization	China Institute of Water Resources and Hydropower Research (IWHR) The Centre for Groundwater Monitoring, Ministry of Water Resources
Operating members	Researchers from pilot areas, government officials and professors
Active term of this Case Study	From June 2008 to June 2011
Contact person	Dr. Gao Zhanyi (gaozhy@iwhr.com ) Miss. Hu Yaqiong (huyq@iwhr.com)
Background	<p>Groundwater is the important water source for both drinking and irrigation in most parts of China. With the rapid economic and social development, water shortage problems arise in many regions; in particular in northern China. Competition for water is getting more and more serious among different sectors. Furthermore, climate change presents a particularly daunting challenge to local life as its impacts include more frequent and intense extreme droughts, crop failures, pollution and disease outbreaks, salinization and intrusion of seawater, and the change of species diversity. The increased scale of possible impacts creates water vulnerabilities and livelihood risks to the poor. Climate change in the last decades accelerated the situation, particularly in northern China, where groundwater is getting more and more important as a dependable water sources. (See the Figure 1)</p>

However, with the large exploration of groundwater, both groundwater quality and groundwater level are changing sharply. In Beijing and Tianjin municipalities, and Shandong, Hebei, Liaoning, Shanxi, Shaanxi and Gansu provinces, groundwater levels are continually falling due to the over exploitation. Following the heavy and improper extraction of groundwater in these regions, the groundwater is also seriously contaminated by industry waste, agricultural pesticide and fertilizers, and through mining, etc., in the recent years. Adding to the effects of climate changes, all together, these induce serious problems of safe drinking water supply and environmental sustainability in many areas.

Thus, proper actions to ease local water problems become necessary and pressing. Groundwater monitoring and analysis are the essential means and the basis of such actions.

In China, the groundwater monitoring system is developed in most regions, both groundwater level and groundwater quality are being monitored in large areas for a long time. Although a developed groundwater monitoring system is in place in large parts of China, it has limited capacities in a number of areas, including in areas of high risk to climate change. Indeed, there is an urgent need to upgrade the system. In addition, there is a critical need to increase capacity for data analysis at the local and central level and to define and enact appropriate response mechanism to safeguard water supply from affected groundwater, on which large parts of China depend.

Therefore, it is essential and urgent to implement a project providing a separate focus given to the monitoring and analysis of groundwater in selected high alert areas in arid and semi-arid regions of Northern China, the areas already affected by serious groundwater depletion and deterioration. The programme will thus build capacities to track and remedy the impacts of climate change on local groundwater resources as well as the human livelihood including women and children, and to the extend, provide demonstration and experiences to other regions thereafter.

#### **Purpose and Goal**

**Goal:** To rebuild the irrigation system of groundwater affected by climate change.

**Step 1:** Update the existing groundwater monitoring system to carry out continuous intensive monitoring of groundwater level and quality, and build capacities to track the effects of climate changes on groundwater, using monitoring data at the selected areas;

**Step 2:** Increase capacity for comprehensive data analysis, and identify appropriate remedial measures for rational groundwater management for the selected areas, such as development pattern, safe yield and recharge;

**Step 3:** Propose improved access to groundwater and safe drinking for poor, especially women and children in rural areas, through raising public awareness regarding the effects of climate change on groundwater availability for sustainable development at the selected areas, based on the groundwater monitoring and analysis.

**Step 4:** Demonstrate and recommend the outcome and experiences of the project to other regions where groundwater resources are highly depended upon and groundwater availability is greatly affected by both climate change and human activities.

#### **Present situation**

In order to achieve the goals mentioned above, the following activities have been conducted.

- Choose of pilot areas: The activities are being conducted in the high alert areas in Heibei Province, Shandong Province and Shaanxi Province. (See the Figure 2) In these three provinces, the groundwater is the major source for irrigation. Cangzhou in Heibei Province, Weihai city in Shandong Province, and Xiyan in Shaanxi Province were selected as the pilot areas, with particular emphasis on impacts of climate change on groundwater level and quality in Heibei Province, impacts of climate change on seawater intrusion in Shandong Province, and impacts of climate change on groundwater dynamics and irrigation in Shaanxi Province, respectively.
- Capacity building for groundwater monitoring through updating the existing groundwater monitoring system, field technical support of groundwater monitoring.
- Assessment of climate change on groundwater and livelihood vulnerability by using historical data in three pilot areas.
- Development of and testing of the groundwater management model.
- Holding trainings, workshops to build the capacity of three pilot areas.

### The Effect and Result

(In case the activity is ongoing one, its future plan is preferable to be filled up.)

- By implementing the project, water vulnerability is raised to the local people by capacity building. This greatly improves the local residents' knowledge and awareness of water vulnerability affected by the climate change and human activities in the pilot areas.
- By considering the impacts of climate change, the outputs of this project provide a set of integrated measures for groundwater level and quality control, which is of the utmost importance for social, economic and environmental sustainability.

By summarizing the outcomes from field investigation and modeling study recommendations and suggestions were prepared and submitted to the related policy decision-making departments.

## II. Keys for Success

### i) Integrated Approach to make initial design of activities

#### Experienced problem → How to overcome

- Definition of the existing problems:

In these three pilot areas, the groundwater is major source of irrigation, drinking and industrial water supply. The situation of water utilization, groundwater quality and groundwater depletion is complex. It is difficult to define the existing problems.

→ The project team apply integrated approach including model simulation as well as on-site investigation, questionnaires and available information review in order to identify the existing problems.

#### Key points or requirements for success

- The initial design of activities to collect Data collection with same standard is very important;
- For modeling study the boundary conditions are critical for setting up of the models

### ii) Capacity Building

#### Experienced problem → How to overcome

- Imbalanced technical capacity of technicians in different pilot areas

When project is being conducted in different pilot areas, technicians are in different technical level of groundwater monitoring, well maintenance, water sampling and storage etc.

→ The project team provides the field technical support and holds trainings and workshops for training technicians through updating the existing groundwater monitoring system, field technical support of groundwater monitoring. (See the Photo 1)

#### Key points or requirements for success

- Importance of capacity building (\*Key points)

The capacity building is one of the goals of this project. The improvement of the capacity of three pilot areas will promote the conducting of project and this is very helpful to maintain the sustainable development of three pilot areas.

- Awareness of high government to impacts of climate change on groundwater (\*requirements for success)

The outputs from this project will lead to better understanding of the sustainable groundwater management and utilization. This will facilitate policy making on sustainable measures, which may be applied to reduce the worst effects of climate change on groundwater availability.

### iii) Data Collection

Experienced Problem → How to overcome

- Difficulties to collect data.

When project is being conducted, the data collection is a big problem, especially the data relating to different sectors such as hydro-geological, meteorological, land use and water supply.

→ The project team collaborates with other sectors such as Bureau of Water Resources, Bureau of Land and Resources, Bureau of Industry and Committee of Development of Planning and Reform to acquire the data.

Key points or requirements for success

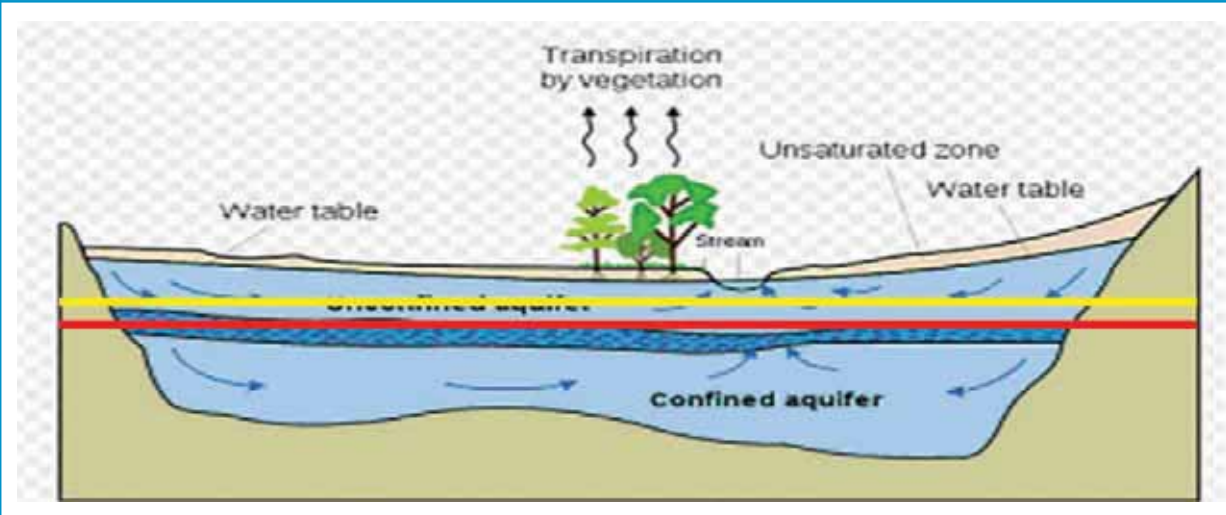
The collection of historical data from different water users and various institutions and governmental sectors is the base of the study; hence a close cooperation among stakeholders is very necessary.

### III. Key findings from failure

No specific information available.

Groundwater is strategic resources to cope with extreme draught and should be utilized and managed properly

Figure1: Policy for groundwater utilization and management



Yellow line: when groundwater level reaches yellow line, groundwater exploitation should be limited

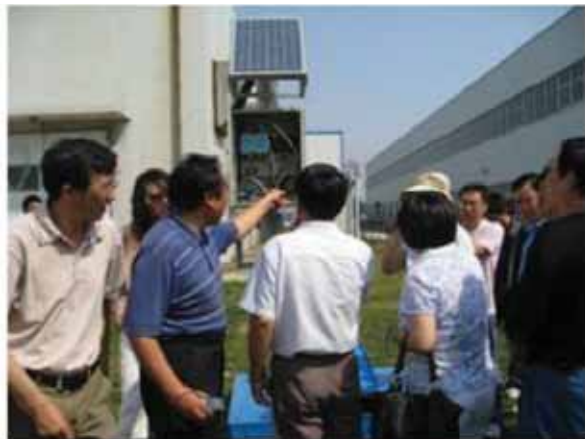
Red line: when groundwater level reaches red line, groundwater exploitation should be prohibited



Figure2: The place of activities



Photo1: Field technical support for groundwater monitoring





# Case Study Format

## Region – East Asia

### Country – Chinese Taipei

### Lessons from actual case

#### Focused on sustainable agriculture and irrigation and drainage

Group of Case Studies: (please check one)	<input checked="" type="checkbox"/> "Science& Technology" <input checked="" type="checkbox"/> "Peoples Recognition or Social Movement" <input type="checkbox"/> "Governance" <input type="checkbox"/> "Local Practices" <input type="checkbox"/> "Others"
Field of Case Studies: (please check one)	(If you check "Science& Technology" in the Group) <input type="checkbox"/> "Strategy" <input type="checkbox"/> "Investigation" <input checked="" type="checkbox"/> "Research" <input type="checkbox"/> "Analysis"  (If you check "Peoples Recognition or Social Movement" in the Group) <input type="checkbox"/> "Symposium" <input type="checkbox"/> "Media" <input checked="" type="checkbox"/> "Campaign"  (If you check "Governance" in the Group) <input type="checkbox"/> "Law & Regulation" <input type="checkbox"/> "Organization" <input type="checkbox"/> "Budget" <input type="checkbox"/> "Political Will"  (If you check "Local Practices" in the Group) <input type="checkbox"/> "People participation" <input type="checkbox"/> "NGO activities"
Country:	Chinese Taipei

### I. Outline of the activity

Title of Case Studies	Study on Paddy Fields Multi-Functionality for Sustainable Environment and Climate Change in Taiwan (Chinese Taipei)
Implementing Organization	Council of Agriculture, Agricultural Engineering Research Center, National Taiwan University, Tamkang University, Kang Ning University
Operating members	Agricultural Engineering Research Center
Active term of this Case Study	On going from 1996
Contact person	Professor Kuo Sheng Feng (kuosf@ukn.edu.tw; kuosf123@gmail.com )
Background	<p>(1) R&amp;D Project supported by COA</p> <p>Located in the Asian monsoon area, Taiwan has sufficient reasons and a long history of paddy cultivation. Due to the increasing variety of food sources and the change of agricultural policy after joining the WTO, the cultivation area of paddy rice has reduce from 659,600 ha in 1982 to 428,938 ha in 1991. The eco-environmental benefits of multifunctional roles declined significantly due to the reduction of paddy cultivation areas.</p>

Therefore, the Council of Agriculture (COA) have planned a series of basic research and education, promotion projects, integrating the capacity of local governments, agricultural groups, and academic institutes, to promote multi-functionality of paddy fields. The “Preservation of eco-environmental functions of paddy fields and groundwater recharge” project has been implemented from 1996. The total research budget have exceeded 200 million NT\$, with 55% in the ecology study, 20% extension, 19% irrigation management, 3% production function, 2% livelihood function and 1% others.

Moreover, it has been revealed that global warming and climate change would influence the type of rainfall and temperature as well as the agricultural water requirements from paddy fields. It became an important topic and challenge to effectively and efficiently use the agricultural water resource with the promotion of irrigation technique. The research team collected the agricultural climate and irrigation management data from ChaiNan irrigated area, and simulated the crop water requirement for different climate change environment by using the crop production model.

#### Purpose and Goal

Goal: To promote the paddy field preservation policy along with the change of the society and the environment through enhancing the people’s knowledge of multi-functionality of paddy fields and influence of climate change.

Step 1: To quantify and evaluate the (direct or indirect) multi-functionalities of paddy fields including the functions of soil water conservation and the amount of ground water recharge from terraced field within fifteen irrigation associations in Taiwan

Step 2: To study the effect by paddy fields including carbon-dioxide absorption and cooling effect and to analyze the influence of climate change to crop irrigation requirements and yield based on field experiment and application of AquaCrop model developed by FAO.

Step 3: To disseminate the importance of paddy fields’ multi-functionality and influence of climate change.

#### Present Situation

In the section of policy extension, activities such as the demonstration and promotion of environmental protection of paddy fields, hands-on experiences of planting paddy rice for elementary school students, photograph contest of multi-functionalities of paddy fields, and web-based digital demonstration of the roles of paddy field were implemented.

#### Effect and Result

COA has supported 93 research projects for several years, including flood mitigation evaluation, groundwater recharge assessment, evaluation of regulated micro-climate, reduction in carbon dioxide emission, and restoration of aquatic fauna in fallow paddy fields.

## II. Keys for Success

### i) Government’s support

#### Experienced problem → How to overcome

The COA came to have a sense of crisis that the reduction of paddy cultivation areas would amount to loss of the beautiful paddy field landscape and increase of adverse effects such as land subsidence actually brought about in alluvial plains in Taiwan.

Unless the various effects of multi-functionality of paddy fields have been studied and proved scientifically or numerically, it would be hard to enhance the knowledge of multi-functionality of paddy fields and to extend the understanding of roles of paddy fields to the entire society.

→ COA decided to start the “Preservation of eco-environmental functions of paddy fields and groundwater recharge “ project in 1996 and has been supporting this project. The total research budget has exceeded 200 million NT\$.

#### Key points or requirements for success

- Long term projects supported by Council of Agriculture, Taiwan

### ii) Dissemination

#### Experienced problem → How to overcome

If the research results are shared only among researchers or government officials, people would not understand the importance of multi-functionality of paddy fields and its relations to climate change. As a result, COA would face difficulties to promote paddy field protection policy in order to preserve the multi-functionalities and to cope with climate change effects.

→ COA has made efforts to transmit the research results to the people with a variety of methods. Some of the major activities were demonstration and promotion of environmental protection of paddy fields, hands-on experiences of planting paddy rice for elementary school students, photograph contest of multi-functionalities of paddy fields, and web-based digital demonstration of roles of paddy field. These activities were effective to make more people understand the ecological importance or flood mitigation role of paddy fields and its relation to climate change.

#### Key points or requirements for success

- Making different advertising methods for different target groups.
- Web pages designed especially for the children to make them understand the importance of paddy fields with a lot of simple texts and graphics
- Promotion projects, integrating the capacity of local governments, agricultural groups, and academic institutes
- Hands-on experiences of planting paddy rice for elementary school students,
- Photograph contest of multi-functionalities of paddy fields.

### III. Key findings from failure

The project is not yet completed.

#### Annex

## Study on Paddy Fields Multi-Functionality for Sustainable Environment and Climate Change in Taiwan

Ming-Hua Tsai<sup>1</sup>, Wei-Taw Lin<sup>2</sup>, Yi-Fong Ho<sup>3</sup>, Chih-Hung Tan<sup>4</sup>  
Sheng-Feng Kuo<sup>5</sup> and Liang-Wei Yang<sup>6</sup>

### Abstract

Located in the Asian monsoon area, Taiwan has sufficient reasons and a long history of paddy cultivation. Due to the increasing variety of food sources and the change of agricultural policy after joining the WTO, the cultivation area of paddy rice has been reduced from 428,938 ha in 1991 to 307,037 ha in 2002. The area has been further reduced to less than 300 thousands hectare in these two years due to water competition from urban and industrial sectors, forcing some of the paddy fields to set-aside or transform to grow upland crops. However, the paddy fields hold three different functions covering production, livelihood and eco-environmental aspects. The beneficiaries are not only the farmers but also the regional residents and the entire population. Only through well planned irrigation policies and appropriate implementations it is possible to ensure the multi-functionalities of paddy fields. In the past ten years, the eco-environmental benefits of multifunctional roles declined significantly

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6 Research Assistant, Water Resources Management and Policy Research Center of Tamkang University

due to the reduction of paddy cultivation areas. In view of this, the Irrigation and Engineering Department of the Council of Agriculture has planned a series of fundamental research and promotion projects since 1996, integrating efforts from central and local governments, agricultural organizations, and related research institutes to fulfill the objective. In the section of policy extension, activities such as the demonstration and promotion of environmental protection of paddy fields, hands-on experiences of planting paddy rice for elementary school students, photograph contest of multi-functionalities of paddy fields, and web-based digital demonstration of the three roles of paddy field are implemented. In the section of fundamental research, the flood mitigation benefits of paddy fields, the water resource fostering, the microclimate change due to paddy cultivation, and the investigation and restoration of aquatic faunal communities in fallow paddy fields are among the supported projects. Those measures are expected to enhance the knowledge of multi-functionality of paddy fields and to extend the understanding of the three roles of paddy fields to the entire society.

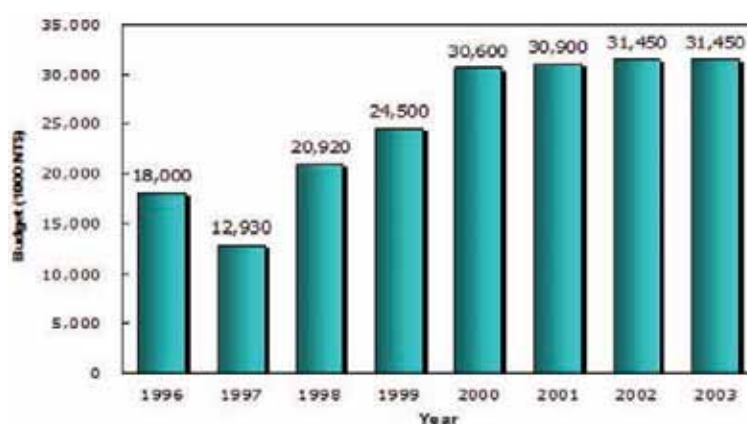
**Keywords:** Paddy field, Multi-functionality, Policy and extension.

## 1. Preface

Paddy rice has been the staple food in Taiwan for many generations. Rice production plays important role in all economics, social, political, and cultural aspects. However, along with the change of social-economic environment, the major economic activities shift from agriculture to industry or high technology production. The ratio of rice production to the GDP decreases year by year, from 27.45% in 1961 to 1.74% in 2004. The paddy cultivation areas also decrease from 659,600ha in 1982 to 237,400ha in 2004. The agricultural policy was to reduce rice production and encourage shift to other crops in 1984 and gradually shifted to promote the three aspects of agriculture-production, ecologic and livelihood in 1991.

Therefore, the Council of Agriculture (COA) has planned a series of basic research and education, promotion projects, integrating the capacity of local governments, agricultural groups, and academic institutes, to promote the multi-functionality of paddy fields. The “Preservation of eco-environmental functions of paddy fields and groundwater recharge” project has been implemented for eight years, under which there were 93 sub-projects related to ecological and environmental preservation of paddy fields and groundwater recharge of paddy fields, including evaluation of effect of flood storage, groundwater recharge function of paddy fields, data collection of irrigation management, promotion and education of eco-environmental function of paddy fields, micro-climate regulation function of paddy fields, fauna and flora change of paddy fields and so on. The total research budget have exceeded 200 million NT\$, with 55% in the ecology study, 20% extension, 19% irrigation management, 3% production function, 2% livelihood function and 1% others. The annual budget changes of eco-environmental research of paddy fields are shown in Figure 1. As we can see from the figure, the budget increased rapidly in 1998 and came to a steady state after 2000.

Figure 1: Annual budget of eco-environmental research of paddy fields.



## 2. Policy Extension

### 2.1 Ecological Conservation Education for Paddy Fields

In order to let more people understand the ecological importance of rice paddies and the meaning and value of their existence, the National 4H Club Association of R.O.C. has held lectures and visits for farmers and Farmers' Associations. It has provided lectures for farmers to realize the meaning of their work, and then has continually published books and videotapes about rice-paddy ecology conservation so as to proceed with extension education since 1997. In the following years, the 4H Club held rice-paddy experience camps, rice-paddy study achievement presentations for club members, and gradually let not only members but also all people to participate and realize the contribution of rice-paddies.

In the rice-paddy experience camps, seed-teachers were firstly selected and trained with lessons of the ecology and environment contributions of paddy fields, and then sent to various locations to demonstrate the importance of paddy fields. Figure 2 shows the seed-teachers of the rice-paddy experience camp trained in classrooms and environmental specialist explains the environment function of paddy fields (Figure 3).

Figure 2: Seed-teachers of the rice-paddy experience camp trained in classrooms.



Figure 3: Environmental specialist explains the cooling function of paddy fields to the seed-teachers.



The rice-paddy experience camp consist of not only classroom lessons but also many hands-on practices, such as explaining the use of ancient farmers' tools (Figure 4) and kids experiencing the farmers' hard works by planting paddy with bare foot standing in the muddy fields (Figure 5.)

Figure 4: Kids listened to the seed teacher explain the use of ancient farmers' tools.



Figure 5: Kids experienced paddy cultivation with bare foot standing in the muddy fields.

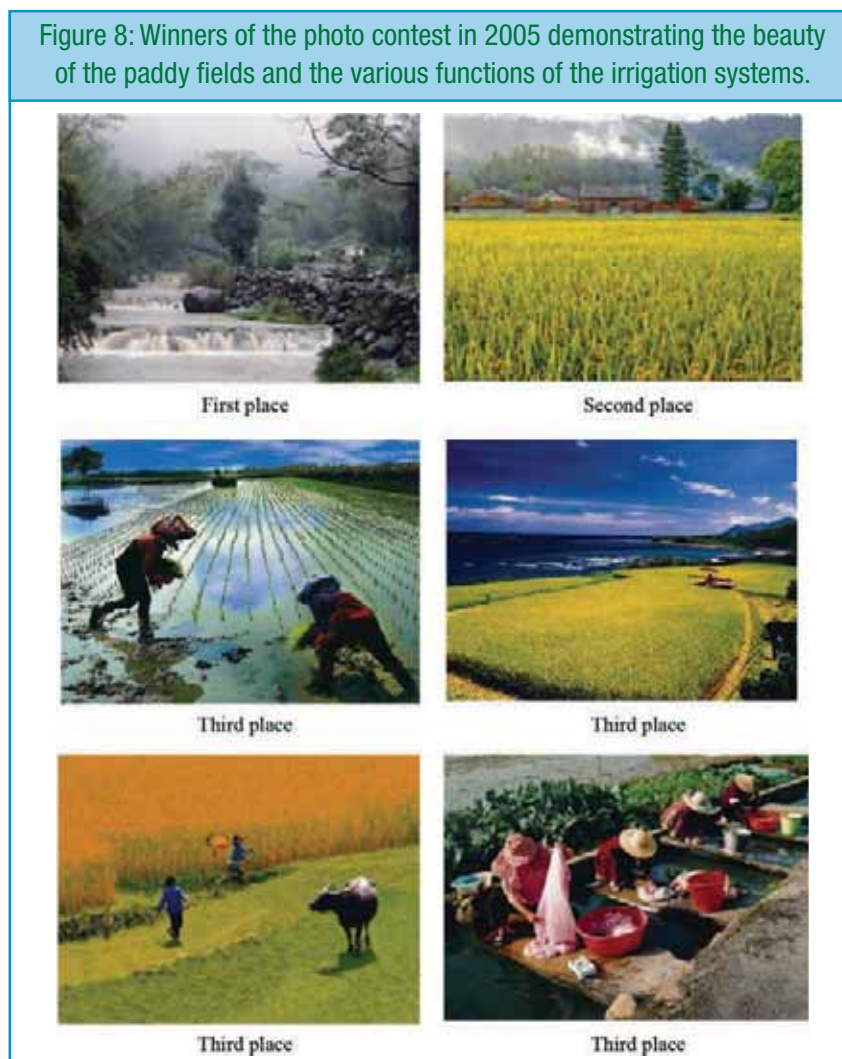




The parent and kid camp was held as overnight activity with visit to the rural areas (Figure 6). The multifunctional roles of paddy fields were explained to the family in the appropriate sites during the trip. Figure 7 shows that the irrigation association staff explained the function of irrigation systems to the participants.



In order to demonstrate the beauty and attractiveness of rural environment as well as to promote the concept of multi-functionality, a photo contest with the theme “Beauty of Paddy Fields” and “Function of Irrigation Systems” was held by the 4H club. There were 844 photos sent in the contest in 2005. Some of the award-winning photos were shown in Figure 8.



## 2.2 Demonstration of Paddy Fields Environmental Protection

In order to establish a demonstration of urban cropland and to combine the production, living and ecological functions, the COA and the city government of Taipei have set up an educative and demonstrative paddy rice field at the Guandu Plain in Northern Taiwan. The main purpose of the demonstrative paddy fields are promoting the knowledge of rice, holding activities of ecological study, and collecting ecological data of paddy fields. The activities held in 2005 including a series of “Guandu Paddy Fields Experience” activities from March to December, Tour of Environment Narration of Paddy Fields from June to December, and “Taipei Bird Watching Fair” in December.

Figure 9: Experience of paddy transplanting for kids from the city as part of the activities in the “Guandu Paddy Fields Experiences.”



Figure 10: Group of city farmers experienced the happiness of harvest in the Guandu educative and demonstrative paddy fields.



Figure 11: Kids listen to stories of paddy rice as part of activities in “Tour of Environment Narration of Paddy Fields”



Figure 12: Volunteer explaining the function of paddy fields and introducing birds and wildlife living in paddy fields and wetlands.



## 2.3 Establishment of portal site for Eco-environment of Paddy Fields

A website and knowledge database has been established to promote the significant of eco-environment functions of paddy fields. It collected and displayed the achievements of related research results, provided information and knowledge of recent developments in eco-environment studies of paddy fields, and presented educational web pages for people of all ages. The portal site has attracted more than 18,000 different visitors since 2004 as surveyed by the TWNIC.



Figure 13: Portal site of the Eco-environment of Paddy Fields features flash motion pictures to attract people.



Figure 14: News and knowledge of eco-environmental functions of paddy fields were updated regularly in the portal site.



In addition, there are web pages designed especially for the children to understand the importance of paddy fields with a lot of simple texts and graphics (Figure 15).

Figure 15: Web pages for the children feature lots of easy understanding texts and graphics.



### 3. Eco-environmental Researches

The COA has supported researches of eco-environmental functions and effect of climate change to paddy fields for several years. There were totally 93 projects completed in the past, including flood mitigation evaluation, groundwater recharge assessment, evaluation of regulate micro-climate, reduction of carbon dioxide emission, and restoration of aquatic fauna in fallow paddy fields. Some of the results are listed in the following sections.

### 3.1 Flood mitigation

The “quantitative investigation and benefit evaluation on flood mitigation effect for paddy fields” project was to quantify the contribution to flood alleviation or reduction (direct or indirect) caused by the existence of paddy fields. Based on the geographic features of Taiwan, the project analyzes and evaluates the function of flood detention for different flood intensities and land uses. The influences of paddy fields on flood detention and the temporal distributions of outlet flow rate are figured out. The research are conducted in the ChouMei county with an area of 242 ha and rapid growth of population. Through computer simulation, the research assumed several scenarios including local urbanization, and raise the height of ridge of the paddy fields, to analyze the flood outflow. It is found that paddy fields, similar to artificial wetland areas, can effectively reduce the peak discharge rate and gradually defer water movement.

Figure 16: Dimensionless runoff curve with 300 mm rainfall in the Sicuoliao drainage area. The solid black line was urbanization, blue line was paddy fields in fallow condition, dot line was raise the ridge 30 cm in the paddy fields.

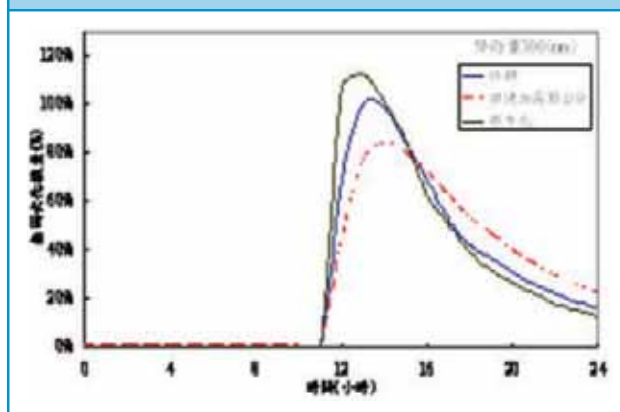
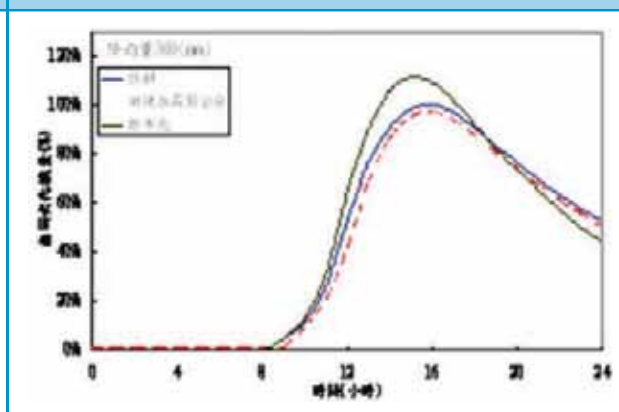


Figure 17: Dimensionless runoff curve with 300 mm rainfall in the Dayo drainage area. The solid black line was urbanization, blue line was paddy fields in fallow condition, dot line was raise the ridge 30 cm in the paddy fields.



### 3.2 Ground water recharge

A study entitled “Comprehensive Evaluation of Terraced Field to the Recharge of Groundwater and Conservation of Water and Land” which comprehensively evaluates the functions of soil water conservation and the amount of ground water recharge from terraced field. Terraced field of fifteen irrigation associations in Taiwan including Pei-Chi, Tao-Yuan, Shih-Men, Hsin-Chu, Miao-Li, Tai-Chung, Nan-Tou, Yun-Lin, Chia-Nan, Kao-Hsiung, Ping-Tung, Yi-Lan, Hua-Lien and Tai-Tung are investigated. Additionally, a three dimensional model, FEMWATER, was applied to simulate percolation and lateral seepage in the terraced fields under various conditions. In the terraced paddy fields, percolation mainly moves vertically downward in the central area, while lateral seepage occurs mainly around the bund. Although the simulated lateral seepage rate through the bund exceeded the percolation rate in the central area of the paddy field, annual subsurface return flow was only 0.39 percent to 1.69 percent of the total irrigation water required for rice growth. Terraced paddy fields have significant efficiency of ground water recharge, with 6.38 to 43.52 per cent of the total irrigation water required for rice growth. The amount of annual groundwater recharge is  $0.57 \times 10^9 \text{m}^3$  from Taiwanese terraced paddy. Based on the paddy field area, the soil infiltration properties and flooded water depth, the amount of annual ground water recharge from Taiwanese paddy field is about  $2.002 \times 10^9 \text{m}^3$ .

The study also analyzes the geographical characteristic of data from paddy field and classifies the Taiwanese paddy by a high quality yield type with area of 148,514.92 ha, a planting water type with area of 159,555.18 ha, and a upland crop type with area of 86,706.82 ha.

Figure 18: Flow direction and amount of the percolation and lateral seepage in the terraced fields near the bund as simulated by FEMWATER.

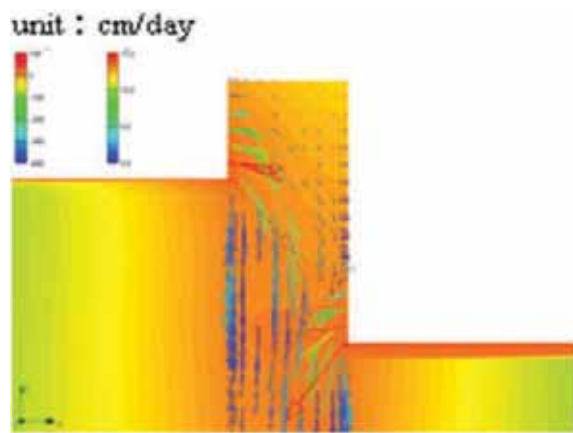
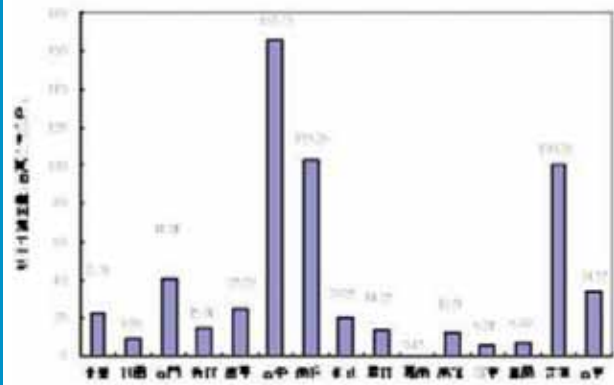


Figure 19: The amount of groundwater recharge for each of the irrigation association, unit: million m<sup>3</sup>.



### 3.3 Regulate micro-climate

A project entitled “Assessment of microclimatic impacts for paddy field eco-environment” was supported by the COA to study the carbon-dioxide absorption and cooling effect of paddy fields. The sunlit-shade microclimate model was modified to incorporate the effects of beam, diffusive, and scattered radiations, and by coupling the photosynthesis and microclimate models through the stomata resistance. The field data collected from the Hwa-tang station of Chang-hwa irrigation association were used for evaluation of the microclimate models. Results showed that the rice was more efficient in carbon-dioxide assimilation than fertilizer crops.

The research also utilized the Landsat ETM+ images to investigate the temporal and spatial variation at three developing stages of the Taiwan High Speed Rail (THSR) Chinpu station to demonstrate the impact of environmental temperature due to elimination of agricultural land. The results showed that land surface temperature was the lowest before the development of THSR in 1999 while the land cover was agriculture in the area. During the THSR development in 2002, when the agricultural lands were excavated and the area covered with bare soil, the surface temperature of THSR was 3.8C higher than its surrounding area. After the completion of THSR station in 2005, the temperature was 2.6C higher when the trees and turfs were replanted back to the area. The temperature profile and the neighborhood analysis of the region illustrated that the THSR station performed as a heat island to the vicinity, while the agricultural land absorbing the heat.

Figure 22: The development area of the THSR Chinpu station, circled by red dot, was significant in Landsat ETM+ image.

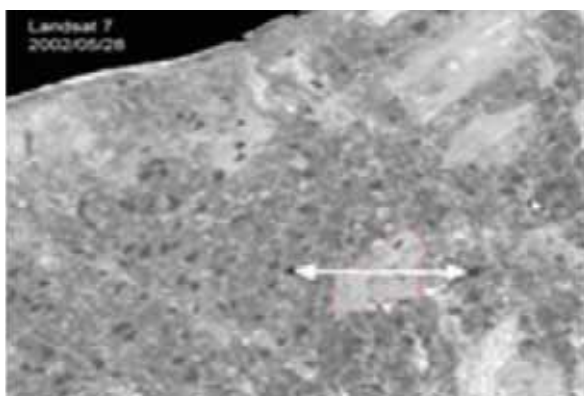


Figure 23: Temperature profile of the THSR and surroundings. The central part (THSR) of the surface temperature was notably higher than the two ends (agricultural lands).

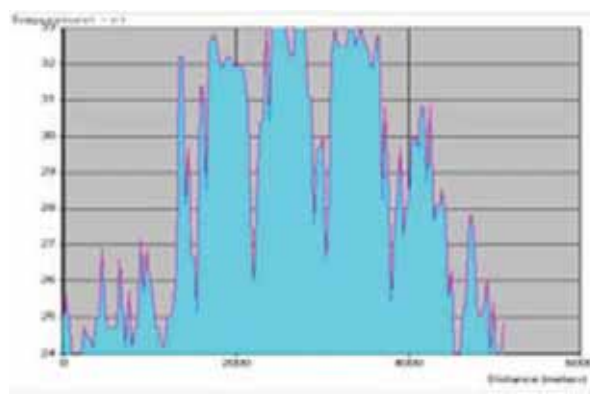




Figure 24: The neighborhood analyses choose circular areas from the THSR Chinpu station. The four lines indicate 0, 1, 2, and 4 km from the station.

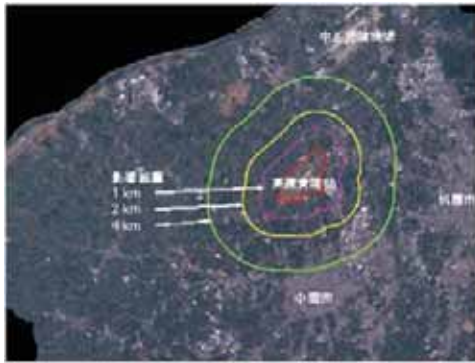
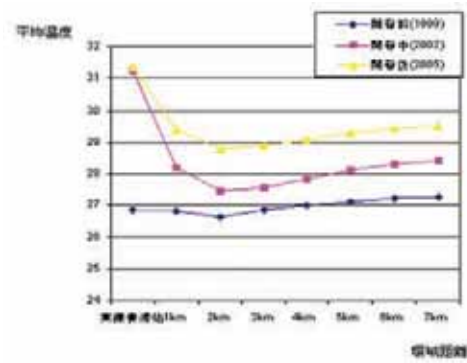


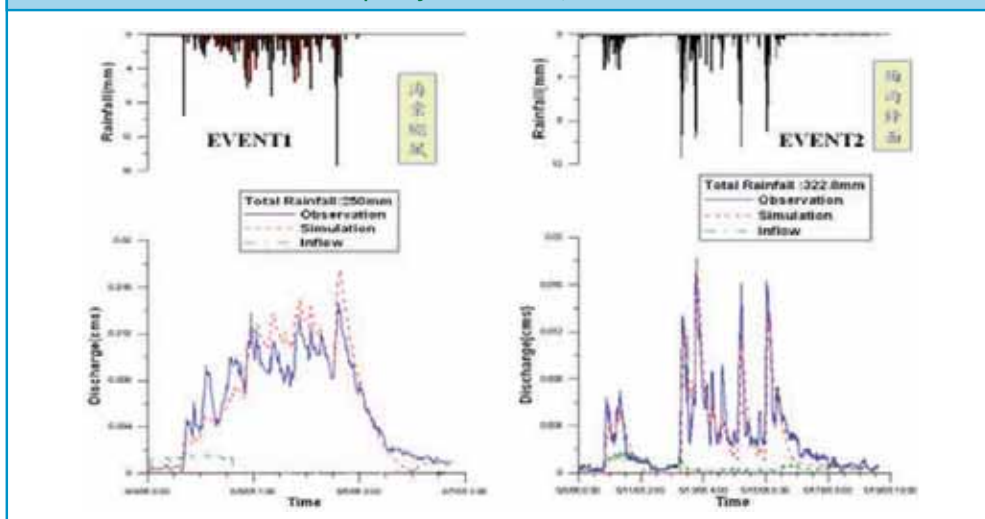
Figure 25: Surface temperature change as the distance from the THSR increase. In the figure, blue line indicated temperature before development, purple line during development, and yellow line after development.



### 3.4 Soil conservation

In order to understand the soil and water conservation in the terraced rice field under fallow and alternative upland cropping pattern, a research project was supported by the COA to assess the effect of terraced field. The experiment site is a steep terraced rice field and surrounding fields under alternative upland cropping pattern, including fruit farm, vegetables and miscellaneous crops, and fallow land covered with green manure, located in Hsin-pu, Hsin-chu County. According to the results of infiltration tests, the terraced rice fields under fallow/alternative upland cropping pattern increased infiltration rate, among which the digging furrows were the most significant factor to increase infiltration rate. The observed values of rainfall-runoff and suspended solid during two crop seasons were used to estimate the annual erosion quantity of steep terraced rice fields. The results showed that the steep terraced rice fields had an erosion quantity of 0.77 ton/ha/yr, which is much lower than the average of the steep fruit farm, beetle nuts farm or the cultivated tea plantation. In addition, the tank rainfall-runoff model was also built to simulate the change of outlet runoff, under the conditions that the height of bund and outlet reduced or demolished due to the lack of maintenance or fallow. The results showed the simulated downstream flow underwent significant change when the height of bund decreased by 40%. In case of the complete demolition of bund, the peak flow will increase to more than 5 times. Therefore, the maintenance of farming practice in terraced rice fields is important to keep water storage capability and reduce flood pressure downstream.

Figure 26: Observed and simulated results of runoff curves with a strong rainfall (HaiTang typhoon) and a low intensity rainfall. Red line represents simulation with the bund of terraced rice paddy demolished, while blue line is with bund.



### 3.5 Crop water requirements

Global warming and climate change will influence the type of rainfall and temperature as well as the agricultural water requirements for paddy fields. The reservoirs' storage is currently inadequate to irrigate the first paddy field in southern Taiwan. Therefore, it is an important topic and challenge to effectively and efficiently use the agricultural water resource with the promotion of irrigation technique. The research executed field experiment for paddy fields with different methods in the HsuehChia Experiment Station of ChaiNan Irrigation Association as shown in Figure 27. Table 1 show that the irrigation water requirements for 4 day, 7 day and 10 day irrigation interval was 1083 mm, 830 mm and 665 mm, respectively. Furthermore, the crop yields for 4 day, 7 day and 10 day irrigation interval was 7620 kg/ha, 6918 kg/ha and 5313 kg/ha.

The research collected the agricultural climate and irrigation management data from ChaiNan irrigated area, established database by evapotranspiration model of ETo calculator; furthermore, the crop production model of AquaCrop, developed by Food and Agricultural Organization, was used to simulate the crop water requirement for different climate change environment, as shown in Figures 28 and 29.

**Table 1: Comparison of irrigation water requirements and yields with three different irrigation intervals for first paddy field in Taiwan**

Irrigation interval \ Items	Irrigation Region I (mm)	Irrigation Region II (mm)	Irrigation Average (mm)	Crop Production (kg/ha)
4 day	1083	--	1083	7620
7 day	810	850	830	6918
10 day	660	670	665	5313

**Figure 27: Field experiment for paddy fields in HsuehChia Experiment Station of ChaiNan Irrigation Association**

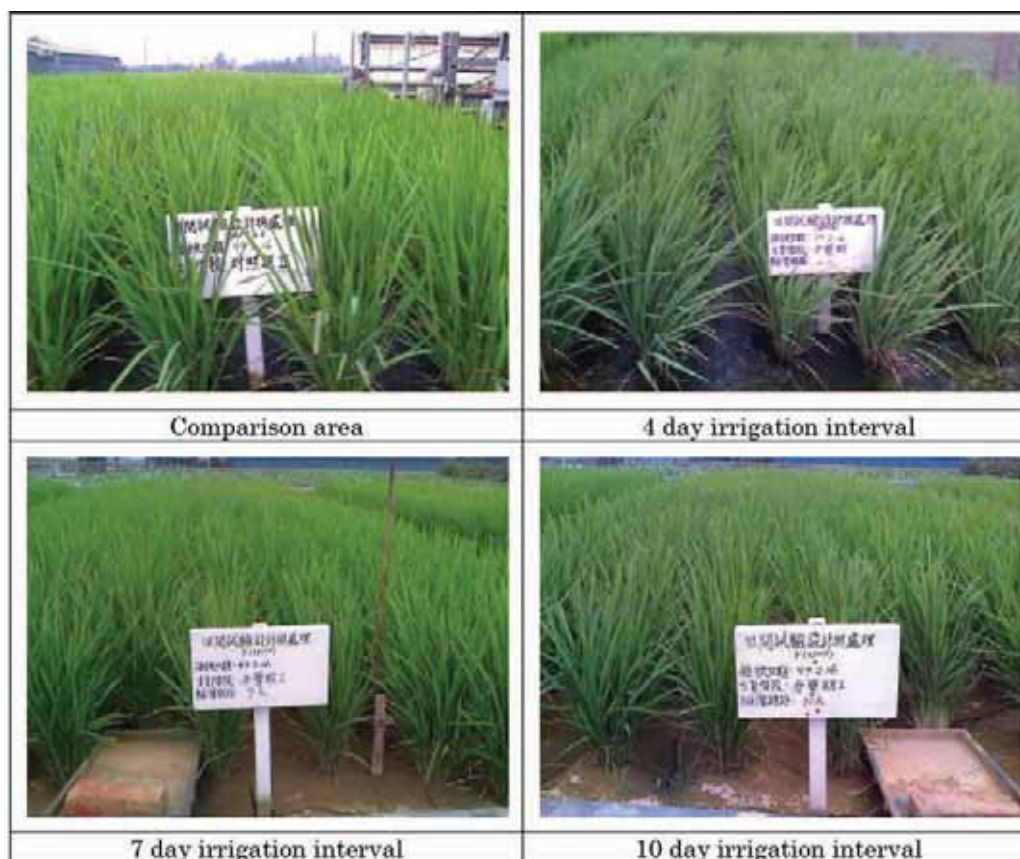


Figure 28: Implemented of ETo and AquaCrop models to evaluate crop water requirements with climate change environment for paddy fields in Taiwan

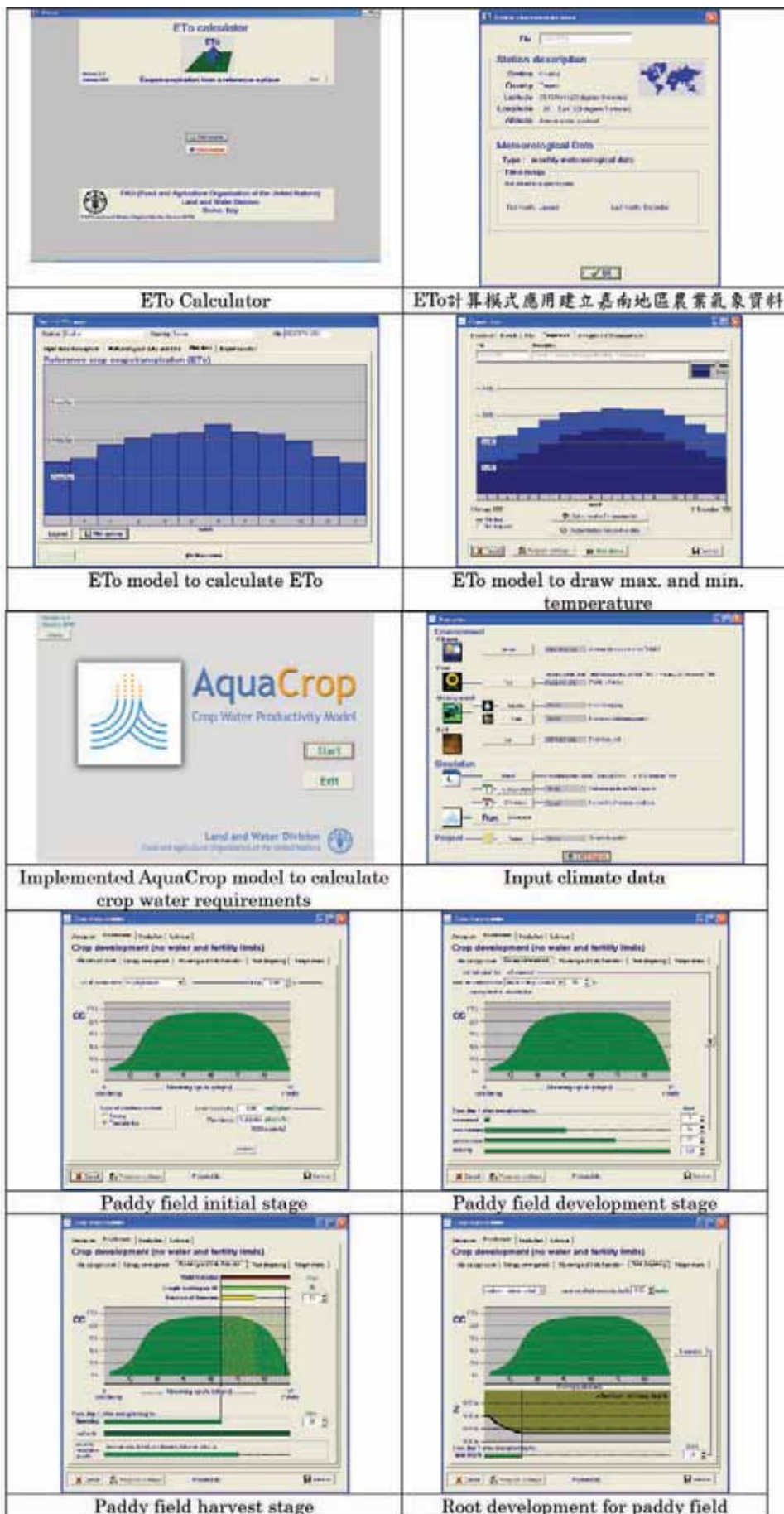
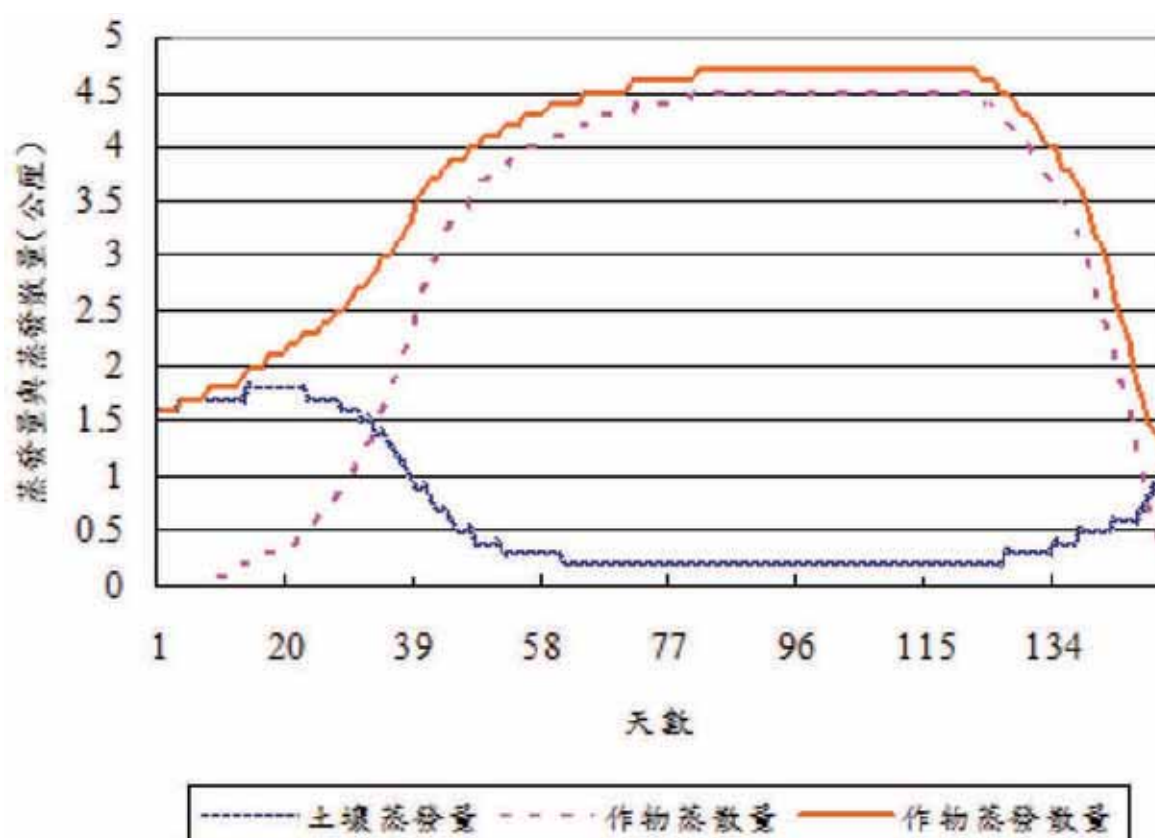


Figure 29: AquaCrop model to estimate the soil evaporation, crop evaporation and evapotranspiration for first paddy field in Taiwan



## 4. Conclusions and Recommendations

The fundamental researches of the bio-environmental functions of paddy fields have shown that the existence of paddy fields is extremely important to our living environment. Those functions have worked silently for thousands of years since our ancestors started rice cultivation. Even though it seems that the only function of paddy fields is to produce rice, the COA believes that it's our responsibility to educate people and the next generation to understand the contribution of paddy fields and the wisdom of our ancestors. Hence, the promotional and educational schemes of the multi-functionalities and contributions of paddy fields should be sustained.

There is a strong and inevitable trend that the paddy fields are decreasing or transferred to other usages due to the low-priced imported rice, which greatly impacted our rice market after joining to the WTO in recent years. However, the impact to the ecology, environment and the rural society should be kept to a minimum level. Therefore, the COA has set up policies to encourage farmers to keep the functions of paddy field even they don't grow rice. For example, the paddy fields can be transferred to grow aquatic plants in order to keep water in the environment. The lotus, water lily farm and water chestnut (*Trapa natans* L.) farms are some of successful examples. They not only keep the water resources fostering and climate regulation function as the paddy farms, but also attract people to the farms in weekends, providing another function of the paddy fields. As the domestic and international circumstances change, the paddy fields play more and more roles in our life. Hence the paddy field preservation policy should be adjusted along with the change of the society and the environment.



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# Case Study Format

## Region – East Asia

### Country – Japan (1)

## Annexure

# 13

### Lessons from actual case

#### Focused on sustainable agriculture and irrigation and drainage

Group of Case Studies: (please check one)	<input checked="" type="checkbox"/> "Science& Technology" <input type="checkbox"/> "Peoples Recognition or Social Movement" <input type="checkbox"/> "Governance" <input type="checkbox"/> "Local Practices" <input type="checkbox"/> "Others"
Field of Case Studies: (please check one)	(If you check "Science& Technology" in the Group) <input checked="" type="checkbox"/> "Strategy" <input type="checkbox"/> "Investigation" <input type="checkbox"/> "Research" <input type="checkbox"/> "Analysis" (If you check "Peoples Recognition or Social Movement" in the Group) <input type="checkbox"/> "Symposium" <input type="checkbox"/> "Media" <input type="checkbox"/> "Campaign" (If you check "Governance" in the Group) <input type="checkbox"/> "Law & Regulation" <input type="checkbox"/> "Organization" <input type="checkbox"/> "Budget" <input type="checkbox"/> "Political Will" (If you check "Local Practices" in the Group) <input type="checkbox"/> "People participation" <input type="checkbox"/> "NGO activities"
Country:	JAPAN

### I. Outline of the activity

Title of Case Studies	Formulation of strategy for enhancing research related to global environment established
Implementing Organization	The Japanese Society of Irrigation, Drainage and Rural Engineering(JSIDRE)
Operating members	The special committee constituted consisting of researchers, government officials and professors
Active term of this Case Study	On going from 2008
Contact person	Dr. Tsugihiko WATANABE (nabe@chikyu.ac.jp ) Dr. Takao MASUMOTO (masumoto@affrc.go.jp)
Background	<p>Recently many members of the Japanese Society of Irrigation, Drainage and Rural Engineering (JSIDRE) have shown interest in global environmental issues. They strongly believe that irrigation, drainage and rural engineering approaches have good scope of contribution for improving the global environment. These approaches, however, are yet to be integrated in Japan.</p> <p>The G8 Hokkaido Toyako Summit was held in Japan in 2008 to discuss the global issues such as global warming. Additionally, the year of 2008 was the starting year of commitments to reduce green house gas emissions under Kyoto Protocol to the United Nations Framework Convention on Climate Change.</p> <p>The Aich-Nagoya COP10 Promotion Committee was established in 2008. The 10th Conference of the Parties to the Convention on Biological Diversity (COP10) was held in October 2010 in Japan.</p> <p>In 2008, JSIDRE started reviewing the present situation and discussing how to coordinate irrigation, drainage and rural engineering approaches for addressing environmental issues in Japan.</p>

<p><b>Purpose and Goal</b></p> <p><b>Goal:</b> To work out a research strategy to cope with global environment issue so that the resources of human and budget of JSIDRE is utilized effectively.</p> <p><b>Step 1:</b> To review the present situation of irrigation, drainage and rural engineering researches concerning global environmental issue in Japan.</p> <p><b>Step 2:</b> To understand specific problem and theme of global environment to be tackled by the field of irrigation, drainage, and rural engineers</p> <p><b>Step 3:</b> To sort out and prioritize research themes to be tackled by JSIDRE.</p>
<p><b>Present situation</b></p> <p>In order to promote researches relating to global environment effectively, JSIDRE, which consists of researchers, engineers and related persons concerning rural development, set up the committee to promote researches on global environment in September 2008.</p> <p>The committee examined and summarized the present situation of researches on global environmental issues in the field of irrigation, drainage and rural engineering.</p> <p>The committee reported to JSIDRE members their progress on the occasion of their annual meeting.</p>
<p><b>Effect and Result</b></p> <p>(In case the activity is ongoing one, its future plan is preferable to be filled up.)</p> <p>As a result of the review, the committee categorized all the issues into 7 fields, 30 themes and 74 sub-themes, from which the committee has chosen 15 special sub- themes as the urgent issues.</p> <p>JSIDRE disseminates the importance of global environmental issue under the field of irrigation, drainage and rural engineering widely to society and citizen through their activities. A special issue for global environment was organized and published in the issue (Vol.78, No.1, 2010) of Journal of JSIDRE.</p>

## II. Keys for Success

### i) Initial design of activities

<p><b>Experienced problem → How to overcome</b></p> <p><b>At first:</b> Irrigation and Drainage, Agricultural environment, Land and water resources utilization, Rural engineering, Hydrology, Water and food</p> <p><b>Addition:</b> Ecological engineering</p> <ul style="list-style-type: none"> <li>■ Imbalanced proportion regarding field of specialization</li> </ul> <p>When it comes to the level of summarizing and examining the issue of global environment synthetically, the committee needed members who have wider specialization.</p> <p>→ The committee chose additional members of ecologist and social scientist.</p> <ul style="list-style-type: none"> <li>■ The method for setting of 7 fields:</li> </ul> <p>Because core members of the committee are researchers, it was difficult for the committee to recognize perspectives for global environmental issue</p> <p>→ The JSIDRE decided to extend duration of committee's activity for 1 year and try to include more opinions from professors or government officials to reconsider the 7 fields categorizing a large number of issues by the committee.</p>
<p><b>Key points or requirements for success</b></p> <ul style="list-style-type: none"> <li>■ Flexibility of administration in the committee</li> </ul> <p>Members of the committee need to be consisted of various special fields person from government officials, professors and researchers. But, the committee should be started for making main framework of the activities by the small core member to converge. And after deciding the main framework, the committee adjusted the member according to the necessity.</p> <p>That is to say, because the board of committee is flexible, the committee can adjust the member according to its felt need.</p>

## ii) Dissemination

### Experienced problem → How to overcome

- Low knowledge level of the JSIDRE members about the activity:

The activities of the committee need to be known to the JSIDRE members to enhance the consciousness of the issue.

But JSIDRE members did not have many chances to easily comprehend the activities of this committee.

→ The committee made presentation of its past achievements to JSIDRE members on the occasion of an annual JSIDRE meeting (2009) to apprise the JSIDRE members. It also planned and published a special issue (78(1), 2010) in the Journal of JSIDRE, which included an article of a round table talk by the committee members.

### Key points or requirements for success

- Effective use of existing system

JSIDRE hold annual meeting every year and issue the magazine regularly to inform some news to JSIDRE members as the existing system.

So, the committee could use that tool to inform the activities of the committee effectively to the JSIDRE member.

It can also avoid the special effort and expenditure by using the existing system.

## III. Key findings from failure

No specific information are yet available, as the project is not completed.

# Case Study Format

## Region – East Asia

### Country – Japan (2)

## Lessons from actual case

### Focused on sustainable agriculture and irrigation and drainage

Group of Case Studies: (please check one)	<input checked="" type="checkbox"/> "Science& Technology" <input type="checkbox"/> "Peoples Recognition or Social Movement" <input type="checkbox"/> "Governance" <input type="checkbox"/> "Local Practices" <input type="checkbox"/> "Others"
Field of Case Studies: (please check one)	(If you check "Science& Technology" in the Group) <input type="checkbox"/> "Strategy" <input type="checkbox"/> "Investigation" <input checked="" type="checkbox"/> "Research" <input type="checkbox"/> "Analysis" (If you check "Peoples Recognition or Social Movement" in the Group) <input type="checkbox"/> "Symposium" <input type="checkbox"/> "Media" <input type="checkbox"/> "Campaign" (If you check "Governance" in the Group) <input type="checkbox"/> "Law & Regulation" <input type="checkbox"/> "Organization" <input type="checkbox"/> "Budget" <input type="checkbox"/> "Political Will" (If you check "Local Practices" in the Group) <input type="checkbox"/> "People participation" <input type="checkbox"/> "NGO activities"
Country:	JAPAN

## I. Outline of the activity

Title of Case Studies	Impact assessment of climate change on agriculture water use in Mekong River Basin and Seki River Basin (Japan)
Implementing Organization	National Institute for Rural Engineering (NIRE)
Operating members	Researchers of National Institute for Rural Engineering
Active term of this Case Study	On going from 2002
Contact person	Dr. Takao MASUMOTO (masumoto@affrc.go.jp)
<b>Background</b> (1) R&D Project supported by MEXT ("Kyousei Projects") After publication of the IPCC third assessment report in 2002, the various projects contributing fourth assessment report were promoted by government agencies, especially the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in Japan. The government of Japan positioned the global environmental issues as one of the highest priority areas, the MEXT promoted "Kyousei Projects (Symbiosis among human, nature, and globe)", which included the study on development of the model of upland water circulation in Monsoon Asia Region. (2) R&D Project under CSTP initiative (Global water circulation changes) The government of Japan established Council for Science and Technology Policy (CSTP) under the Cabinet Office in 2002. CSTP promoted various researches in four priority fields, e.g., Life-Science, Information and Communications Technology, Environmental Science, Nanotechnology & Materials under the 2nd Science and Technology Basic Plan.	

In the field of Environmental Science, researches concerning global water circulation changes attract high priority.

(3) R&D Project supported by MAFF

After publication of IPCC fourth assessment report in 2007, Ministry of Agriculture, Forestry, and Fisheries (MAFF) formulated "MAFF Comprehensive Strategy on Global Warming".

Bureau of Rural Development also considered how to adapt development and maintenance of irrigation and drainage facilities to the impact of global warming in 2007.

Dr. Masumoto, as a member of some research groups, promoted "Impact assessment of climate change on agricultural water use in Mekong River Basin and Seki River Basin in Japan through those R&D projects mentioned above.

#### Purpose and Goal

**Goal:** Quantitative Assessment of the Impact of Global Warming on Water Circulation and Food Production through the distributed model in large river basin and small river basin in Monsoon Asia Region

**Step 1:** Development of a distributed water circulation model under the condition of a variety of paddy water use in Mekong River Basin (See Figure1)

**Step 2:** Development of AFFRC Water – Food Model for evaluating the impact of water circulation change on food production

**Step 3:** Development of a water circulation model in the Seki River Basin, (See Figure2) where irrigation and drainage facilities were highly developed, based on the model in Mekong River Basin

#### Effect and Result

(In case the activity is ongoing one, its future plan is preferable to be filled up.)

This Distributed Water Circulation Model can evaluate various elements including cultivated paddy area, intake water volume, soil moisture content, and so on at any place in the basin and at any time in the past and the future.

The model in Mekong River Basin enables assessment of the impact to food production quantitatively in paddy cultivating area, instead of the model for upland crop area developed by western countries in the past.

Pursat river basin (in Cambodia)- branch of Mekong River (See the Figure3): In dry season, the water flow will be decreased to less than the current situation. In rainy season, the gap between the maximum and the minimum flow will be increased.

The model in Seki River Basin enables assessment of the impact to food production in the small river basin and highly developed irrigation area, whereas the model in the Mekong River Basin is used for the assessment in the large river basin and rainfed paddy area.

Seki River Basin: The snowmelt runoff volume in April and May will be decreased, caused by earlier snow melting, although paddy needs much water at the initial growing stage in Japan in April and May.

NIRE has already been applying the model developed for the Seki River Basin to other basins (336) in Japan.

## II. Keys for Success

### i) Importance of human network

#### Experienced problem → How to overcome

(1) Data collection

In the case of data collection in Cambodia, meteorological and hydrological data from 1970s to 1990s did not exist due to political reason.

→ Dr. Masumoto collected meteorological and hydrological data by observing them at several locations for some duration.

In some countries, funding support is needed to purchase hydrological and meteorological data.

→ He collected those data under R&D projects supported by MAFF and other institutes concerned. He also collected them effectively with the support of Mekong River Committee (MRC)

In Japan, data format of Water and Soil Data Base was not suited to that required by the model in Seki River Basin. Therefore, conversion from the data format of Water and Soil Data Base to the model was needed.

→ He outsourced data conversion under the R&D projects supported by MAFF and other research institutes concerned

(2) Huge volume of data

The meteorological data for simulation is huge in volume.

→ He treated the huge volume of data efficiently with the support from the Meteorological Research Institute (Japan) and by outsourcing under R&D projects supported by MAFF and other institutes in order to extract meteorological data for some duration for the simulation of the impact of global warming.

**Key points or requirements for success**

**“Establishment of Human Network”**

Dr. Masumoto visited MRC between 1999 and 2001, just before starting the above research and development projects. He established good human network during his visits through his activities there. He promoted his R&D projects effectively and smoothly under the human network in MRC, which he established during his visits.

Before starting the above R&D projects, he was also in charge of several R&D projects supported by MAFF and research institutes concerned in Japan. He developed human network through those R&D projects.

## ii) Originality

**Experienced problem → How to overcome**

When the model was developed for the Seki River basin in Japan, it was planned to apply it to other 335 river basins all over Japan, in order to make a national map for climate change assessment on agricultural water use and its facilities. To make use of existing information regarding irrigation facilities and to make calculation simpler, some changes of the original model were needed.

→ Some modifications were introduced, such as the reduction of model cell resolution from 1km for the Seki River Basin to 5km for all the Basins after checking accuracy of the larger cell scale. In addition, the digitalization of the important data was done because there was difficulty in this, as the information on irrigated areas and irrigation facilities (“GIS Suido-Zukan” in Japanese) was not fully digitized yet.

**Key points or requirements for success**

**“Originality”**

It was essential for NIRE to have their original distributed water circulation model. Although it took several years to develop the original model, they could apply easily their model to make various assessments concerning agriculture and water. As a consequence, they got several R&D projects continuously by using their original model.

## iii) Government's support

**Experienced problem → How to overcome**

Our basic target for research funds would be the support from MAFF (Ministry of Agriculture, Forestry and Fisheries). However, in order to undertake the wide range of research, we also had to find other research fund sources.

→ We applied for Grant-in-Aid for Scientific Research (KAKENHI in Japanese) by JSPS (Japan Science for the Promotion of Science) supervised by MEXT (Ministry of Education, Culture, Sports, Science & Technology), by presenting the preceding outcomes and the importance of further development of the research. We also kept cooperation with the bureau concerned in MAFF and constantly gave feedback of the research outcomes to the bureau.

**Key points or requirements for success**

**“Long term projects supported by Japanese Government”**

The long term R&D projects supported by government of Japan secure continuous activities of NIRE, although it takes long time to develop their original model at their initial stage.

## III. Key findings from failure

No specific information are yet available, as the project is not completed.



Figure 1: Structure of a Distributed Water Circulation Model

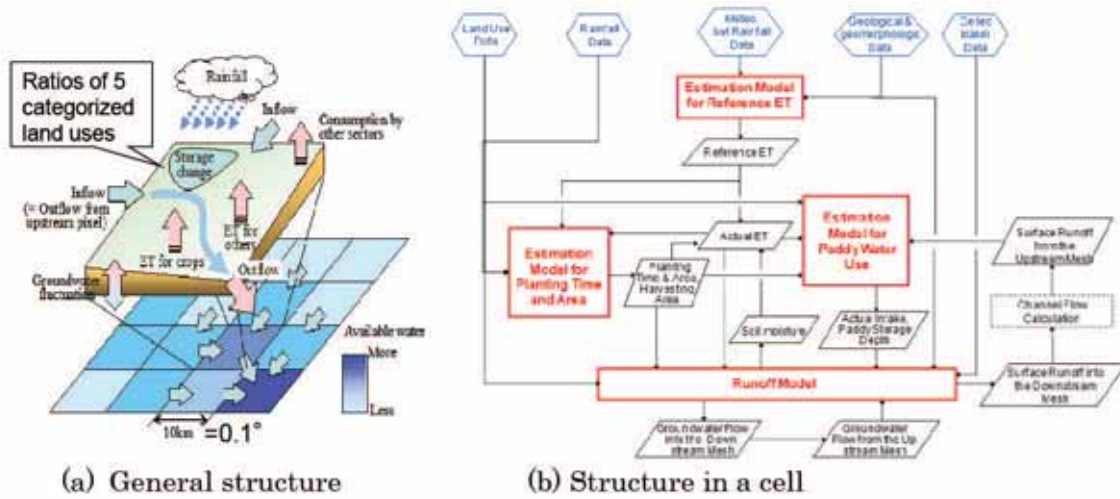


Figure 2: Seki River Basin in Japan

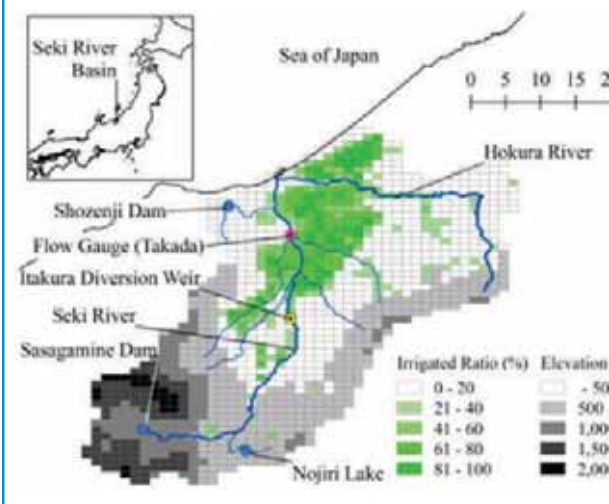
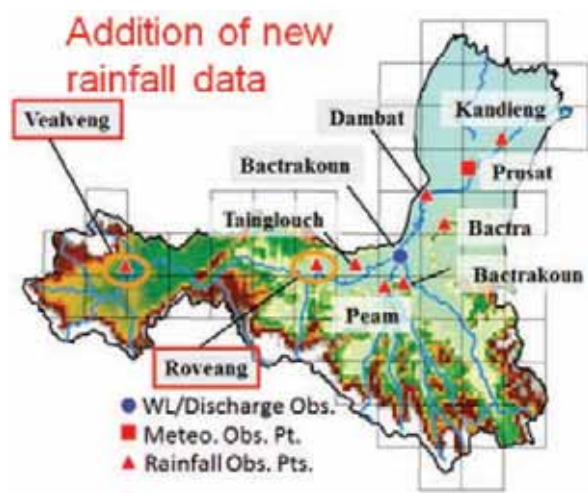


Figure 3: Pursat River Basin in Cambodia



# Case Study Format

## Region – East Asia

### Country – Korea

## Lessons from actual case

### Focused on sustainable agriculture and irrigation and drainage

Group of Case Studies: (please check one)	<input checked="" type="checkbox"/> "Science& Technology" <input type="checkbox"/> "Peoples Recognition or Social Movement" <input checked="" type="checkbox"/> "Governance" <input type="checkbox"/> "Local Practices" <input type="checkbox"/> "Others"
Field of Case Studies: (please check one)	(If you check "Science& Technology" in the Group) <input checked="" type="checkbox"/> "Strategy" <input type="checkbox"/> "Investigation" <input checked="" type="checkbox"/> "Research" <input type="checkbox"/> "Analysis"  (If you check "Peoples Recognition or Social Movement" in the Group) <input type="checkbox"/> "Symposium" <input type="checkbox"/> "Media" <input type="checkbox"/> "Campaign"  (If you check "Governance" in the Group) <input type="checkbox"/> "Law & Regulation" <input type="checkbox"/> "Organization" <input type="checkbox"/> "Budget" <input checked="" type="checkbox"/> "Political Will"  (If you check "Local Practices" in the Group) <input type="checkbox"/> "People participation" <input type="checkbox"/> "NGO activities"
Country:	Korea

## I. Outline of the activity

Title of Case Studies	Design criteria for emergency spillway to cope with extreme flood in the irrigation dam
Implementing Organization	Ministry of Agriculture, Forestry, and Fishery (MAFF) The Korean Society of Agricultural Engineers (KSAE)
Operating members	Special research committee consisting of researchers, government officials and professors
Active term	From 2002 to 2003
Contact person	Dr. Tai-Cheol Kim (dawast@cnu.ac.kr)
Background	<p>Lots of dam and reservoir have been constructed to efficiently manage water resources with a view to reducing flood and drought damages. Analysis revealed that dam inflow increased after the 1990s, but most of the inflow was concentrated during the August flooding period, which actually added to the difficulties of flood control. As a result of assessments of water resources based on the IPCC SRES A2 Scenario, it was viewed that evapotranspiration would increase with increased annual precipitation and temperatures rising by up to 4.50C. Consequently, annual outflow would decrease, and the decrease in outflow at the southern areas would be relatively high in comparison with the northern areas. It showed that there would be a general decrease in outflow during the spring and summer season, while the outflow in the autumn and winter season would increase due to the increase in precipitation. (See the Figure 1)</p>

However this rainfall pattern is often disturbed by heavy storms mainly caused by typhoon. Actually, we experienced such heavy storms mainly caused by the typhoon Rusa from Aug.4 to Sept.1 and serious flood damages like collapse of embankment and spillway occurred on earth-fill dams in 2002. On the 31st August 2002, the 24 - hour rainfall reached 870.5mm (and 100.5mm/hr) which corresponds to the level of Probable Maximum Precipitation (PMP) in Gang-reung area. This 24-hour rainfall is 2.24 times higher than the present design criterion of 200 years frequency rainfall of 388.4mm.

Such heavy storms and floods were believed to have occurred due to climate change.

Most of people watching the drastic condition of 0.5m freeboard of embankment in TV on Aug. 31, 2002 in the Sung-ju dam were so scared that social consensus on the government's strategy was formed, even though huge amount of financial budget is required.

Therefore, in 2002, Ministry of Agriculture, Forestry, and Fishery (MAFF) decided to established necessary countermeasures to cope with the dam safety (See Remark 1)

#### Purpose and Goal

**Goal:** To take necessary measures to irrigation dams in order to keep them safe in the event of extreme floods.

**Phase 1:** To define the design criterion for earth-fill irrigation dam to be safe from the extreme flood like flood event on 31st Aug. 2002 in Gang-reung area.

**Step 1:** To organize the special research committee consisting of researchers, and government officials and professors. Dr. Tai-Cheol Kim was appointed as chairman of the committee and he selected 10 professionals and 14 reviewers.

**Step 2:** To review the situations of design criterion and its problems.

**Step 3:** To define new design criterion applicable to the emergency spillway irrigation of irrigation dam and to be safe from the extreme flood.

**Phase 2:** To apply the new design criterion to the existing and new irrigation dams in an appropriate manner

**Step 1:** To make engineers understand the new design criterion.

**Step 2:** To select existing dams necessary for improvement according to the new design criterion.

**Step 3:** To improve the existing dams and to construct the new dams according to the new design criterion.

#### Present situation

1. The design criterion of Probable Maximum Flood (PMF) was enacted by MAFF.

2. Design criterion for Earth-fill dam and reservoir was published by MAFF.

Manual of flood design for Earth-fill dam published by KRC.

3. According to new design criterion, rebuilding of emergency spillway in the 35 existing dams were to be accomplished. Some of these are already done, some are under progress and some have been proposed (See Remark 2). According to new design criterion, new irrigation dam which has larger watershed area than 2,500ha and bigger storage than 5million m<sup>3</sup> is designed and constructed. (See Photo 1)

#### Effect and Result

1. Consequently, the adaptation to climate change and flood has not only strategically been planned, but also practically been executed.

2. Safe but expensive structure.

3. The design criteria of PMF are originally made for the disaster prevention. Consequently it was not intentionally made, but eventually made for the adaptation to climate change.

## II. Keys for Success

### i) Initial design of activities

#### Experienced problem → How to overcome

Experienced problem: Irrigation dam, which had the spillway designed for 200 years of flood frequency collapsed at the extreme flood and produced serious damages on human lives and properties. The 123 irrigation dams were damaged in 2002. The people took this event seriously. Therefore the government had to take the measures, which prevent dam collapse.

→ How to overcome: MAFF came to the conclusion that revision of the design criterion is the basic and the most effective solution. The design criterion of PMF for dam crest and spillway was reinforced and approved by MAFF in 2003.

#### Key points or requirements for success

- To seek advice from experts for revision of the design criterion and to keep transparency of the revision process, a committee was set up, composed of university professors and senior engineers and chaired by Professor Tai C. Kim.
- PMP (Probable Maximum Precipitation) was introduced to the irrigation reservoir instead of the design flood of 200 years frequency with storage capacity bigger than 5million m<sup>3</sup> and/or with watershed area larger than 2,500ha.

### ii) Dissemination

#### Experienced problem → How to overcome

Experienced problem: Engineer should judge the design criterion to apply properly. Otherwise it is felt that too many irrigation dams have the PMF capacity of spillway which is much higher than expected, in other words, over estimate and over design.

For this purpose, the new design criterion and its manual were published, but only reading these written materials seemed not enough to lead proper judgment by engineers and officers.

→ How to overcome: The MAFF took various measures to supplement the information obtained from the written materials, which included meetings to explain the background/key points of the new criterion, workshops to apply the criterion to a virtual dam and organizing committee to give advice how to apply the criterion to a particular dam.

#### Key points or requirements for success

No specific information available.

## III. Key findings from failure

1. Safe but too expensive structure
2. Need to redefine the regulation from the view point of engineering economics.
3. No definition on the capacity of river bank in the up and down stream to be safe in case of such extreme flood.

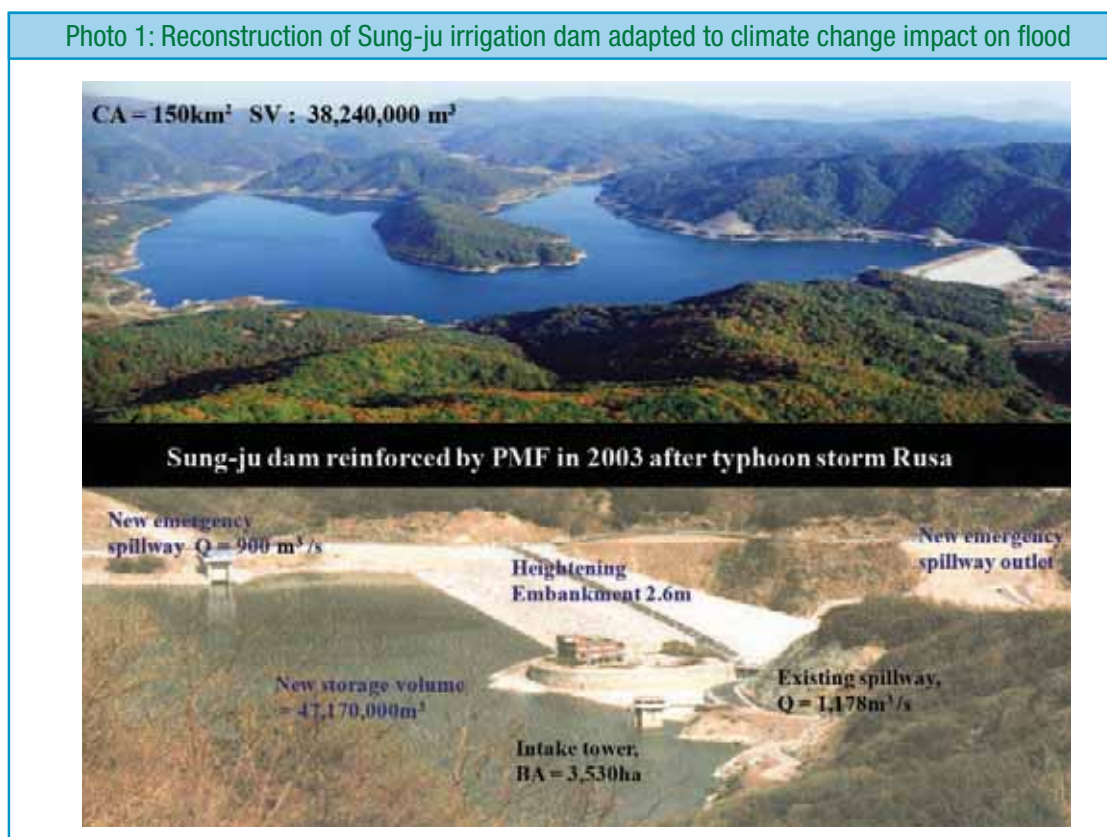
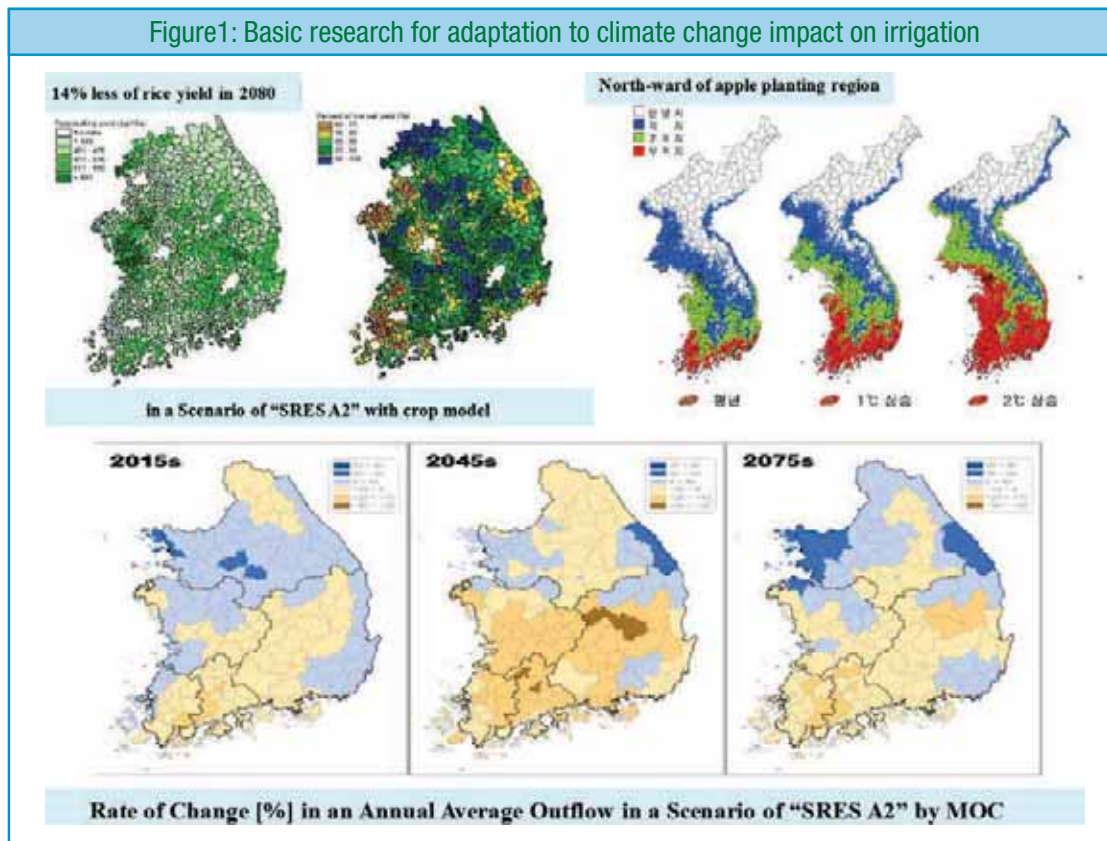
### Remark 1

The special research committee set up new design criterion for the emergency spillway to cope with extreme flood in the irrigation dam in 2002 as followed.

1. Earth-fill dam built by the spillway capacity of 100years frequency flood until 1982 should be reinforced its capacity up to 200years frequency×1.2 of flood.
2. Design criterion of PMF can be applied to irrigation dam, only if the failure of dam by flood causes the serious damages on the people lives and properties.
3. Irrigation dams which have watershed area larger than 2,500ha and storage bigger than 5million m<sup>3</sup> can be the target for PMF.



4. Storage volume of irrigation reservoir should be increased to control the flood in advance, if the surface area is bigger than 50ha. The water level of reservoir should keep to 70 ~ 80% of maximum level for the flood control in the rainy season.
5. Irrigation dams which have bigger storage volume than 5million m<sup>3</sup> should have the gate-typed spillway.
6. Irrigation dam with storage volume over 1million m<sup>3</sup> should have its own Emergency Action Plan (EAP).



## Remark 2

Table 1: Irrigation dams with the spillway capacity of PMF

Managed by KRC	Design rainfall (mm)		Watershed area (km <sup>2</sup> )	Design flood (m <sup>3</sup> /s)		Reservoir WL (E.l.m)		Designed WL (E.l.m)		Hydrological check for stability				measure			
	200yr.	PMP		200yr.	PMF	Dam crest	HWL	PMF	200yr. (HWL)	200yr. (Free board)	PMF (HWL)	PMF (Free board)	200yr.	PMF	200yr.	Unit FD (m <sup>3</sup> /s/km <sup>2</sup> )	
Heungduk	269.2	931	44	455.8	1,314	15.20	12.43	12.22	14.43	safe	unsafe 1.23m	safe	unsafe 2.0m	unsafe 1.23m	proposed	10.3	29.8
Gosam	369.1	807	71	691.0	1,166	55.60	53.70	53.29	54.52	safe	unsafe 0.85m	safe	unsafe 0.82m	unsafe 1.67m	done	9.7	16.4
Geumkwang	316.4	948	48	782.6	1,708	69.80	67.70	65.38	68.77	safe	unsafe 0.25m	safe	unsafe 1.07m	unsafe 1.32m	on-going	16.2	35.4
Giheung	369.1	848	53	738.7	1,798	49.00	47.30	46.00	49.07	safe	unsafe 1.05m	safe	unsafe 1.77m	overflow 2.82m	on-going	13.9	33.9
Idong	369.1	796	93	832.7	2,018	49.50	46.10	45.00	48.07	safe	safe	safe	unsafe 1.97m	unsafe 0.79m	discussing	9.0	21.7
Bakgok	322.7	756	85	825.8	2,133	103.20	100.10	98.59	102.26	safe	safe	safe	unsafe 2.16m	unsafe 1.31m	planning	9.7	25.2
Gopung	313.7	881	26	280.1	974	89.20	85.30	85.07	90.49	safe	safe	safe	unsafe 5.19m	overflow 3.29m	done	10.8	37.6
Yedang	383.1	657	374	2809.4	4,656	25.50	22.50	22.93	24.72	unsafe 0.43m	safe	safe	unsafe 2.2m	unsafe 1.68m	proposed	7.5	12.5
Tapjung	297.5	635	219	1193.9	3,038	32.10	30.40	27.39	30.17	safe	unsafe 0.47m	safe	safe	unsafe 0.47m	planning	5.5	13.9
Kyungchun	308.7	732	68	603.7	1,412	87.30	85.60	85.20	86.26	safe	unsafe 0.3m	safe	unsafe 0.66m	unsafe 0.96m	on-going	8.8	20.6
Dongsang	308.7	816	80	874.0	1,901	138.00	141.00	139.80	141.11	safe	unsafe 3.0m	safe	unsafe 0.11m	overflow 3.11m	on-going	10.9	23.6
Dae-a	308.7	705	108	974.7	2,317	123.00	120.00	118.27	122.73	safe	safe	safe	unsafe 2.73m	unsafe 1.82m	proposed	9.1	21.5
Gu-i	308.7	765	62	565.7	1,377	64.30	63.20	62.95	64.19	safe	unsafe 0.9m	safe	unsafe 0.99m	unsafe 1.89m	on-going	9.1	22.2
Naju dam	311.7	867	85	824.7	2,403	67.50	63.90	62.89	64.21	safe	safe	safe	unsafe 0.31m	safe	safe	9.7	28.4
Chongchun	410.3	766	70	881.9	2,076	42.50	40.20	40.16	42.49	safe	safe	safe	unsafe 2.29m	unsafe 2.16m	on-going	12.6	29.6
Dongbu	377.6	914	28	636.9	1,026	18.40	17.00	17.18	18.09	unsafe 0.18m	unsafe 0.78m	unsafe 1.09m	unsafe 1.09m	unsafe 1.69m	on-going	22.7	36.5

Jangsung	311.7	748	123	1196.3	2,734	90.50	86.50	85.49	87.80	safe	safe	unsafe 1.3m	unsafe 0.68m	planning	9.7	22.3
Damyang	311.7	839	47	648.7	1,683	124.00	121.10	120.90	122.29	safe	safe	unsafe 1.19m	unsafe 0.31m	on-going	13.7	35.7
Naesung	329.6	638	92	790.5	1,751	231.50	229.00	228.99	234.21	safe	safe	unsafe 5.21m	overflow 4.93m	on-going	8.6	19.1
Seobu	377.6	798	30	643.6	1,166	25.10	22.80	23.16	23.95	unsafe 0.36m	unsafe 0.08m	unsafe 1.15m	unsafe 0.87m	on-going	21.1	38.4
O-bong	535.7	860	109	1542.9	2,735	121.30	115.80	119.86	122.38	unsafe 4.06m	unsafe 0.97m	unsafe 6.58m	overflow 3.49m	on-going	14.2	25.1
Dalchang	247.3	837	56	435.6	1,554	71.00	68.60	68.27	71.32	safe	safe	unsafe 2.72m	overflow 2.59m	on-going	7.7	27.6
Miho	321.5	820	133	948.5	2,737	65.00	63.30	63.12	65.17	safe	unsafe 0.3m	unsafe 1.87m	overflow 2.17m	proposed	7.1	20.6
Gungpung	316.4	927	43	723.3	1,471	67.50	65.00	65.08	66.16	unsafe 0.08m	safe	unsafe 1.16m	unsafe 0.66m	on-going	16.7	33.9
Bomun	398.9	860	71	587.6	1,370	96.90	94.00	93.89	94.99	safe	safe	unsafe 1.16m	unsafe 0.38m	done	8.3	19.4
Biryong	438.5	712	39	880.0	1,310	259.70	257.60	253.94	255.42	safe	safe	safe	safe	on-going	22.8	34.0
Wonnam	321.5	892	37	726.6	2,060	119.00	117.40	117.37	118.90	safe	unsafe 0.4m	unsafe 1.5m	unsafe 1.90m	on-going	19.9	56.4
Yongyon	398.9	665	69	843.4	1,661	61.50	58.90	59.05	60.08	unsafe 0.15m	safe	unsafe 1.18m	unsafe 0.94m	proposed	12.3	24.1
Geumpung	318.4	877	26	564.2	1,200	57.00	54.30	53.11	57.01	safe	safe	unsafe 2.71m	overflow 2.22m	proposed	21.9	46.7
Gwangju	338.3	988	41	630.8	1,528	78.40	76.40	76.38	78.47	safe	unsafe 0.15m	unsafe 2.07m	overflow 2.22m	on-going	15.3	37.0
Suyang	338.3	988	33	482.7	1,241	49.00	47.50	46.84	48.11	safe	unsafe 0.79m	unsafe 0.61m	unsafe 1.4m	on-going	14.6	37.6
Junam	370.9	902	35	233.0	511	8.70	7.00	6.01	7.24	safe	safe	unsafe 0.24m	safe	proposed	19.9	43.6
O-eo	396.6	881	27	527.2	1,159	105.85	104.50	104.48	105.40	safe	unsafe 0.65m	unsafe 0.9m	unsafe 1.55m	proposed	19.5	42.8
33															13	30





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