SOCIALIST REPUBLIC OF VIETNAM

BENTRE PROVINCIAL PEOPLE'S COMMITTEE

BEN TRE WATER MANAGEMENT PROJECT
(B-SWAMP)

ENVIRONMENTAL IMPACTS ASSESSMENT REPORT

2016

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ENVIRONMENTAL IMPACTS ASSESSMENT REPORT

Hydraulic Project Investment and Construction Management Board No. 9

Resources and Environmental Development Joint Stock Company

2016

ABBREVIATIONS AND ACRONYMS

BOD_5	:	Biological oxygen demand measured at 20^0C for 5 days
CC	:	Climate Change
COD	:	Chemical oxygen demand
CPC	:	Communal People's Committee
DARD	:	Department of Agriculture and Rural Development
DO	:	Dissolved oxygen
DONRE	:	Department of Natural Resources and Environment
EIA	:	Environmental Impact Assessment
FAO	:	Food and Agriculture Organization
FS	:	Feasibility Study
HEC-2	:	Hydraulic Enginieering Consultants Coorporation No.II
ICMB 9	-	Hydraulic Project Investment and Construction Management Board No. 9
JICA	:	Japan International Cooperation Agency
MARD	:	Ministry of Agriculture and Rural Development
MONRE	:	Ministry of Natural Resources and Environment
PPC	:	Provincial People's Committee
TDS	:	Total Dissolved Solids
TSS	:	Total Suspended Solids
WHO	:	World Health Organization

INTRODUCTION

1. ORIGIN OF THE PROJECT

The Mekong Delta is known as the Rice Bowl of Vietnam, producing more than half of the total rice paddy production of the country. Not only the rice, but also plenty of other products, such as fruits, coconuts, and vegetables, are also produced in the delta. However, the Mekong Delta is considered to be vulnerable against climate change, such as severe flooding in the rainy season and saline water intrusion in the dry season, which have been caused by a sea level rise. The sea rise measurement shows an average of approximately 15 cm during the recorded period of about 30 years, from 1982 until now in coastal areas. Therefore, the areas of Mekong River tributaries are constantly facing saline water intrusion, particularly in the dry season.

The residents in Ben Tre rely on water from the aforementioned river tributaries for domestic and irrigation purposes. Estuaries of these tributaries are located at the southeast parts of Ben Tre; this is why this area is one of the most affected areas by saline water intrusion in Vietnam under the climate change phenomena. Brine damage by saline instruction will widely and seriously spread into Ben Tre Province; the high level of salinity is expected and it will cause serious damages at not only the paddy fields in the central areas, but also the fruit farms widely developed in the upstream areas. In fact, the damage cost was estimated as the highest among 7 coastal provinces based on the saline water intrusion simulation reported in the former JICA study on 'the Project for Climate Change Adaptation for Sustainable Agriculture and Rural Development in the Coastal Mekong Delta' in April 2013 (JICA Study (2013).

Under the such circumstances, the Vietnamese government has established 'Ben Tre Province Water Management Plan for 2020', which is the policy for preventing saline intrusion mainly composed of structural measures represented by sluice gate construction. Based on the plan, series of sluice gates have been constructed from the downstream side. The Ba Lai sluice gate construction was implemented in 2002, which is located at Ba Lai River; one of the main tributaries of the Mekong River. The Vietnamese government plans not to stop sluice gate construction and has capacity to incur budget for small scale sluice gate but there will be difficulty to arrange budget for large scale sluice gate construction. This is because the Vietnamese government requested JICA a technical assistance for large scale sluice gate project plan formulation.

On the basis of the approved plan and constructed irrigation system, the consulting agency has carried out researches for proposals of an additional 11 headworks of 4 different sub-projects based on the importance and effects of the sluicegates on salinity prevention, namely An Hoa, Thu Cuu, Ben Tre, Ben Ro, Tan Phu sluicegates of the North Ben Tre irrigation system; Cai Quao sluicegate of the Cai Quao irrigation system; Mo Cay Bac and Mocay Nam sluicegates of the Mo Cay Nam and Cho Lach projects; Vung Liem, Bong Bot, Tan Dinh sluicegates of the North Mang Thit sub-project requiring urgent investment in the period 2012 ÷ 2020; this is commonly known as North Ben Tre irrigation Project.

A series of discussions and meetings were made among MARD, PPC, and JICA. As the results of the discussions and meetings, it was agreed in February 2015 to carry out a preparatory survey for the purpose of examination on the development plan of sluice gates and related structures against the impact of climate change. With this background, the Preparatory Survey for the Ben Tre Water Management Project in the Socialist Republic of Vietnam was commenced at the beginning of August, 2015 and proposed for construction of sluice gates at 8 locations (5 sluice gates in North Ben Tre and 3 ones in South Ben Tre) and monitoring devices. The project is known as "Ben Tre Water Management Project"

EIA report of North Ben Tre irrigation project was approved at decision no 3096/QĐ-BTNMT dated 27/12/2014 by Minister of Ministry of Natural Resources and Environment. To be consistent with changes in the project scope in only Ben Tre Province, and many environmental changes in past two years in Ben Tre, as well as additional requirements in criteria for environmental consideration of JICA than Vietnam, so the EIA report of the project should be reviewed and updated.

Agency authorized for approving the investment project:

- Name: Ministry of Agriculture and Rural Development (MARD)
- Address: No. 2, Ngoc Ha, Ba Dinh, Hanoi.

Relations of the project and the development planning:

The government has approved two major strategic programs:

The National Target Program (2008) to respond to climate change proposed by the Ministry of Natural Resources and Environment (MONRE); and

Irrigation Development Strategy until 2020 proposed by Ministry of Agriculture and Rural Development (MARD).

Both strategies focus on the Mekong Delta, because this region will remain a major national center for food production and aquaculture. Rice plays a central role in the food consumption of the country, the Mekong Delta thus will continue to play a key role in ensuring national food security.

Irrigation planning of the Mekong Delta in the 2012-2020 period and orientation towards 2050 under the Decision No. 1373/2012/QD-TTg with the aim to "complete the salinity prevention dyke system at the coastal area and along the rivers to serve the agricultural development, welfare, and aquaculture…build salinity prevention sluicegates to keep freshwater and increase freshwater supply from rivers…to promote the construction of flood control works to facilitate crop shifting and aquaculture development, etc.".

The socio-economic development program (5 year plan) and regional agricultural development strategy of MARD plan to promote the investment in irrigation sector and mitigation measures and adaptation to climate change.

Overall socio-economic development planning for the provinces in the project area. This planning requires to complete the irrigation system, improve canals, build embankments combined with construction of rural roads to effectively use water resources in the area to serve production and mitigate calamities.

2. LEGAL AND TECHNICAL BASIS FOR THE IMPLEMENTATION OF THE EIA

2.1. Legal basis

On environmental protection:

- Law on Environmental Protection no 55/2014/QH13, dated 23/6/2014.
- Decree No. 18/2015/NĐ-CP signed on 18/4 2011 by the Government dated 14/2/2015 providing strategic environmental assessment, environmental impact assessment and environmental protection commitment;
- Decree No. 19/2015/ND-CP dated 14/2/2015 by the Government on detailing and guiding the implementation of a number of articles of the Law on environmental Protection;
- Circular No. 27/2015/TT-BTNMT dated 29/5/2015 by the Ministry of Natural Resources and Environment on strategic environmental assessment, environmental impact assessment;
- Circular No. 16/2009/TT-BTNMT dated 07/10/2009 by the Ministry of Natural Resources and Environment providing national technical regulations on environment, air quality and toxic substances in ambient air environment;
- Circular No. 21/2015/TT-BNN, dated 08/06/2015 by MARD on management of plant protection;
- Circular No. 36/2015/TT-BTNMT, dated 06.30.2015 of the Ministry of Natural Resources and Environment on management of hazardous waste.
- Circular No. 65/2015/TT-BTNMT, dated 21.12.2015 issuing national technical regulations on environment - regulation of surface water quality;
- Decision No. 22/2006/QD-BTNMT dated 25/12/2006 by Ministry of Natural Resources and Environment on compliance with Vietnamese environmental standards.

Regarding land resources:

- Land Law No. 45/2013/ ratified by the Socialist Republic of Vietnam on 29/11/2013
- Decree No. 43/2014/NĐ-CP detailing on regulations for implementation of some articles in the Land Law (effective since 01/07/2014).
- Decree No.44/2014/NĐ-CP detailing land prices (effective since 01/07/2014).
- Decree No. 46/QĐ-CP dated 15/5/2014 by the Government on collection of land use fees, fees for renting water surface;
- Decree No. 45/QĐ-CP dated 15/5/2014 by the Government on land use fees;
- Decree No. 47/QĐ-CP dated 15/5/2014 by the Government on compensation, support and resettlement when land is acquired by the state;
- Circular No. 37/2014TT-BTNMT by Ministry of Natural Resources and Environment dated 30/6/2014 detailing regulations on compensation, support and resettlement when land is acquired by the state;
- Circular No. 36/2014TT-BTNMT by Ministry of Natural Resources and Environment dated 30/6/2014 detailing regulations on land pricing method; building and adjustment of land price; identification of land price and consultation on identification of land price.

Regarding water resources:

- Law No. 17/2012/QH13 on water resources ratified by the National Assembly of the Socialist Republic of Vietnam on 21/6/2012;
- Decree No. 201/2013/NĐ-CP detailing regulations on implementation of some articles of water resources law;
- Decree No. 149/2004/ND-CP dated 27/07/2004 of the Government regulating the licensing of exploration, exploitation and use of water resources, waste water discharge into water sources;
- Decree No. 142/2013/NĐ-CP, dated 24/10/2013 by the Government providing for sanction of administrative violations in domain of water resources and minerals;
- Law on biodiversity No.28/2008/QH12 approved by the National Assembly of the Socialist Republic of Vietnam on 13/01/2008. Chapter III Conservation and sustainable development of natural ecosystems, and Chapter IV Conservation and development of species.

Regarding standards and technical regulations:

- Law. On standards and technical regulations dated 29/6/2006;
- Decree No. 127/2007/NĐ-CP dated 1/8/2007 by the Government detailing the implementation of a number of articles of the Law on standards and technical regulations;
- Circular No. 32/2013 TT-BTNMT dated 25/10/2013 by MONRE regulating 04 National technical regulations on the environment; including QCVN 05:2013 - Technical Regulations national ambient air quality;
- Circular No.25/2009 TT-BTNMT dated 16/11/2009by MONRE regulating 08 National technical regulations on the environment; including QCVN 07:2009/BTNMT - National Technical Regulation on the threshold of hazardous waste;
- Circular No.39/2010/TT-BTNMT dated 16/12/2010 by MONRE regulating 04 National technical regulations on the environment; including QCVN 26: 2010/BTNMT - National Technical Regulations on noise and QCVN 27: 2010/BTNMT - National Technical Regulation on vibration;
- Decision No. 16/2008/QD-BTNMT dated December 31, 2008 by the Minister of Natural Resources and Environment regulating 08 National technical regulations on the environment; including QCVN 08:2008/BTNMT - National Technical Regulation on surface water quality; NTR 09:2008/BTNMT - National Technical Regulation on groundwater quality; and NTR 14:2008/BTNMT - National Technical Regulation on domestic wastewater;

2.2. Some documents related to the construction process of the project

- Decision No. 862/QD-BNN-TCCB dated 17/3/2016 of Minister of Agriculture and Rural Development on assigning Hydraulic Project Investment and Construction Management Board No. 9 (ICMB 9) as Project Owner of Ben Tre water resources management project, loan of Japanese Government (JICA);
- Minutes of contact mission trip for for Ben Tre water management project (B-SWAMP), Socialist Republic of Vietnam between Ministry of Agriculture and Rural

Development, Ben Tre Province People's Committee and the Japan International Cooperation Agency (JICA) on 5/26/2016.

2.3. Vietnam's environmental standards

The current Vietnam National Standards on the Environments are the national standards established by MONRE and they are to be applied for all agencies, enterprises and projects carried out in Vietnam.

QCVN 05:2013/ BTNMT - National Technical Regulations on ambient air quality;

QCVN 08:2008/BTNMT - National Technical Regulations on surface water quality;

QCVN 09:2008/BTNMT - National Technical Regulations on groundwater quality;

QCVN 14:2008/BTNMT - National Technical Regulations on domestic wastewater;

QCVN 26:2010/BTNMT – National Technical Regulations on noise;

QCVN 27:2010/BTNMT – National Technical Regulations on vibration;

QCVN 07: 2009/BTNMT - National Technical Regulations on the thresholds of hazardous waste;

QCVN 03: 2008/BTNMT - National Technical Regulations on permissible limits of heavy metals in soil;

QCVN 15: 2008/BTNMT – National Technical Regulations on chemical residues in soil and plant protection;

2.4. Related documents and reports

Final report of preparation survey for Ben Tre water management project (B-SWAMP) prepared by JICA's consultant in 6/2016;

Feasibility study Report - Ben Tre water management project (JICA 3);

Report on the current environmental state of Ben Tre provinces from 2006-2010 by Ben Tre PPC, 2011.

Report on Adaptation to Climate Change project for sustainable agriculture and rural development in the Mekong Delta coastal area;

Report on environmental observation No.1 of Ben Tre province in 2014;

Report on the Mekong Delta area - long-term vision fora safe, prosperous and sustainable area;

Report on the Planning for preservation of biological diversity in Ben Tre province for the period 2010 – 2015 and vision for 2025;

And other documents as listed in detail in the Appendix;

3. EIA implementation agencies

3.1. Organizations responsible for implementation of EIA and preparation of EIA report:

Owner: Central Project Office for water resources projects

Address: No. 23 Hang Tre St., Hoan Kiem district, Hanoi City.

Tel: 04.38253921; Fax: 04.38242372

Representative: Tran Quang Hoai Position: Head of the department

Consulting organization: Partnership of Development Research and Consultancy Centre and Resources and Environment Development Joint Stock Company.

DEVELOPMENT RESEARCH AND CONSULTANCY CENTRE (DRCC)

Address: 15th Floor, No. 1 Lieu Giai St., Ba Dinh district, Hanoi

Representative: Mr. Nguyen Hong Quang. Position: Director

RESOURCES AND ENVIRONMENTAL DEVELOPMENT JOINT STOCK COMPANY (REEN)

Address: No. 44/120, Truong Chinh St., Dong Da, Hanoi

Representative: Ms. Ngo Thi Binh. Position: Director

3.2. List of people participating in preparation of EIA report

Table 1: List of people participating in preparation of EIA report

No.	Name of experts	Specialty	Position
1	Cao Thi Thu Yen	MSc. in Environment and Infrastructure Engineering	Leader
2	Tran Minh	MSc. in Environment	Environment expert
3	Do Thi Nham	MSc. in Environmental Hydrology	Expert in Environmental Hydrology
4	Nguyen Duy Phuong	MSc. in Agriculture	Agriculture expert
5	Do Huu Thu	MSc. in Biology	Ecology expert
6	Le Dinh Thuy	MSc. in Biology	Ecology expert
7	Nguyen Doan Huy	MSc. in Analytical Chemistry	Expert on Environment Chemistry
8	Ha Hai Duong	Fellow PhD student on Climate Change, MSc. on Management and Technical	Expert on Climate Change
9	Nguyen Xuan Lam	Fellow PhD student, MSc. on Water resources management	Support staff for hydraulic model
10	Nguyen Ba Tuan	MSc. in Environmental science	Support staff on field survey and collecting environment's samples
11	Dang Trieu Vung	Engineer on irrigation	Support staff for review of technical drawings
12	Nguyen Tien Luyen	Engineer on construction	Support staff for public consultation and clerical

			works

4. Applied method for the EIA process

4.1. Methods used for environmental impact assessment

a. Comparison method

Assessing the impact is carried out by comparing the measurement results, analysis, calculation of forecasts on the concentration of pollutants due to the activities of the project with the Vietnamese standards of environment established by Ministry of Environment and Natural Resources Committee on soil quality, water, noise, air and standards by the Ministry of Health, Ministry of Construction.

b. Method of environment matrix

A matrix was established as the reference used for each operational activities of the project for each parameter or environmental component to assess the relationship causes and consequences.

The matrix method is valuable for determining the impact of the project and offering some form of summary information on impact assessment. The method is simple, easy to use; it does not require a lot of environmental data but can provide more explicit impact analysis of different actions on the same factor. Using a matrix environment can clearly show the relationship between development and the environment.

c. Rapid assessment method

The method is rapid assessment based on the emission of pollution. Rapid assessment methods are highly effective in determining load, the concentration of pollution emissions due to the use of machinery and operation of vehicles carrying materials, load, the concentration of water pollution caused by the domestic wastewater of the workers during the construction project, water pollution load due to the operation of the project during project operation. So we can predict the potential environmental impact of the pollution sources. Rapid assessment method is used to predict quickly the loads as a basis of generating pollutants.

d. Model method

By studying the information about the Ben Tre water management project, Consultants found that this is a special project with the natural environment related to changes in salinity in the river network of the study area. In this study, the consultant team used model MIKE11 HD and AD because of its ability to calculate fast, easy to use and manipulate, and the level of confidence has been widely recognized in the country and internationally. The model is used to calculate the spread of salinity, flooding and water quality in the river network area with different scenarios to carry out assessment on the impacts as well as the effective operation of the works to prevent river salinity changes, flooding, water quality as a basis for assessing the impact to the river ecosystem in the period before and after work. The model is used and performed as the followings:

For research into water flow under different scenarios as in the feasibility study of the project for before and after construction;

For research into construction under different scenarios during flood season when the salinity intrusion prevention system is in operation;

Simulation for analysis of water quality;

For research and calculation of salinity intrusion using Mike 11 Model;

For update on terrain, boundary, construction works and demand of water into the model;

Simulation for calculation and analysis under different scenarios;

For analysis and evaluation of changes in salinity and preparation of maps on salinity levels corresponding to different scenarios.

4.2. Method for working in group

a. Information collection methods:

There are many methods of gathering information, the consultant will mainly use the following methods in the process of gathering information:

Non-experimental method:

This method is used for:

- Equivalent comparison: use of data collected from the operation of similar projects to compare with the operation of the project.
- Statistics and processing of measured data in the field and the results analyzed in the laboratory.
- List the survey data, collected for natural conditions and environment in the region of the project implementation.

Method of inheritance with selection of available information

From the collection of selective information available, the consultants will get an overview of the project, from which results in direction for the next operation to gather more information that is still missing and then to carry out activity implementation with regard to the content of the consulting services.

Method of inheritance of documents from other consultants of the project

To satisfy the safety policies of donors, project teams consist of those working on safety policies such as social assessment, resettlement policy framework, action plan for resettlement ... Since working for the same project, consultants should be incorporated together; the data on natural conditions, economic and social welfare and environmental damage caused by natural disasters and migration compensation and resettlement should be unified in all of project reports.

Method on field survey

This method enables the consultant team to conduct field surveys in the field where the project will be implemented; from which they can collect more information on the economic, social and environmental status of the project area. It also helps consultants to authenticate information previously collected.

This method also helps experts assess the potential impact of the project on the area in on a more complete and accurate manner

Besides the actual survey activities will help consultants discover the problem to be solved and also outline plans for a suitable solution.

Method of collection samples for analysis

After carefully studying of the available information, the consultants exchange information and agree on samples to take and the sampling area for analysis the current state of the environment.

The monitoring of the quality of environmental soil, surface water, and groundwater is done under the guidance of the procedures/regulations follows:

- Observations on the surface water environment: Circular No. 29/2011/TT-BTNMT regulating the technical process for observations of the surface water environment.
- Observations on groundwater: Circular No. 30/2011/TT-BTNMT regulating the technical process for observations of groundwater.
- Observations on land environment: Circular No. 33/2011/TT-BTNMT regulating the technical process for observations of land environment.

Method of social survey/public consultation

Public consultation is carried out for the following targets: the people affected directly and indirectly; Management agencies; Persons involved in the construction project; organizations and individuals (Sponsors, specialized agencies ...)

EIA and EMP Consultants coordinate with the investor/People's Committee, the local Fatherland Front, and the relevant agencies to conduct consultations. During the consultation process, the consultants inform the negative environmental effects that may occur during project implementation, the measures proposed to mitigate such impact. Leaders and people in the affected area will comment on the environmental issues mentioned and mitigation measures to be implemented.

CHAPTER 1
THE NATURAL ENVIRONMENT CONDITIONS AND THE SOCIO-ECONOMIC CONDITIONS OF THE PROJECT AREA

1.1 CONDITIONS OF THE NATURAL ENVIRONMENT

1.1.1 Geographical and Geological conditions

2.1.1.1. Geographical conditions

Scope of Ben Tre water management project consists of areas of districts Chau Thanh, Giong Trom, Binh Dai, Mo Cay Nam, Mo Cay Bac and Ben Tre city.

The Project area extends from 9 degrees, 47 minutes, 27 seconds to 10 degrees, 20 minutes, 1 second in its north latitude (60 km) and 105 degrees, 55 minutes, 35 seconds to 106 degrees, 47 minutes, 32 seconds in the east latitude (95 km).

Construction location of the works are described in the table below:

Table 2 - 1: Location of the works

No.	Sluice gates	Construction location (village, commune)
1	An Hoa sluice-gate	The sluice-gate is located on the Giao Hoa canal (Chet Say), the west of the gate belongs to Giao Hoa commune, Chau Thanh district; the east belongs to Long Dinh commune, Binh Dai district
2	Thu Cuu sluice-gate	The sluice-gate is located on Thu Cuu canal, the left bank belongs to Thanh Phu Dong commune, Trong Giom district. The right bank blongs to Phuoc Long commune, Giong Trom district
3	Ben Tre Sluicegate	The sluice-gate is located on Ben Tre canal, the North bank belongs to Phu hung commune, Ben Tre city. The North bank belongs to Nhon Thanh commune, Ben Tre city.
4	Ben Ro sluice-gate	The sluice-gate is located on ben Ro canal, the east bank belongs to Tien Long commune, Chau Thanh district. The west bank belongs to Tan Phu commune, Chau Thanh district
5	Tan Phu sluice-gate	The sluice-gate is located on Tan Phu river, the east belongs to Phu Duc commune, Chau Thanh distrit. The west belongs to Tan Phu commune, Chau Thanh district.
6	Cai Quao sluice gate	The sluice-gate is located on Cai Quao canal. The left and the right banks belong to Binh Khanh Dong commune, Mo Cay Nam district.
7	Vam Nuoc Trong sluice-Gate (Mo	Vam Nuoc Trong sluice-gate is planned to be located on Vam Nuoc Trong river, the west of it is in Dinh Thuy commune, Mo Cay Nam district; the west of it is in Tan Thanh Binh commune, Mo Cay Bac district.

No.	Sluice gates	Construction location (village, commune)
	Cay Bac)	
8	Vam Thom sluice-gate (Mo Cay Nam)	Vam Thom sluice-gate is planned to be located on Vam Thom river, the left belongs to Thanh Thoi commune, Mo Cay Nam District. The right belongs to Khanh Thanh Tan commune, Mo Cay Bac district.

2.1.1.2. Characteristics of the terrain

The topographical feature in the project area is rather low in altitude, similar to other regions of the Mekong Delta. It is generally very flat with a popular altitude ranging from only 0.5m to 1.5m (accounting for about three-quarters natural land area) and gradually lowers from the northwest to the southeast direction. The whole project area has an average altitude ranging from 0.5m to 0.75m only.

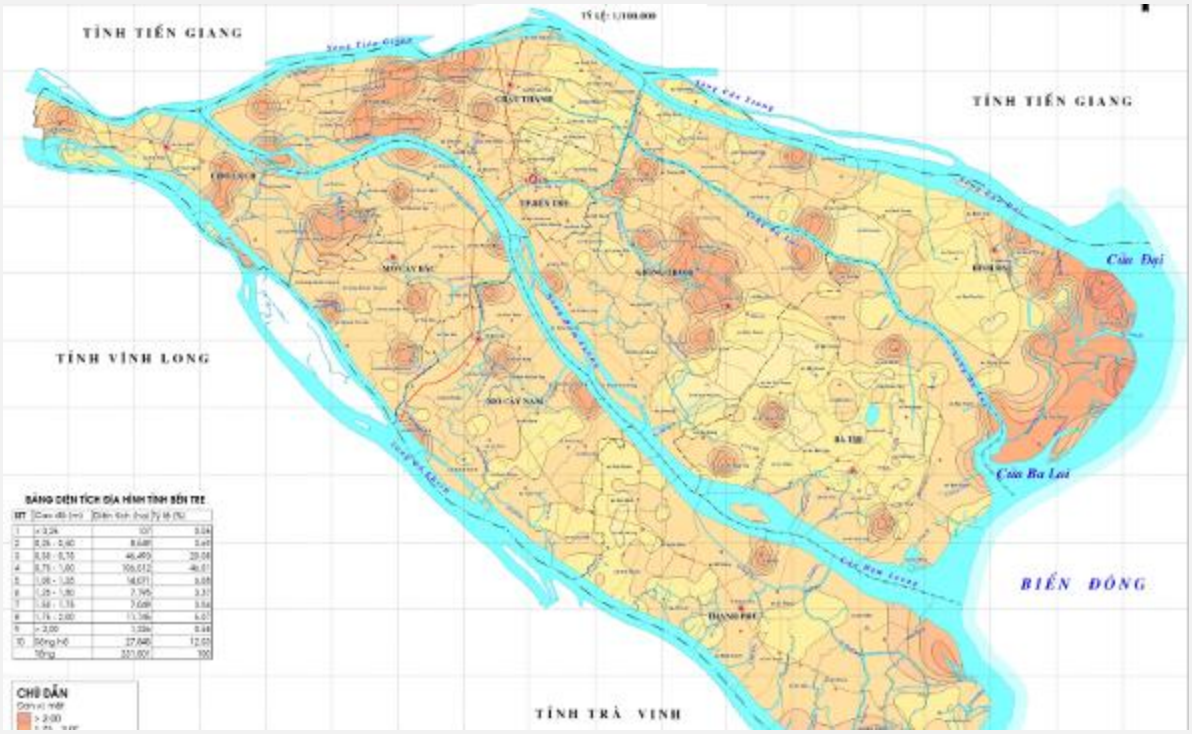


Figure 2 - 1: Topographic condition of Ben Tre province

Source: Southern Institute of Water resources planning, 2014

The highest terrain belongs to the Chau Thanh district area. West of Binh Dai, the Giong Trom and Cho Lac districts have high altitudes with their average altitude ranging from 1.25 to 1.50 m. On the other hand, the coastal area has altitudes ranging from 0.75-1.25m. In particular, some places are very hollow; some parts of the Binh Dai, Ba Tri, and Thanh Phu districts have altitudes ranging only between 0.30 and 0.50m where waterlogging takes place very often in the rainy season.

In the area south of Ben Tre, Giao Hoa riversin where it borders the sea, there raised sand dunes, arcs, convex towards the sea making it difficult for the water to

flow from the top down in order to provide water for irrigation in the region, while the drainage of flooding is in sand dunes also causing many difficulties.

2.1.1.3. Geological characteristics

Drilling surveys were conducted at each site, and the Standard Penetration Test (SPT, N-value) as well as other geotechnical tests were carried out so far. These results show that the variety of geological conditions and layer thickness is remarkable depending on each sluice gate area.

It is said that the ground condition of the Tan Phu, Ben Ro, An Hoa and Ben Tre sluice gates, which are located in the upstream area, is relatively good compared with the lower area because the layer 1 group is thin and the stiff layer 2 group can be found in the shallow depth of the ground. On the other hand, careful examination of foundation treatment is required for Thu Cuu, Vam Nuoc Trong, Vam Thom and Cai Quao sluice gates because the very soft layer 1 is deposited thickly and that N-value of layer 2 varies widely depending on the location.

Table 2 - 2: Geological feature of the foundation

Name of sluice	Geological features
Tan Phu	At the boundary of Layer1 and layer1b, the N-value is quite different. The N-value of layer1b, 2, and 2b does not change much until the depth of 25 m, and it does not correlate with the respective depth. An N-value other than TP10 and TP11 shows less than 20 at the depth of -25 m.
Ben Ro	The bed boundary of layer 1 and Layer 2 is EL. -15 m. At the boundary of Layer1 and layer 2, the N-value is quite different. The N value of layer 1 is5 or less, regardless of the depth. The N value of layer 2 increases by depth. There is no scattered N-value at each depth of borehole; it forms a homogeneous stratum.
An Hoa	The foundation condition seems to be better than others because the stratum boundary between the Layer 1 group and the Layer 2 group is flat at the shallow portion of the underground around EL.-13m. The Layer 2 group is stiff; the N-value is proportionate to the depth with a very wide range. The N-value counts 20 or more at under 25 m of depth.
Ben Tre	The Stratum boundary between the Layer 1 group and the Layer 2 group is flat at the shallow portion of the underground around EL.-13m. The Layer 2 group is stiff; the N-value is proportionate to the depth. But, Layer 2b indicates a low N-value (about 10) only at BT05 and BT07 on-water drilling. Very stiff Layer 3 is found only in Ben Tre, and the N-value indicates 20 or more under EL. -25m.
Thu Cuu	The week stratum is deposited and it forms quite a thick layer of approximately 50 meters in North Ben Tre. Among these, layer1 is organic clay, and layer1c and 1d are heavy sandy clay. Stratum boundary of layer1 and layer2 is EL. 60 m above, and strata are

	nearly horizontal. The N-value increases depending on the depth. However, this basis cannot be identified, and so the N-value shall be more than 20 before the depth of 60 m. There is no scattered N-value at each depth of borehole; it forms a homogeneous stratum.
Vam Nuoc Trong	Layer 1bis distributed at deep portion (EL.-40m) in VNT04 borehole. The foundation in this site has the most favorable geological conditions in the South Ben Tre. The N-value of Layer 1 group shows 5 or less, and the N-value of layer 2 group is generally 20 or more. The N-value increases depending on the depth.
Vam Thom	The weak stratum forms with quite thick layer approximately 50 m or more. Layer1 is formed by organic clay; layer1b, 1c and 1d are of sandy clay. Stratum boundary of layer1 and layer2 is not identified in this area. The N-value increases gently depending on the depth. However, this foundation cannot verify the N-value as more than 20 at the depth of -45m.The scattered N-values at each depth of borehole are not observed and are indicated as homogeneous.
Cai Quao	This sluice gate area is located in the southernmost of the project area. Because of this, thick weak stratum is identified. The bed boundary of Layer 1 and Layer 2 changes sharply. In particular, Layer 1d distribution continues until the depth of -60m in the borehole CQ07 performed under this survey. N-value indicates 20 or more until 60m of depth. The N-values of Layer2a varies widely and is heterogeneous.

Source: Survey team JICA B-SWAMP, 2016

1.1.2 Meteorological Conditions

Weather, Climate:

Ben Tre water management project, Ben Tre province in particular and the whole Mekong Delta in general has tropical monsoon climate, which is hot and humid and stable every year.

Every year the climate is broken into two distinct seasons corresponding to the two forms of the monsoon: rainy seasons from May to November and the dry season from December to April the following year. During rainy season, rainfall accounts for 80 ÷ 85%. During dry season, rainfall accounts for only about 15 ÷ 20% of the annual rainfall.

Temperature: The average annual temperature is 27 ° C. The hottest month is April with Tbq = 28.8 ° C; the coldest month is January with Tbq = 25.7 ° C. The amplitude $\Delta T \approx 3$ ° C.

Air humidity: During rainy season, moisture averaged 82.0%, for dry months, it is 79.2%; Wettest month is August with Ubq =82.5%. The the driest months are March and April with Ubq = 74.1%

Evaporation: From December to April, largest evaporation averaged about 3,3mm/day. For the remaining months, when humidity is high, evaporation is about 2,3mm / day.

In the whole year, the average evaporation is of about 2.8 mm/day. Evaporation measured by Piche evaporimeter and by letter-A shaped pot of the project are determined directly from the measured data in Ben Tre. Absolute highest evaporation measured by the letter A pot: ZmaxA = 29.1mm/day and Piche evaporimeter: ZmaxP = 12.2mm / day.

Rain: Average annual precipitation is 1450mm. Rainfall levels are divided into two distinct seasons, during rainy season (from May to October) precipitation accounts for 86% of total rainfall, during dry season (November to April) precipitation accounts for 14% of the annual rainfall.

Table 2 - 3: Distribution of annual rainfall

Station	Month												Year
	1	2	3	4	5	6	7	8	9	10	11	12	
Ba Tri	0.4	0.7	4.4	38.5	163	207	184	194	286	278	103	9.9	1450

Wind: Through the year, there are two seasons of wind: winter monsoon from December to April the following year. Wind direction is mainly east - northeast. The average wind speed is of 2.4 ÷ 4.5 m/s. Summer wind is from May to November in the direction of west - southwest. The average wind speed is at about 2.2 ÷ 4.2 m/s.

In Ben Tre, maximum wind velocity is measured at Vmax = 30.8m/s, which is relatively large value compared with other areas of the Mekong Delta. Level 9 hurricane wind velocity is at 24 m/s.

1.1.3 The hydrological, oceanographic conditions

Water level: Due to semi-diurnal, while maintaining both the tide takes about 24 to 25 hours; there are two tidal cycles each month with each cycle lasting 15 days.

Table 2 - 4: Monthly water-level at some of the station (m, national altitude system)

No.	Station	Character	Month											
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1	Ben Trai	Max	1.83	1.72	1.59	1.42	1.39	1.26	1.34	1.46	1.68	1.88	1.90	1.83
		Min	-2.29	-2.22	-2.08	-2.15	-2.40	-2.51	-2.58	-2.50	-2.35	-2.11	-2.30	-2.18
2	An Thuan	Max	1.50	1.42	1.35	1.26	1.12	1.02	1.05	1.14	1.35	1.52	1.53	1.49
		Min	-1.84	-1.82	-1.67	-1.82	-2.04	-2.15	-2.16	-2.14	-1.97	-1.66	-1.78	-1.85
3	My Hoa	Max	1.55	1.55	1.44	1.26	1.20	1.11	1.23	1.30	1.52	1.68	1.66	1.54
		Min	-1.75	-1.88	-1.89	-1.87	-2.09	-2.18	-2.25	-2.06	-1.94	-1.61	-1.73	-1.77

Source: FS Report 2014

Overall, the largest average monthly water level falls in the months of XI, XII and the lowestones are in VI, VII, VIII, so it can be confirmed that hydrology of the project area is affected by mainly tides from the East Sea.

Table 2 - 5: Frequency of water level at some stations

No.	Station	Water level frequency Max (m)					Water level frequency Min (m)				
		1%	1.5%	2%	5%	10%	80%	90%	95%	97%	99%
1	My Hoa	1.77	1.74	1.71	1.69	1.65	-2.18	-2.24	-2.30	-2.34	-2.42
2	An Thuan	1.92	1.91	1.87	1.80	1.74	-2.30	-2.34	-2.38	-2.40	-2.44
3	Ben Trai	1.96	1.94	1.90	1.88	1.83	-2.49	-2.54	-2.58	-2.61	-2.66

Source: FS Report 2014

Table 2 - 6: Frequency of water level at Cho Lach station

Water level frequency Max (cm)							
0.02%	0.2	0.5%	1.0%	1.5%	2.0%	5.0%	10%
2.10	2.03	1.99	1.96	1.93	1.92	1.87	1.83
Water level frequency Min (cm)							
75%	80%	90%	95%	97%	98%	99%	
-1.66	-1.67	-1.69	-1.70	-1.71	-1.74	-1.75	

Source: FS Report 2014

Mike 11 model was used to simulate the distribution of water in the project area. Results are shown in the following figure:

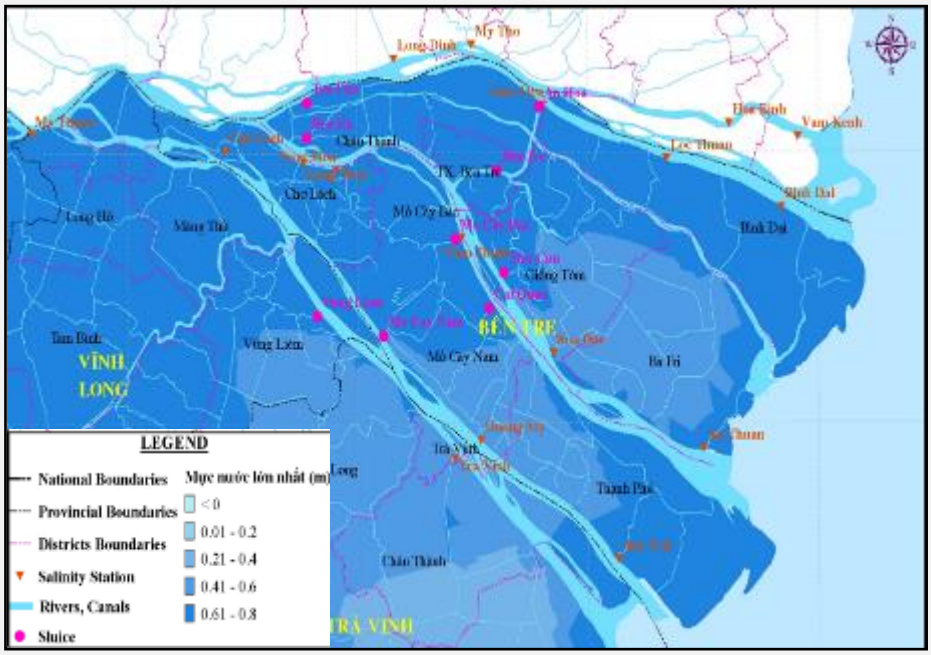


Figure 2 - 2: Current status of the largest water distribution during low tide in May

Salinity state: Saltwater from the East Sea has entered the project area under the Ham Luong River and Co Chien River and opening canals. Evolution of salinity is similar to fluctuations of the tide and it depends on tidal period (more or less intensity).

Statistics of salinity measurements at locations in the My Hoa in 10 years from 1997 to 2006 are as follows:

Table 2 - 7: Salinity level in My Hoa´

1	Years with salinity level< 4‰	1997, 2000, 2001, 2003, 2006				
2	Years with salinity level> 4‰	1998	1999	2002	2004	2005
a	Number of days with salt water	52	24	11	69	75
b	Months with salt water	3, 4, 5	3, 4	4, 5	3, 4, 5	3, 4, 5
b1	The number of days with salty water in January					
-	Number of hours in the day that water is salty:					
-	Number of hours with the least level of salinity					
b2	The number of days with salty water in Febuary					
-	Number of hours in the day that water is salty:					
-	Number of hours with the least level of salinity					
b3	The number of days with salty water in March	30, 31	2÷5, 17÷31		6÷31	5÷31
-	Number of hours in the day that water is salty:	14 hours	22hours		20hours	24hours
-	Number of hours with the least level of salinity	8 hours	hours		2hours	6 hours
b4	The number of days with salty water in April	1 ÷ 30	1÷4, 6	27÷30	1÷30	1÷30
-	Number of hours in the day that water is salty:	24 hours	18hours	4hours	24hours	24hours
-	Number of hours with the least level of salinity	6 hours	2 hours	2hours	8hours	12hours
b5	The number of days with salty water in May	1 ÷ 20		1÷6,10	1÷11, 14, 15	1÷10, 21÷28
-	Number of hours in the day that water is salty:	24 hours		8hours	20hours	14hours
-	Number of hours with the least level of salinity	2 hours		2hours	2hours	2hours

Source: FS Report 2014

The distribution of the concentration of salt in the project area is simulated by the Mike model, calculated with hydrological conditions in 2005. This is the year with the lowest water level in the area, sometimes in April and May, water flow at Kratie gets really low, affecting salinity intrusion across the Mekong Delta. Data used in calculating the figures are observed since late March to early April 2005.

Table 2 - 8: Current status of salinity level in the field and in the river outside at 8 locations planned for construction works.

No.	Sluice-gate location	Current state	
		In the river (‰)	At the field (‰)
1	Tan Phu	0.63	0.56
2	Ben Ro	0.72	0.67
3	An Hoa	10.85	10.57
4	Ben Tre	4.99	3.69
5	Vam Nuoc Trong	8.14	5.90
6	Thu Cuu	10.28	7.66
7	Cai Quao	10.28	8.89
8	Vam Thom	4.08	3.54

Source: Results from MIKE11, 2014 model

Results showed that the level of salinity intrusion is very high in the area of An Hoa, Thu Cuu, Cai Quao sluice-gates, where salinity outside the rivers ranges from 10.28 ‰ to 10.85 ‰ and the level in the field ranges from 7.66 ‰ to 10.57 ‰. Especially in place planned for construction of An Hoa sluice-gate, the salinity intrusion inside the field and outside the river exert a very small difference (10.57‰ and 10.85‰). As recommended by the Department of Agriculture, Rural Development, Ben Tre, even for the fruitsthat can withstand high salinity including some crops like mango, sapoche, coconut, they can only just tolerate salinity level of 2-5‰. Thus, in the sluice-gate construction communes, An Hoa, Thu Cuu, Cai Quao including Long Dinh, Giao Hoa, Phuoc Long, Thanh Phu Dong, Binh Dong Khanh, it is nearly impossible to grow any fruit trees in the area close to the river.

The results are presented in the following figure:

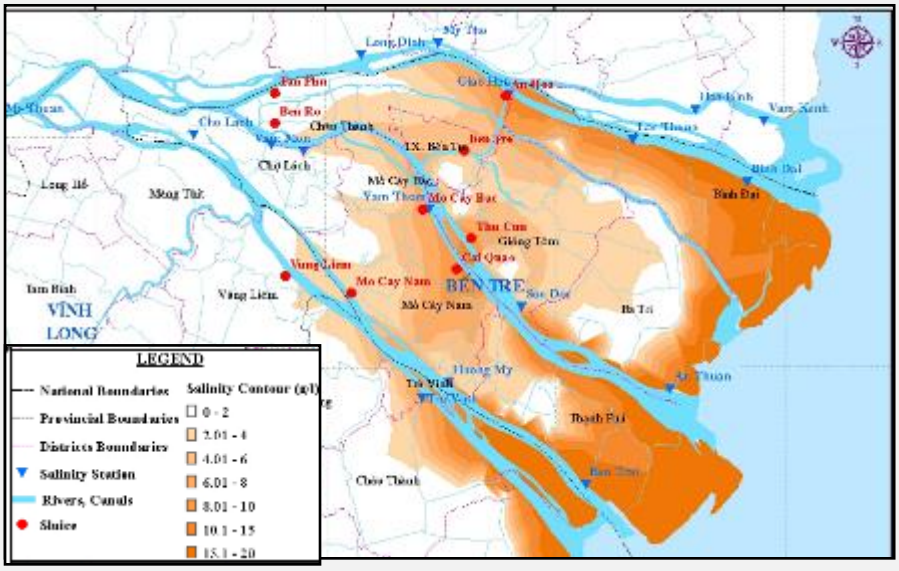


Figure 2 - 3: Distribution of salinity levels in the project area

Conditions of the rivers:

Located in the Lower Mekong Basin, bordering the East Sea, Ben Tre has a vast river network with a total length of 6,000 km, of which Co Chien River is 82km, Ham Luong River is 71 km, Ba Lai River is59 km, My Tho river is 83 km ...

River system creates favorable waterway, rich aquatic resources and watering for crops is less difficult. However, it interferes with the water supply in the dry season, when the tide from the East Sea put salt deep into the canals during the wind season...

Also, Ben Tre has a network of rivers, streams, canals connecting local together, forming a communication network and convenient irrigation system. On average along the main river, about 1 to 2 km is a canal or channel. Ben Tre has hundreds of rivers, canals and channels, while there are more than 60 rivers, canals, channels with 50 ÷ 100 m wide. Notably is the following rivers and canals:

- Ben Tre River: approximately 30 km long and runs from the center of Bao isle (Tan Hao - Giong Trom), a channel linking the Chet Say canal through Ba Lai river, a

branch across town, towards Ham Luong River. This is an important waterways of the province.

- Cai Mon canal: 11 km long, flowing through the famous fruit-rich Vinh Thanh, Vinh Hoa (Cho Lach) towards Ham Luong River.
- Mo Cay canal: flowing through Mo Cay communal town (through Mo Cay Thom canal) to Hoa Loc, entering the Giong Keo canal, towards Ham Luong River.
- Mo Cay Thom canal: connecting Mo Caywith Thom canal, creating traffic route between Ham Luong and Co Chien Rivers, 15 km long. This canal with Chet Say - An Hoa canal in the Minh isla form an important waterway connecting My Tho (Tien Giang), Ben Tre, Tra Vinh and Mo Cay.
- Bang Cung canal: a branch of Ham Luong River flowing from Dai Dien, My Hung to Giao Thanh towards Ham Luong river, 23km long a tributary flowing into the Co Chien River.
- Ba Tri canal: flowing from Phu Le, Phu Ngai through the town of Ba Tri towards Ham Luong River, just 8km has valuable traffic, it is for irrigation in Ba Tri district.
- Dong Xuan canal 11km long connecting Ba Tri and Tan Xuan canals.
- Chet Say – An Hoa canal: 6km long connecting Ben Tre river with Ba Lai river. Next is the 3.5 km long canal of An Hoa canal linking the Ba Lai river with My Tho river, it is an important waterway from Ham Luong River across the town of My Tho, Ben Tre and other provinces.

Some new canals have just been dug after the liberation with pump station hub to cater to the requirements of development of agricultural production, such as:

- Main canals, A and B (Giong Trom – Ba Tri).
- Huu Dinh – Chet Say canal (Chau Thanh).
- An Hoa – Thoi Lai canal (Binh Dai).
- Hung Khanh Trung – Vinh Thanh canal (Cho Lach).
- An Dinh – Tan Trung canal (Mo Cay).

1.1.4 The hydrological, oceanographic conditions

Unusual weather events, natural disasters, floods, landslides

Negative influence from saline water intrusion is intensifying in the Mekong delta. The Irrigation and Flood Prevention Division in DARD has been issuing ‘a damage report’ since 1993, which says that damage by saline water intrusion became obvious after 1998. Saline water intrusion damages fishing industries and domestic non-commercial water as well as farming. Recently, there was saline damage around the proposed Ben Tre sluice gate construction site in December 2014 and the saline content was recorded as high as more than 4%. The major damages in the past are summarized in the following table.

Table 2 - 9: Damage by Saline water intrusion

Year	Affected Area (ha)	Damage Cost (VND billion)	Shortage of Domestic water (household)
1998	25,600	30,000	
2002	20,000	1,900	50,000
2004	10,000	12,078	16,000
2005	60,000	569,760	110,000
2006		80	4,000
2007	450		
2010	98,000	200	
2011	9,600		
2013	13,000	80	84,900

Source: Damage Report (1993-2014) by Irrigation and Flood Prevention Division

A hydraulic type of saline water intrusion in the Mekong Delta was confirmed in a JICA Study (2013). According to P6-6 of the main report of the JICA Study (2013), there is no salt wedge phenomenon in the Ben Tre province, while there is an intensive mixing phenomenon of saline water intrusion.

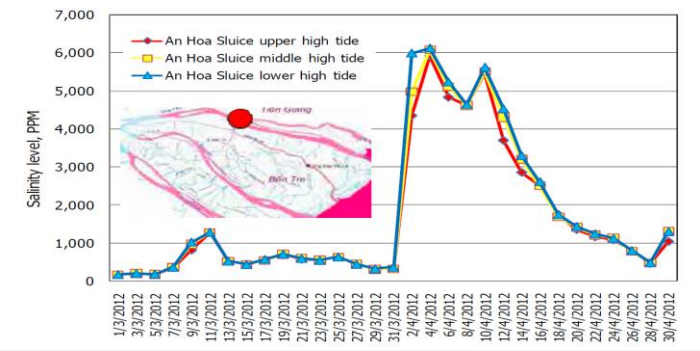


Figure 2 - 4: Salinity Distribution by Depth in An Hoa District in Ben Tre Province

Source: JICA Project for Climate Change Adaptation for Sustainable Agriculture and Rural Development in the Coastal Mekong Delta (2013)

Although the tolerance against salinity differs by type of crop, 4.0‰ is set as a threshold for irrigation water. Nearly 30% of existing agricultural lands are expected to undergo salinity at levels higher than these crops can survive at a productive level.

Table 2 - 10: Agricultural Land Area by Saline Concentration and by Major Crops Categorized

Unit: ha | Saline concentration is "‰" or "gram per litter."

Saline Concentration	Coconuts	Fruits	Paddy	Vegetable	Total	%	%
<0.5	14,554	11,167	2,092	1,629	29,442	21%	72%
0.5-1.0	5,469	3,674	3,278	2,423	14,844	11%	
1.0-2.0	7,952	5,440	7,942	2,389	23,723	17%	
2.0-4.0	11,459	666	15,144	3,722	30,991	23%	
4-10	19,791	3,406	5,564	3,728	32,489	24%	28%
10-20	2,002	107	0	61	2,170	2%	
>20	166	766	726	1,928	3,586	3%	
Total	61,394	25,226	34,747	15,878	137,244	100%	100%
	45%	18%	25%	12%	100%		

Source: JICA B-SWAMP Survey Team (2016)

Note: Total area is the agricultural land use area in whole Ben Tre with simulated saline concentrate in 2050 without project.

Issues Caused by Saline water intrusion for Water Supply in Urban Area

Saline water intrusion into rivers has caused serious issues in the water supply for urban areas, canals, and boreholes/wells. In the Huu Dinh Water Supply Plant, the main water source, which was a borehole (as aforementioned in the groundwater section), salt water has entered into those boreholes resulting in being forced to stop taking water from those boreholes. Currently, the Ba Lai River is only one water resource to be treated and supplied. Consequently, although the designed water supply capacity is 10,500 m3/day, the actual water supply capacity stays at only 3,500 m3/day.

Moreover, in Luong Quoi, source water taken from a canal shows very high salinity concentration. Therefore, metal parts such as pipes and screens have been damaged and deteriorated by corrosion faster than the usual estimation for such.

The water source of the Son Dong Water Supply Plant is the surface water of an adjacent canal. From March to May in the dry season, saline water intrusion into the canal results in water intake being stopped. It shows that the high saline content period in raw water as more than 300 mg/l continued for a long time, especially in 2004, 2005, 2010, 2011 and 2013.

Situation and Damage from Flood and High Tide

Based on the Natural Disaster Report prepared by the Steering Committee for Flood and Storm Prevention of the Ben Tre Province since 1993, the situation and damage from floods and high tide were analyzed. The highest damage cost by flood and high tide in the Ben Tre Province was VND 205 billion in 2000. And the average for 22 years, from 1993 to 2014, is VND 31 billion/year.

Table 2 - 11: Situation of Flood and High Tide Disaster

Year	Situation	District	Damage Cost (VND .Bill)	Inundated Area (ha)
1993	None			
1994	Heavy rain in the upstream caused earlier and longer flood than usual, and with high tide, long inundation was occurred. Damage in whole Mekong Delta was VND 2,399 Billion.	Cho Lach, Chau Thanh, Thanh Phu, Binh Dai Distric	1.000	
1995	Flood and high tide caused dyke collapse and inundation.	Thanh Phu District, Cho Lach District	0.200	
1996	Dyke collapse caused long inundation.	Cho Lach, Chau Thanh, Thanh Phu District	18.697	3,604.50
1997	Typhoon Linda (No. 26) caused flooding and high tide and damaged heavily.	Cho Lach, Ba Tri, Thanh Phu District		
1998	None			

Year	Situation	District	Damage Cost (VND .Bill)	Inundated Area (ha)
1999	Rice, sugar cane, fruit tree were damaged and national roads and provincial roads were inundated.	Mo Cay, Thanh Phu, Ben Tre City, Binh Dai	8.926	4080.4
2000	Overflow and erosion of dyke caused large area inundation.		205.000	8490
2001	Overflow and erosion of dyke and erosion of sluice gate caused large area inundation.		109.369	28350
2002	Overflow and erosion of dyke and erosion of sluice gate caused large area inundation.		17.366	
2003	None			
2004	Tornado, storm and tropical depression caused house damage.	Mo Cay, Ba Tri, Binh Dai District	0.226	
2005	Heavy rain with tornado and heavy rain with high tide caused inundation.	Giong Tom, Ba Tri District	0.132	
2006	High tide in February and Typhoon No. 9 caused damage.		9.779	
2007	High tide caused damage.	Cho Lack, Chau Thanh	0.945	
2008	High tide caused damage.	Binh Dai, Thanh Phu, Ba Tri	0.700	
2009	High tide caused damage.	Mo Cay Bac, Cho Lach, Binh Dai, Ba Tri, Thanh Phu	1.463	
2010	Tropical depression, tornado and high tide caused damage.		69.520	
2011	Unseasonal heavy rain and high tide caused inundation.	Ba Tri, Binh Dai	87.672	
2012	High tide and tropical depression caused damage.		2.130	
2013	High tide and tropical depression caused damage.		15.906	
2014	High tide caused damage.		17.900	
Ave.			31.496	

Source: JICA B-SWAMP Survey Team (2016)

River Bank Erosion

a) Types of Erosion

Riverbank erosion and sediment deposition are regarded as homeostatic phenomena caused by river force; this is because those natural phenomena are unavoidable in the project area. The project cannot protect all riverbanks from erosion in and around Ben Tre, so that the project shall deal with the riverbank erosions only at and vicinity of the sluice gates to be constructed. In general, some protection works such as riverbank revetment and bed protection are required and provided at up-and-down-streams of sluice gate. It is considered that there are predominantly three types of riverbank erosion in and around the project area; it is summarized in the following table.

Table 2 - 12: Types of Erosion observed in and around Ben Tre Province

Erosion Types	Causes of Erosion in and around Ben Tre
Lateral Erosion	The river flow force flashes soils away from the river banks.
Erosion by Ship-generated Wave	The ship-generated wave flashes soils away from the river banks.
Erosion due to Dredging	Due to over dredging at river bed, river banks are collapsed,

B-SWAMP Survey Team (2016)

According to the 'River Bank Erosion Report' produced by the Rural Development Division in DARD, it is reported that there is some bank erosion in canals, including the proposed construction site of eight (8) sluice gates. The JICA survey team has confirmed bank erosion in An Hoa, Vam Nuoc Trong, Vam Thom, and Cai Quao among eight (8) sites surveyed during a field survey in August 2015.

Figure 2 - 5: Observed Bank Erosion (Left: Cai Quao Right: Vam Thom)

Source : JICA B-SWAMP Survey Team (2016)

b) Lateral Erosion

An engineer in charge of riverbank erosion of DARD considers that cause of this riverbank erosion is lateral erosion by running water, not seepage failure. Figure 2-6 shows the condition of riverbank erosion in the 'River Bank Erosion Report'.

There are huge bank erosions -- more than 7m in a year -- shown by red-colored lines. In the vicinities of An Hoa, Ben Tre, and Moc Cay Bac, the red colored lines can be seen. According to this report, more than a total of 10 ha of residential area was lost and a total of 1,122 households had to evacuate from the bank areas due to bank erosion from 1990 to 2011 in the Ben Tre province. In addition, it is estimated that 8,928 households will be affected until 2020.

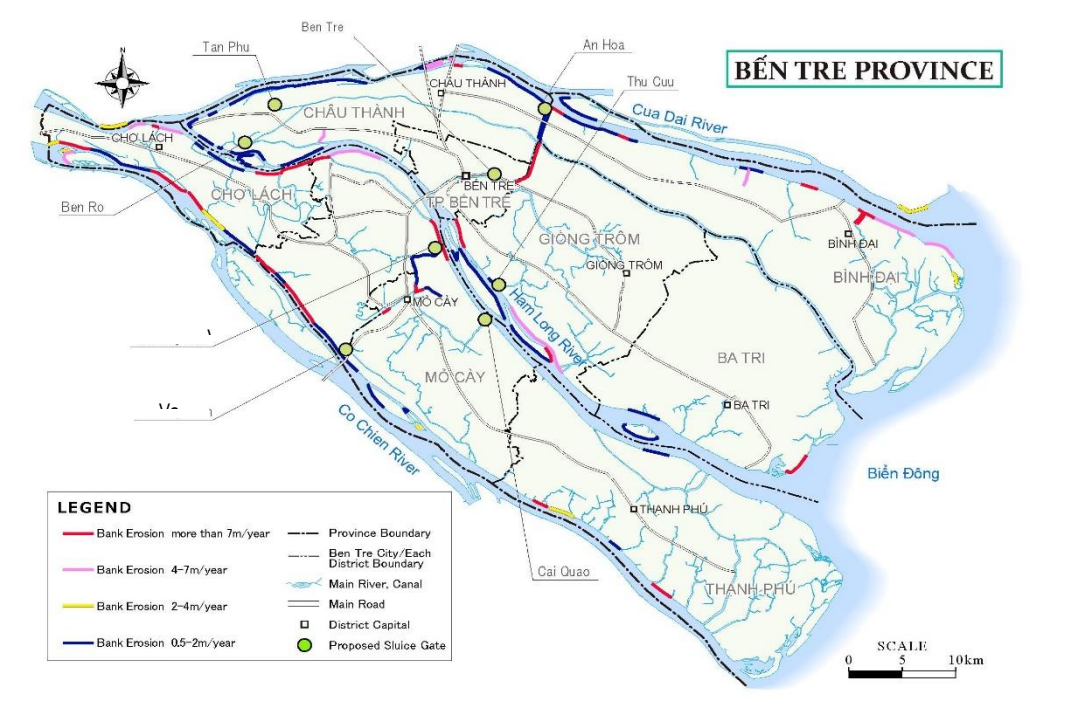


Figure 2 - 6: Bank Erosion Condition in Ben Tre province

Source : DARD Rural Development Division (2011)

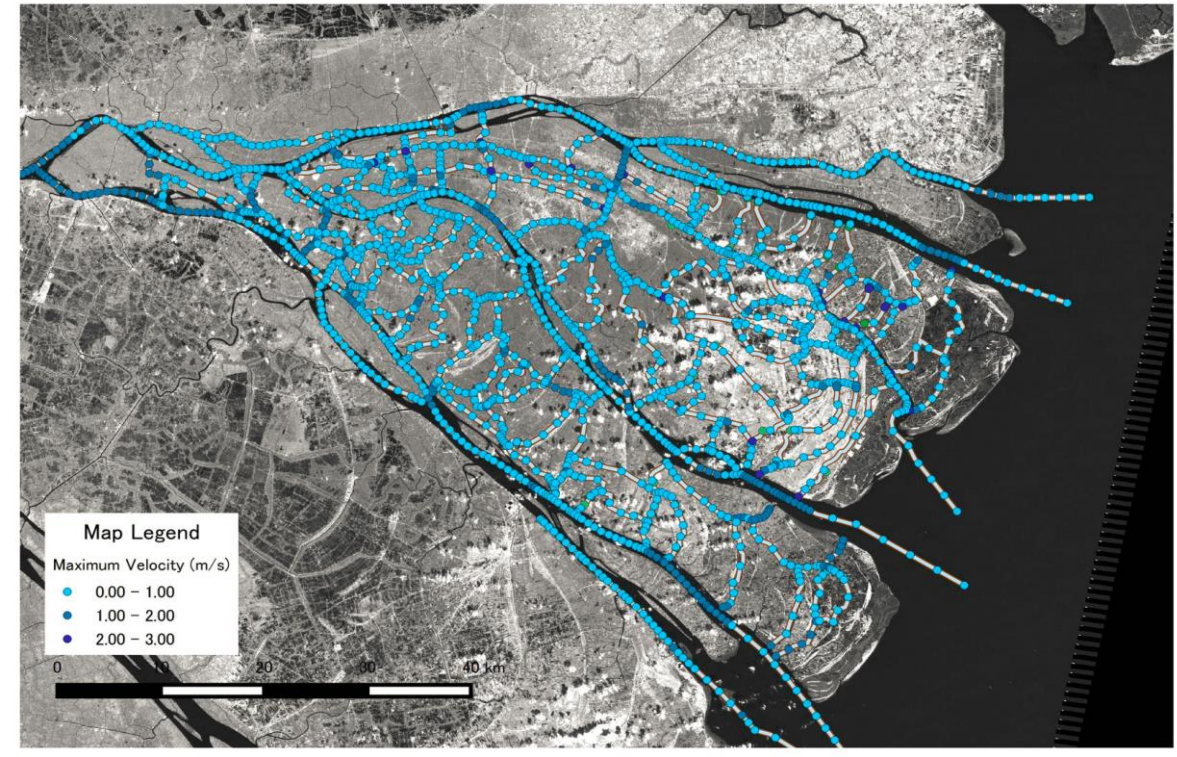


Figure 2 - 7: Distribution of Maximum Velocity (Calculated with Existing Condition)

Source： JICA B-SWAMP Survey Team (2016)

Figure 2-7 shows calculated maximum flow velocity in the dry season which was obtained from computer simulation developed under this survey. Maximum flow velocity of the Ben Tre Province is about 3 m/s according to the results. Locations of the maximum flow velocity shown in Figure 2-7 mostly corresponds to the severe erosion areas shown in Figure 2-6 It means that high flow verbosity is the major cause of lateral erosion in and around Ben Tre as the Engineer's comment aforementioned.

The current velocity around the proposed sluice gates is at most about 2 m/s. This results indicate that revetment works can be applied to prevent riverbank erosion in the lower reaches and the upper reaches of the sluice gates.

c) Ship-generated Waves and Effect of Dredging

Ship-generated waves and effect of dredging are also considered as causes of riverbank erosion. The riverbank in the Arakawa lower reaches undergoes the influence of ships generating waves in Japan[1]. An experiment is being conducted to reduce the effect of ship-generated waves by using Yoshi vegetation planted along the riverbank. (However, this experiment is to protect against erosion along with keeping the natural bank.) High density of waterway transportation in Ben Tre will also cause riverbank erosion and it can be also mitigated by the same method as aforementioned. It's possible to prevent riverbank erosion caused by ship-generated waves by installing revetment works.

There are some sand mines to collect sands for construction in the Ben Tre province. The sand mining may affect bank erosion and the foundation of the sluice gate. Figure 2-8 shows the permitted area on sand dredging. Three areas are identified which correspond to high erosion area '7m/year' shown in Figure 2-8. Note that there is a sand mining area near the Thu Cuu sluice gate. Because the river width around the gate is about 500m at Ham Luong River, the sand mining will not affect this sluice gate in case of mining in the center of the river. Ordinary protection works can prevent bank erosion at the Thu Cuu sluice.

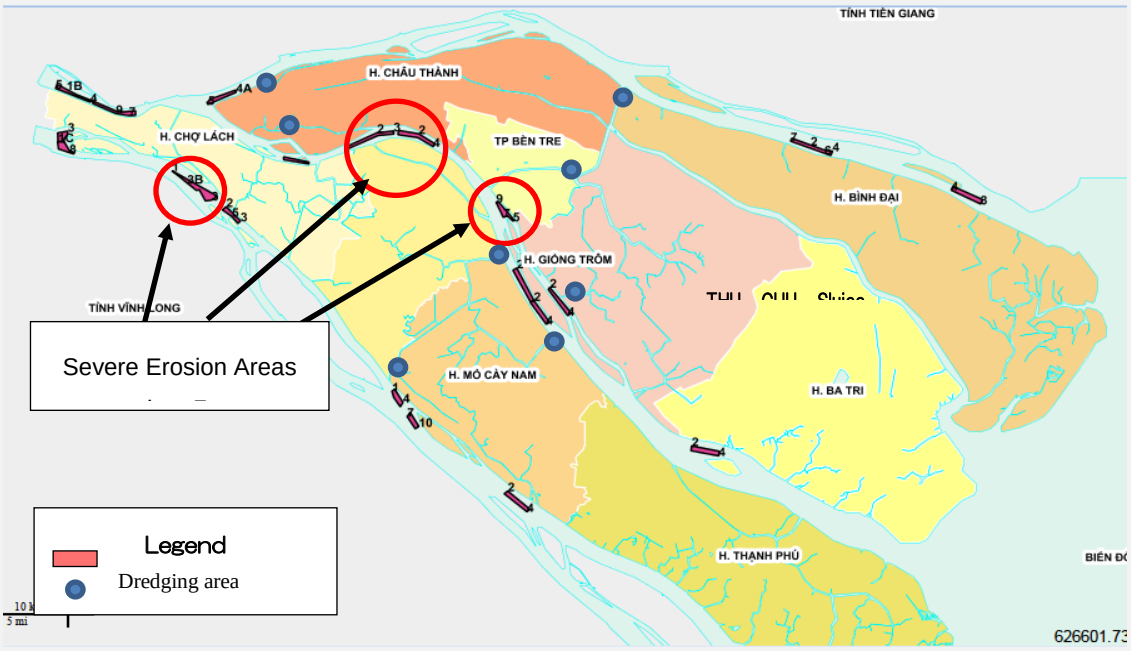


Figure 2 - 8: Permitted area for Dredging

Source：Ben Tre DONRE

1.1.5 Status of the quality of the physical components of the environment

To assess the current state of environmental quality in the project area, EIA consultants has (i) collected samples of surface water, groundwater, soil i to evaluate the biological, physical and chemical parameters. (ii) used the MIKE 11 model to simulate BOD, N, P concentration levels in the project area.

Sampling was carried out from 10/10/2014 until 16/10/2014. The process of sampling and preservation of samples were carried out in accordance with current regulations.

Total number of samples for observation and analysis is 64 samples, in which:

- 8 air quality samples from the Department of Natural Resources and Environment of Ben Tre Province measured in the rainy season in 2014.
- 32 samples of surface water, 4 samples were taken at each location of construction.
- 16 samples of groundwater, 2 samples were taken at each location of construction.
- 16 samples of soil, 2 samples were taken at each location of construction.

2.1.4.1. Monitoring and analysis of environmental parameters

a Location map of environmental sampling for analysis

At each position of the surface water, samples taken include 04 from surface, 02 from groundwater and 02 soil samples. Map of the location for collecting samples is as in Figure 2-5. Among them:

- NM1: First surface water sampling location
- NM2: Second surface water sampling location
- NM3: Third surface water sampling location
- NM4: Forth surface water sampling location
- NN1: First ground water sampling location
- NN2: Second ground water sampling location
- Đ1: First soil sample location
- Đ2: Second soil sample location

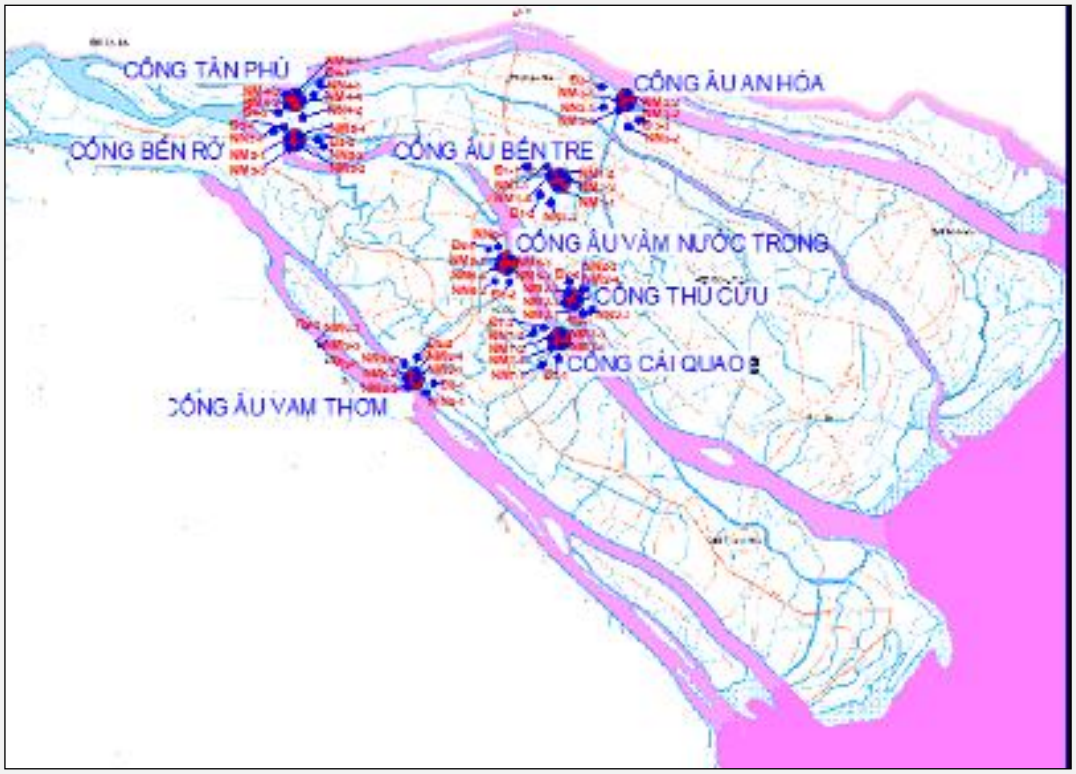


Figure 2 - 9: Locations of environmental sampling positions

b Air environment

Annually, the Center for Environmental Monitoring, Department of Natural Resources and Environment of Ben Tre province perform environmental monitoring in the town on the districts. According to the results of environmental monitoring of Ben Tre 1st batch in 2014 the parameters of air quality are as in the following table:

Table 2 - 13: Air quality at the communal-town in the district area

Unit: mg/m^3

No	Location	Time	Total dust	PM10	SO2	NO2	CO	O3	Pb
1	Giong Trom communal town, Giong Trom district	Rain season 2014	0.23	0.10	0.083	0.050	3.07	0.052	0.019
2	Ba Tri communal town, Ba Tri district	Rain season 2014	0.27	0.15	0.088	0.061	3.73	0.040	0.010
3	Binh Dai communal town, Binh Dai district	Rain season 2014	0.32	0.17	0.097	0.075	4.15	0.043	0.033
4	Chau Thanh communal town, Chau Thanh district	Rain season 2014	0.18	0.08	0.079	0.046	2.20	0.029	KPH
5	Cho Lach communal town, Cho Lach district	Rain season 2014	0.16	0.07	0.063	0.027	0.80	0.022	KPH
6	Mo Cay Bac communal town, Mo Cay Bac district	Rain season 2014	0.24	0.12	0.092	0.070	3.66	0.033	0.028
7	Mo Cay Nam communal town, Mo Cay Nam district	Rain season 2014	0.33	0.23	0.12	0.078	5.38	0.050	0.064
8	Thanh Phu communal town, Thanh Phu district	Rain season 2014	0.22	0.09	0.077	0.043	2.09	0.028	0.010
QCVN 05:2013/BTNMT		Average in 1h	0.3	-	0.35	0.2	30	0.18	-
		Average in 24h	0.2	0.0015	0.125	0.1	5.0	0.08	0.0015

Source: Center for Environmental Monitoring, Ben Tre DONRE

The analysis of air quality in towns and districts in comparison with 05 QCVN: 2013/BTNMT shows that the majority of the parameters meet the standards. Except for dust content in Mo Cay Nam and Binh Dai towns, which is beyond permissible limits but it's not significant at 1.07 and 1.10 times the allowed level. The main reason may be due to the transport. For the project area, the dust activities are mainly the activities of agricultural production and transport vehicles which are mainly motorized vehicles and motorcycles; therefore it can be said that the air environment in the project area is good and the parameters are within permissible limits in comparison with QCVN 05: 2013 / BTNMT.

c Surface water

<u>According to Ben Tre DONRE</u>

DONRE measures water quality twice a year. Sampling points are 54. Measurement items are pH, DO, TSS, BOD, COD, N-NH4 and Coliform. According

to the 'Environmental Monitoring Report' prepared by DONRE（dry season in 2014）, there are 54 sampling points in the Ben Tre province and 54% (29/54) of the points have the worst level of water quality (polluted and purification measures are necessary) in the water quality index. The second worst level of water quality (water transportation or similar uses are possible) is 2% (1/54), and the third level (irrigation or similar uses are possible) is 14% (8/54). The fourth level (available for drinking water but with any treatment necessary) and the fifth level (available for drinking water) are 30% (16/54) referred to in Figure 2 - 10）.

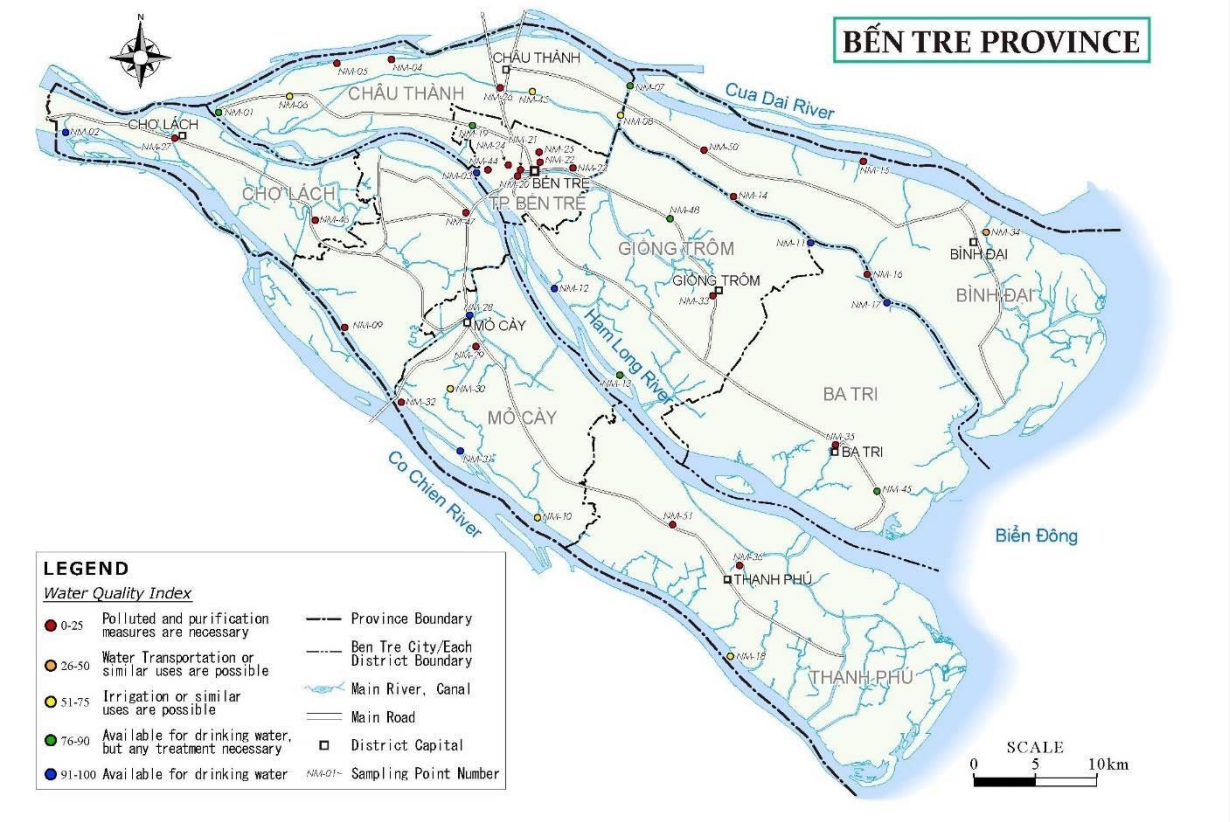


Figure 2 - 10: Observed Water Quality at 54 Points in Ben Tre Province

Source : DONRE (2014)

On the other hand, ammonia and coliform are over 'the water quality standard' in the upper stream in the dry season. Causes include absence of a sewage plant, growth of population in the upper stream, and the growth of stock farming (pigs, etc.).

<u>According to environmental monitoring results in 2014</u>

1. Sampling locations:

Table 2 - 14: Sampling locations of surface water

No.	Location	Code	Coordinate	
			N	E
I	Ben Tre lock			
1	Surface water at the central part of the sluice-gate in Ward 8, Ben Tre city	NM1-1	10°14'131''	106o23'486''
2	Surface water at the central part of the sluice-gate in Nhon Thanh commune	NM1-2	10°14'830''	106o23'082''

No.	Location	Code	Coordinate	
			N	E
3	Upstream surface water 200m from the central part of the sluice-gate	NM1-3	10°14’330’’	106o23’382’’
4	Downstream surface water 200m from the central part of the sluice-gate	NM1-4	10°14’017’’	106o23’013’’
II	Thu Cuu sluice-gate			
1	Surface water at the central part of the sluice-gate in Thach phu Dong commune	NM2-1	10o08’266’’	106o24’456’’
2	Surface water at the central part of the sluice-gate in Phuoc Long commune	NM2-2	10o08’452’’	106o24’105’’
3	Upstream surface water 200m from the central part of the sluice-gate	NM2-3	10o08’392’’	106o24’6561’
4	Downstream surface water 200m from the central part of the sluice-gate	NM2-4	10o08’258’’	106o24’304’’
III	An Hoa lock			
1	Surface water at the central part of the sluice-gate in Giao Hoa commune	NM3-1	10o17’175’’	106o26’680’’
2	Surface water at the central part of the sluice-gate in Long Dinh commune	NM3-2	10o17’652’’	106o26’356’’
3	Upstream surface water 200m from the central part of the sluice-gate	NM3-3	10o17’470’’	106o26’423’’
4	Downstream surface water 200m from the central part of the sluice-gate	NM3-4	10o17’016’’	106o26’246’’
IV	Tan Phu sluice-gate			
1	Surface water at the central part of the sluice-gate in Phu Duc commune	NM4-1	10o17’201’’	106o12’283’’
2	Surface water at the central part of the sluice-gate in Tan Phu commune	NM4-2	10o17’256’’	106o12’412’’
3	Upstream surface water 200m from the central part of the sluice-gate	NM4-3	10o17’389’’	106o12’473’’
4	Downstream surface water 200m from the central part of the sluice-gate	NM4-4	10o17’075’’	106o12’092’’
V	Ben Ro sluice gate			
1	Surface water at the central part of the sluice-gate in left of Tien Long commune	NM5-1	10o15’960’’	106o11’885’’
2	Surface water at the central part of the sluice-gate in right of Tien Long commune	NM5-2	10o15’881’’	106o11’746’’
3	Upstream surface water 200m from the central part of the sluice-gate	NM5-3	10o15’764’’	106o11’673’’
4	Downstream surface water 200m from the central part of the sluice-gate	NM5-4	10o15’820’’	106o11’745’’
VI	Vam Nuoc Trong sluice-gate			

No.	Location	Code	Coordinate	
			N	E
1	Surface water at the central part of the sluice-gate in Tan Thanh Binh commune	NM6-1	10o10’976’’	106o20’013’’
2	Surface water at the central part of the sluice-gate in Dinh Thuy commune	NM6-2	10o10’623’’	106o20’299’’
3	Upstream surface water 200m from the central part of the sluice-gate	NM6-3	10o10’779’’	106o20’284’’
4	Downstream surface water 200m from the central part of the sluice-gate	NM6-4	10o10’553’’	106o20’453’’
VII	Cai Quao sluice-gate			
1	Surface water at the central part of the sluice-gate in the left bank	NM7-1	10o06’133’’	106o23’486’’
2	Surface water at the central part of the sluice-gate in the right bank	NM7-2	10o06’159’’	106o23’581’’
3	Upstream surface water 200m from the central part of the sluice-gate	NM7-3	10o06’029’’	106o23’276’’
4	Downstream surface water 200m from the central part of the sluice-gate (Phuoc Ly ferry	NM7-4	10o05’939’’	106o23’293’’
VIII	Vam Thom sluice-gate			
1	Surface water at the central part of the sluice-gate in Thach Thoi B commune	NM8-1	10o05’134’’	106o16’724’’
2	Surface water at the central part of the sluice-gate in Khanh Thanh Tan commune	NM8-2	10o05’098’’	106o16’818’’
3	Upstream surface water 200m from the central part of the sluice-gate	NM8-3	10o05’305’’	106o16’586’’
4	Downstream surface water 200m from the central part of the sluice-gate (Rach ferry)	NM8-4	10o05’034’’	106o16’824’’

2. Comparison basis:

The results of analysis of surface water samples were compared with QCVN 08:2008/BTNMT - National Technical Regulation on water quality (level B1 for irrigation purposes).

3. Evaluation:

Table 2 - 15: Results of analysis of surface water samples at the project area

No	Parameter	Unit	Ben Tre sluice-gate				Thu Cuu sluice-gate				QCVN 08:2008
			NM1-1	NM1-2	NM1-3	NM1-4	NM2-1	NM2-2	NM2-3	NM2-4	
1	pH	-	6.8	6.8	6.8	6.8	6.7	6.7	6.8	6.7	5.5-9
2	Salinity level	‰	0	0	0	0	0.01	0.01	0.01	0.01	
3	SS	mg/l	160	164	158	165	154	155	155	157	50

4	DO	mg/l	5.1	5.2	5.2	5.3	5.2	5.3	5.4	5.3	≥4
5	COD	mg/l	14	15	15	15	17	16	17	18	30
6	BOD5	mg/l	7	7	6	8	8	8	7	8	15
7	Fe2+	mg/l	0.6	0.6	0.7	0.6	0.4	0.4	0.4	0.4	1.5
8	Fe3+	mg/l	1.2	1.2	1.3	1.2	1.1	1.1	1.1	1.1	1.5
9	Na+	mg/l	125	126	125	127	130	131	131	132	
10	Cl-	mg/l	350	352	348	351	354	354	349	351	600
11	NH4+	mg/l	0.35	0.34	0.33	0.36	0.41	0.42	0.40	0.41	0.5
12	NO2- N	mg/l	0.008	0.008	0.008	0.008	0.02	0.02	0.02	0.02	0.04
13	NO3- N	mg/l	0.5	0.5	0.5	0.6	1.5	1.5	1.5	1.6	10
14	SO42-	mg/l	1.3	1.3	1.2	1.4	1.1	1.2	1.2	1.2	
15	Al3+	mg/l	0.7	0.65	0.6	0.7	0.6	0.65	0.6	0.7	
16	PO43-	mg/l	0.08	0.08	0.07	0.08	0.08	0.07	0.07	0.07	0.3
17	Zn	mg/l	0.2	0.2	0.2	0.2	0.18	0.18	0.19	0.19	1.5
18	Pb	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
19	Hg	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.001
20	As	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
21	Oil	mg/l	0.008	0.008	0.008	0.008	0.007	0.007	0.007	0.007	0.1
22	Coliform	MPN/ 100ml	8200	8250	8198	8270	7200	7220	7228	7230	7500
23	The residues of plant protection root P	µg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.32
24	The residues of plant protection root C1	µg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004

Source: Results of environmental factor sample analysis, October 2014.

Table 2 - 16: Results of analysis of surface water samples at the project area (continue)

No	Parameter	Unit	An Hoa sluice-gate				Tan Phu sluice-gate				QCVN 08:2008
			NM3-1	NM3-2		NM3-4	NM4-1	NM4-2	NM4-3	NM4-4	
1	pH	-	6.5	6.5	5.5-9	6.5	7.5	7.5	7.6	7.5	5.5-9
2	Salinity level	‰	0	0		0	0	0	0	0	
3	SS	mg/l	144	145	50	147	114	115	115	117	50
4	DO	mg/l	5.5	5.4	≥4	5.5	5.7	5.8	5.8	5.7	≥4
5	COD	mg/l	15	14	30	15	10	11	11	11	30
6	BOD5	mg/l	6	6	15	7	5	5	5	6	15
7	Fe2+	mg/l	0.5	0.5	1.5	0.5	0.3	0.3	0.3	0.3	1.5
8	Fe3+	mg/l	1.2	1.2	1.5	1.2	0.8	0.8	0.8	0.9	1.5
9	Na+	mg/l	140	141		142	120	121	121	122	
10	Cl-	mg/l	364	364	600	361	284	284	289	291	600
11	NH4+	mg/l	0.21	0.22	0.5	0.21	0.12	0.12	0.11	0.11	0.5
12	NO2- N	mg/l	0.02	0.02	0.04	0.02	0.01	0.01	0.01	0.01	0.04
13	NO3- N	mg/l	0.8	0.8	10	0.9	0.08	0.08	0.08	0.09	10
14	SO42-	mg/l	0.9	0.9		0.8	0.5	0.5	0.4	0.5	
15	Al3+	mg/l	0.5	0.55		0.5	0.3	0.3	0.3	0.4	
16	PO43-	mg/l	0.05	0.05	0.3	0.05	0.04	0.04	0.05	0.05	0.3
17	Zn	mg/l	0.17	0.17	1.5	0.17	0.11	0.11	0.11	0.12	1.5
18	Pb	mg/l	<0.001	<0.001	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
19	Hg	mg/l	<0.0001	<0.0001	0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.001
20	As	mg/l	<0.001	<0.001	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
21	Oil	mg/l	0.009	0.009	0.1	0.009	0.009	0.009	0.009	0.009	0.1
22	Coliform	MPN/ 100ml	5200	5210	7500	5230	2700	2710	2720	2730	7500
23	The residues of plant protection root P	µg/l	<0.001	<0.001	0.32	<0.001	<0.001	<0.001	<0.001	<0.001	0.32
24	The residues of plant protection root C1	µg/l	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	0.004

Source: Results of environmental factor sample analysis, October 2014.

Table 2 - 17: Results of analysis of surface water samples at the project area (continue)

No	Parameter	Unit	Ben Ro sluice-gate				Vam Nuoc Trong lock				QCVN 08:2008
			NM5-1	NM5-2	NM5-3	NM5-4	NM6-1	NM6-2	NM6-3	NM6-4	
1	pH	-	7.6	7.6	7.6	7.5	6.6	6.6	6.6	6.5	5.5-9
2	Salinity level	‰	0	0	0	0	0	0	0	0	
3	SS	mg/l	124	125	125	127	89	88	89	90	50
4	DO	mg/l	5.6	5.6	5.6	5.7	6.6	6.6	6.7	6.6	≥4
5	COD	mg/l	12	12	11	11	17	17	17	18	30
6	BOD5	mg/l	5	5	5	6	9	9	9	10	15
7	Fe2+	mg/l	0.2	0.2	0.2	0.2	0.4	0.4	0.4	0.4	1.5
8	Fe3+	mg/l	0.8	0.8	0.8	0.9	1.5	1.5	1.5	1.5	1.5
9	Na+	mg/l	122	124	122	126	162	164	160	166	
10	Cl-	mg/l	294	294	289	296	305	305	304	306	600
11	NH4+	mg/l	0.12	0.12	0.11	0.11	0.25	0.25	0.24	0.26	0.5
12	NO2- N	mg/l	0.01	0.01	0.01	0.01	0.03	0.03	0.03	0.03	0.04
13	NO3- N	mg/l	0.08	0.08	0.08	0.09	0.7	0.7	0.7	0.8	10
14	SO42-	mg/l	0.5	0.5	0.6	0.5	0.55	0.54	0.56	0.55	
15	Al3+	mg/l	0.2	0.2	0.28	0.3	0.3	0.3	0.28	0.3	
16	PO43-	mg/l	0.04	0.04	0.05	0.05	0.09	0.09	0.09	0.09	0.3
17	Zn	mg/l	0.09	0.09	0.09	0.09	0.13	0.13	0.13	0.14	1.5
18	Pb	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
19	Hg	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.001
20	As	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
21	Oil	mg/l	0.009	0.009	0.009	0.009	0.011	0.011	0.011	0.011	0.1
22	Coliform	MPN/ 100ml	3730	3730	3710	3750	9330	9350	9310	9360	7500
23	The residues of plant protection root P	µg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.32
24	The residues of plant protection root C1	µg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004

Source: Results of environmental factor sample analysis, October 2014.

Table 2 - 18: Results of analysis of surface water samples at the project area (continue)

No	Parameter	Unit	Cai Quao sluice-gate				Vam Thom lock				QCVN 08:2008
			NM7-1	NM7-2	NM7-3	NM7-4	NM8-1	NM8-2	NM8-3	NM8-4	
1	pH	-	7.2	7.2	7.2	7.2	7.4	7.4	7.4	7.4	5.5-9
2	Salinity level	‰	0	0	0	0	0	0	0	0	
3	SS	mg/l	165	168	166	166	115	118	116	116	50
4	DO	mg/l	5.5	5.6	5.6	5.6	5.8	5.8	5.9	5.8	≥4
5	COD	mg/l	14	14	14	14	13	14	13	13	30
6	BOD5	mg/l	7	7	7	8	6	6	6	6	15
7	Fe2+	mg/l	0.35	0.35	0.34	0.4	0.25	0.25	0.24	0.3	1.5
8	Fe3+	mg/l	1.2	1.2	1.2	1.3	1.15	1.2	1.2	1.2	1.5
9	Na+	mg/l	152	154	150	156	162	163	160	116	
10	Cl-	mg/l	295	295	294	296	285	285	284	286	600
11	NH4+	mg/l	0.22	0.22	0.22	0.23	0.2	0.2	0.2	0.2	0.5
12	NO2- N	mg/l	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
13	NO3- N	mg/l	0.3	0.3	0.3	0.3	0.6	0.6	0.6	0.6	10
14	SO42-	mg/l	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	
15	Al3+	mg/l	0.2	0.2	0.25	0.25	0.3	0.3	0.26	0.28	
16	PO43-	mg/l	0.08	0.05	0.09	0.08	0.05	0.05	0.06	0.05	0.3
17	Zn	mg/l	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.13	1.5
18	Pb	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
19	Hg	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.001
20	As	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
21	Oil	mg/l	0.011	0.011	0.011	0.011	0.008	0.008	0.008	0.008	0.1
22	Coliform	MPN/ 100ml	5630	5650	5610	5660	5700	5750	5750	5760	7500
23	The residues of plant protection root P	µg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.32
24	The residues of plant protection root C1	µg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004

Source: Results of environmental factor sample analysis, October 2014.

Detailed results of the analysis of samples of surface water in project area is attached at Annex. Results of analysis of 32 samples of surface water in the project area are compared with QCVN 08: 2008 / BTNMT: National technical regulation on surface water quality, B1 level shows the majority of the observed indicators are lower than allowable standards. Thus, surface water quality in the area of sub-projects have the analyzed basic parameters to meet QCVN 08: 2008 / BTNMT column B1, the water used for irrigation purposes. The project area is predominantly rural, and there is almost not any industrial production activities; sources of environmental pollutants mainly come from agricultural production and animal husbandry. However, this source is negligible, surface water quality in the project area is relatively good and the water can be used for irrigation purposes, or other uses requiring water of similar quality. Suspended solids concentrations in all samples analyzed were higher than the criteria in QCVN (114 -183 mg/l, exceeding the allowable limit by 2.28 to 3.36 times) reflecting the current status of surface water in the Mekong Delta with characteristics of water containing large amounts of sediment and the turbidity is at high levels.

Salinity: salinity level is factor affects to the growth and development of plants and aquatic animals and plants in general. Saline water sources are not suitable for development of agricultural production and such water causes the negative impact on the lives of people living in the area; but it is favorable to the development of aquaculture such as saltwater seafood, especially giant tiger prawn.

Overall salinity levels measured from the environmental monitoring samples from the intended location for construction have low value and they are close to 0, ranging from 0 to 0.04‰.

Results of the analysis of water samples in comparison with QCVN 08: 2008/ BTNMT are shown in the following figure:

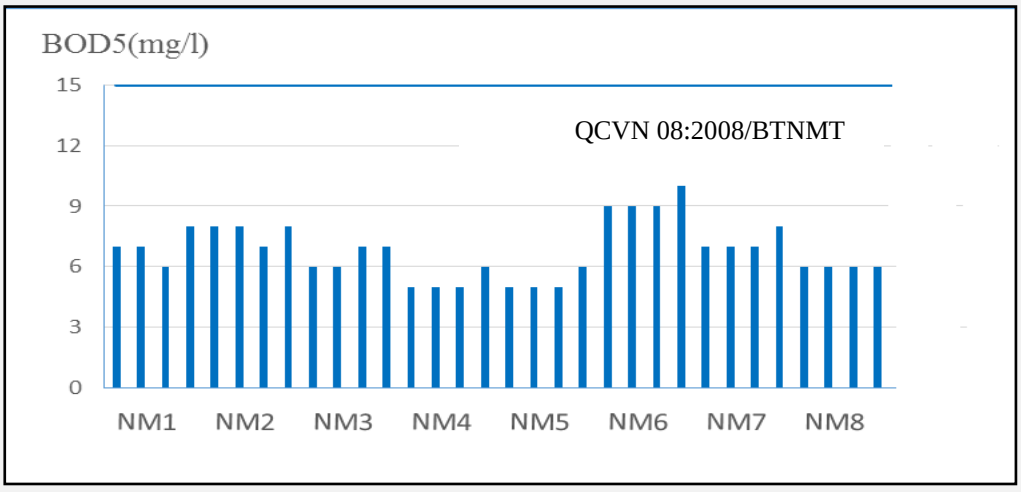


Figure 2 - 11: BOD5 concentration in surface water samples

Source: Results of environmental factor sample analysis, October 2014.

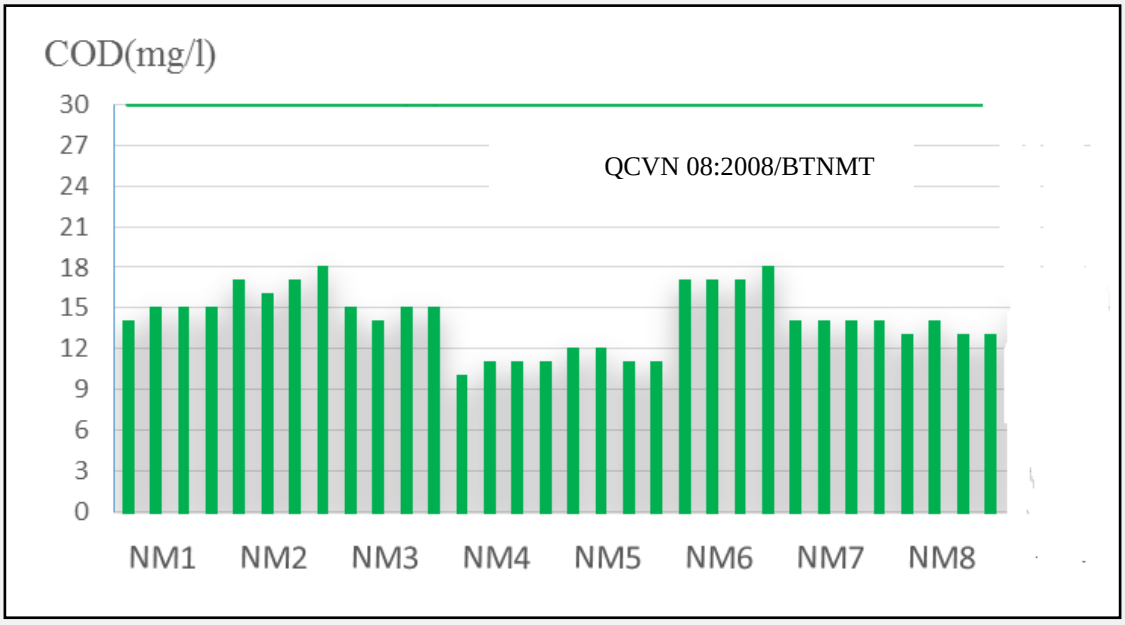


Figure 2 - 12: COD concentration in surface water samples

Source: Results of environmental factor sample analysis, October 2014.

Chemical oxygen demand (COD) and biochemical oxygen demand (BOD) are the basic parameters to assess the level of pollution of water resources. The higher the level of COD and BOD, the more severe level of water pollution. Under the provisions of the regulations on environmental Vietnam (QCVN 08: 2008), surface water used for irrigation purposes (B1) or the other uses requiring water of quality similar to water traffic should have the value of BOD5 <15 mg/l and COD <30 mg/l.

BOD and COD concentrations in the project area ranged from 5-10 mg/l and from 10-18mg/l. Concentration of COD, BOD in surface water at the locations is within the allowable ranges.

Because the construction area of the project are popular with aquaculture production, the parameters of water quality in aquaculture are important; most important ones are pH, suspended solids - SS (to determine turbidity), BOD, COD, NO2, NO3, NH4, PO4.

Through the observations, the parameters met the requirements for water to aquaculture activities. Specifically:

Table 2 - 19: Comparison with the parameters of surface water suitable for aquaculture

Parameter	Unit	Results	Allowable levels
BOD	mg/l	5-10	5-10
COD	mg/l	10-18	10-20
NO2	mg/l	0.01-0.04	≤0.1
NO3	mg/l	0.08-0.9	≤3
NH4	mg/l	0.11-0.5	≤0-6
PO4	mg/l	0.04-0.3	≤0.5

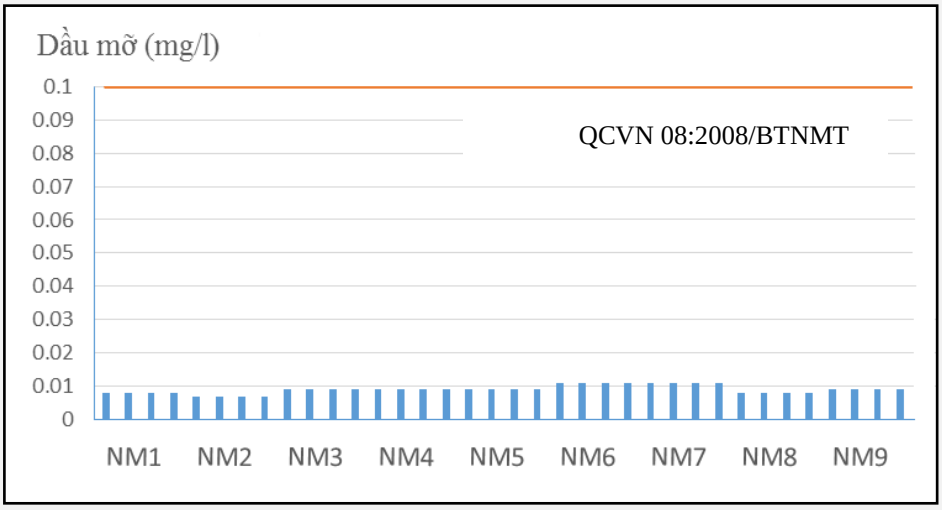


Figure 2 - 13: Oil concentration in the surface water samples

Source: Results of environmental factor sample analysis, October 2014.

Results from the analysis of oil shows that even though there is oil in the surface water, the concentration level is at allowable range.

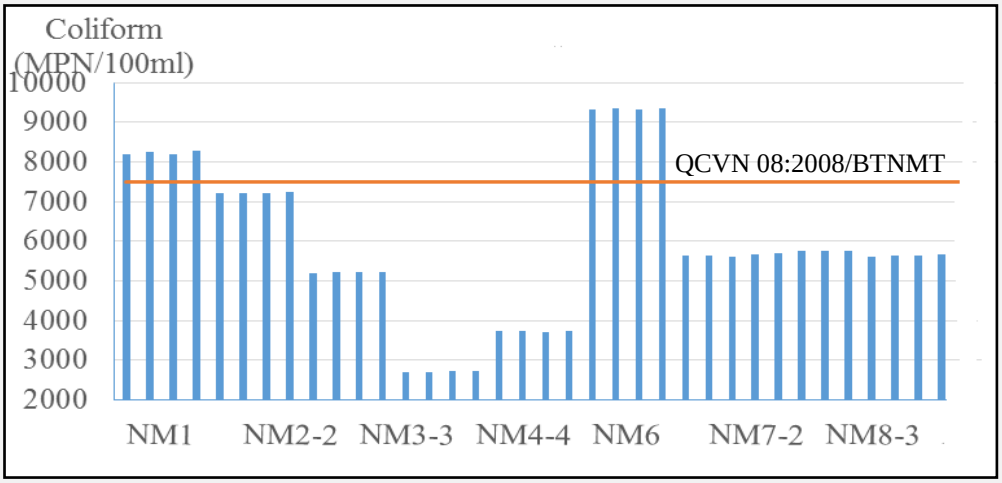


Figure 2 - 14: Coliform concentration in surface water samples

Source: Results of environmental factor sample analysis, October 2014.

Coliform concentration levels in BenTre lock and Vam Nuoc Trong sluice-gate are higher than the required levels.

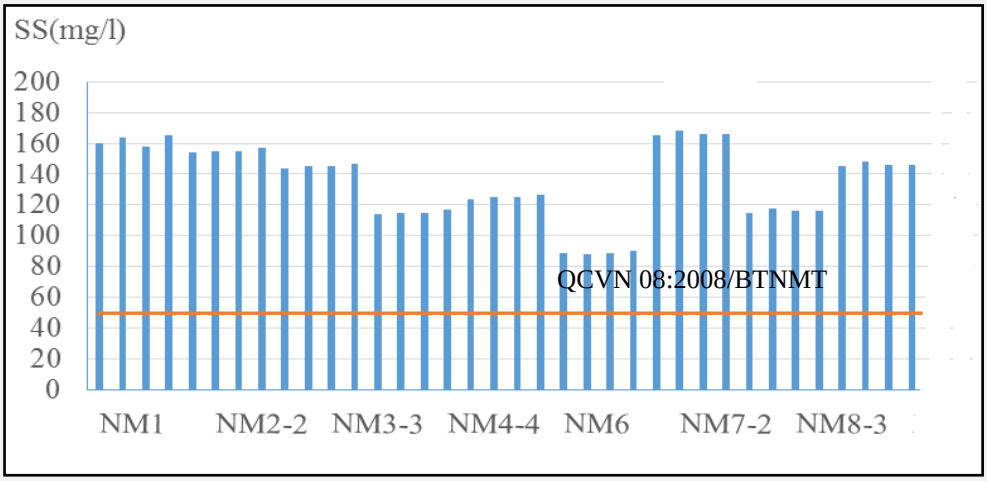


Figure 2 - 15: Suspended sediments concentration in the surface water samples

The concentration of suspended sediments in all of the surface water samples is higher than the level regulated in QCVN indicating the actual state of water in the Mekong Delta region with the nature of having high concentration of alluvium and high turbidity level.

d Groundwater environment

According to local records

In Ben Tre Province, the groundwater data is obtained and processed by Ben Tre Water Supply One-member Limited Liability Company (WSC.) and Department of Natural Resources and Environment (DONRE) of Ben Tre Province.

WSC had measured groundwater quality at boreholes, which were usually utilized as water sources for the Huu Dinh Water Supply/ Purification Plant owned by WSC. Those boreholes were distributed in the Chau Thanh District and Ben Tre City as shown in the following figure and table.

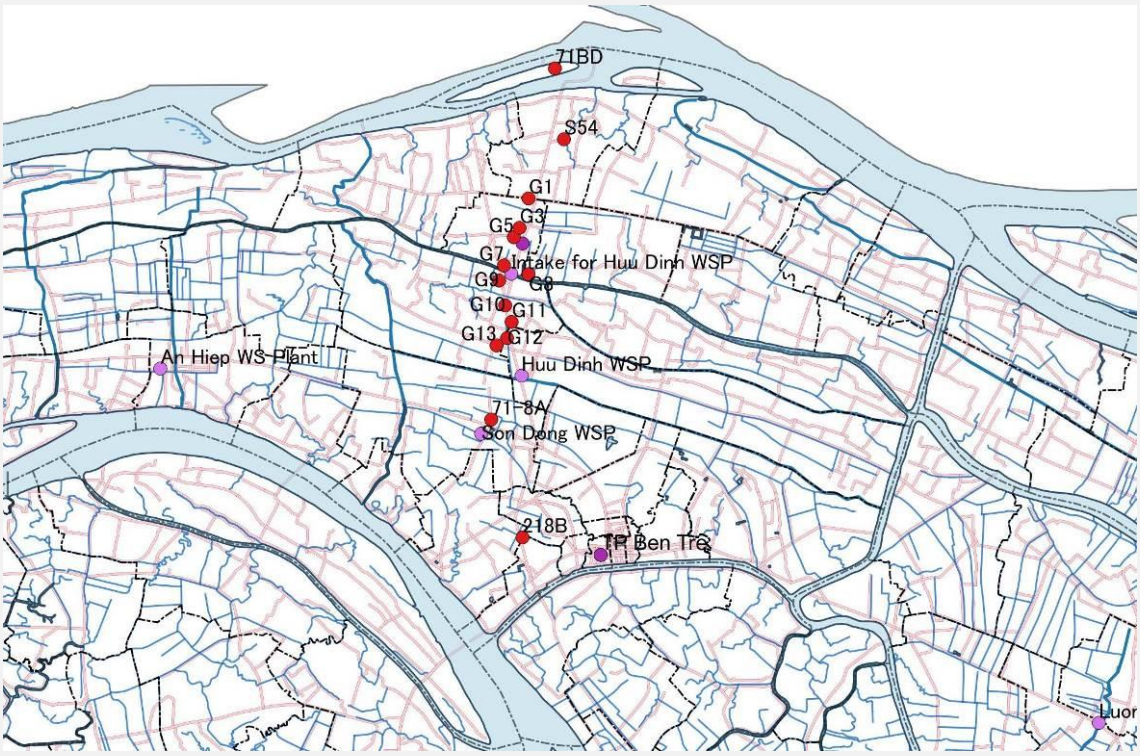


Figure 2 - 16: Location of Wells/ Boreholes

Source: JICA B-SWAMP Survey Team (2016)

Table 2 - 20: List of Wells

No.	Name of wells	Depth (m)	Water level (m)	Salinity 2005 (mg/l)	Salinity 2010 (mg/l)	Salinity 2014 (mg/l)
1	71-BD	417.5	-			
2	S54	465.3	-			
3	G1	458.0	3.0	152	260	270
4	G3	315.0	3.15	95	160	380
5	G5	307.0	2.0	89	180	220
6	G7	316.0	3.0	101	300	500
7	G8	320.0	3.0	214	400	420

8	G9	316.0	2.3	174	340	400
9	G10	310.0	2.5	131	270	290
10	G11	318.0	3.0	202	600	630
11	G12	311.0	2.5	302	2,700	*1
12	G13	305.0	2.8	320	400	*2
13	71-8A	437.5	-			
14	21-8B	457.5	-			

Source: Ben Tre Water Supply One-member Limited Liability Company

Note *1: Stopped exploitation from 2006 because salinity was too high

*2: Stopped exploitation from 2009 because of no-water to pump

In recent years, salinity observed from most of the boreholes exceeds 300 mg/l, a stipulated value in the Vietnam water supply standard. The following figure shows the yearly change of salinity content of the groundwater in Ben Tre City and in the Chau Thanh District.

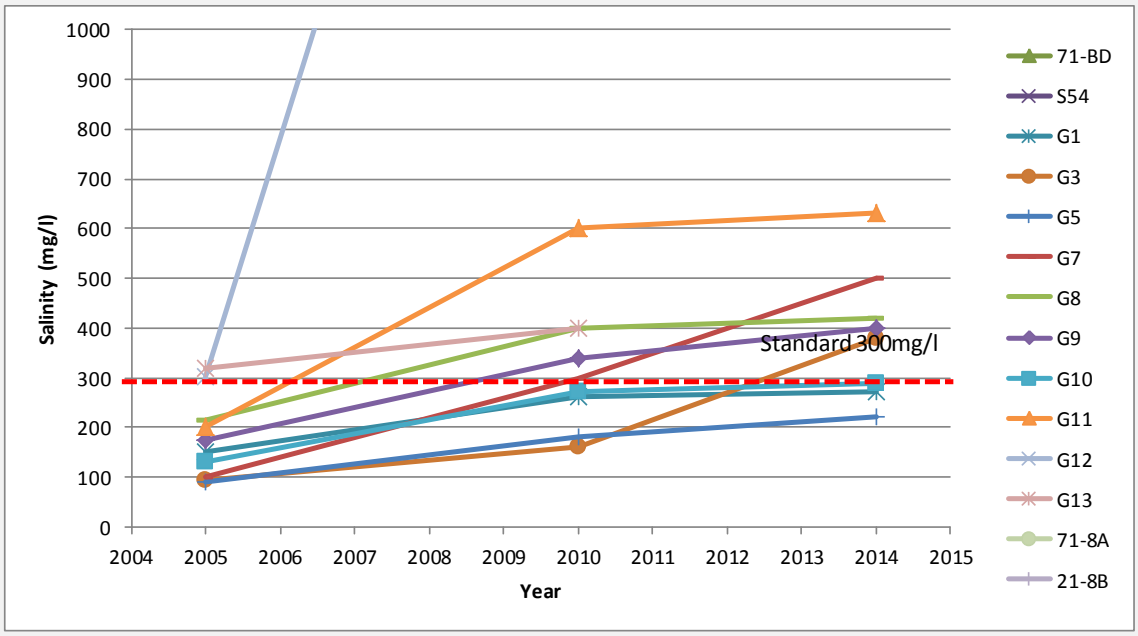


Figure 2 - 17: Salinity of Groundwater Obseved in Ben Tre City and Chau Thanh District

Source: JICA B-SWAMP Survey Team (2016)

DONRE measured groundwater quality and quantity at boreholes to assess groundwater potential for domestic and aquaculture water supply in Ben Tre province from 2010 to 2020. In that report, they concluded as follows;

"About the quality of underground water, generally in the distribution area of light fresh water, it can be used to supply water for drinking and living after treatment of the problems of full hardness, total Fe (iron), and exceeded standard limit of SO_4^{2-} (sulfate ion) and Cd (cadmium).

In the distribution areas of brackish to saline, it almost meet the standard for aquaculture, these parameters which do not meet the standard limit are NH_4^+ (ammonium ion), Cd (cadmium), Phenol, pH (n_1^3 aquifer).

These data suggest that light fresh groundwater potential in Ben Tre is not rich compared to other provinces in the Mekong Delta, but still is an important source to

meet the individual needs of water supply in small and medium scale. Brackish to saline water potential is plentiful, which meet the needs of exploitation and service of aquaculture sector."

According to environmental monitoring results in 2014

1. Sample locations

Sampling locations are described as in the following tables:

Table 2 - 21: Location for ground water samples

No.	Location	Code	Coordinate	
			N	E
I	Ben Tre lock			
1	Ground water in Ward 8	NN1-1	10o14'142''	106o23'441''
2	Ground water in Nhon Thanh commune	NN1-2	10o14'790''	106o23'112''
II	Thu Cuu sluice-gate			
1	Ground water in Thach Phu Dong commune	NN2-1	10o08'279''	106o24'451''
2	Ground water in Phuoc Long commune	NN2-2	10o08'401''	106o24'178''
III	Au Hoa lock			
1	Ground water in Giao Hoa commune	NN3-1	10o17'187''	106o26'676''
2	Ground water in Long Dinh commune	NN3-2	10o17'616''	106o26'342''
IV	Tan Phu sluice-gate			
1	Ground water in Phu Duc commune	NN4-1	10o17'198''	106o12'297''
2	Ground water in Tan Phu commune	NN4-2	10o17'556''	106o12'712''
V	Ben Ro sluice-gate			
1	Ground water in the left of Tien Long commune	NN5-1	10o15'965''	106o12'048''
2	Ground water in the right of Tien Long commune	NN5-2	10o15'587''	106o11'896''
VI	Vam Nuoc Trong sluice-gate			
1	Ground water in Tan Thanh Binh commune	NN6-1	10o10'917''	106o20'138''
2	Ground water in Dinh Thuy commune	NN6-2	10o10'762''	106o20'311''
VII	Cai Quao sluice-gate			
1	Ground water in the left bank	NN7-1	10o06'116''	106o23'509''
2	Ground water in the right bank	NN7-2	10o06'150''	106o23'554''
VIII	Vam Thom sluice-gate			
1	Ground water in Thanh Thoi B commune	NN8-1	10o05'027''	106o16'246''
2	Ground water in Khanh Thanh Tan commune	NN8-2	10o05'088''	106o16'688''

2. Comparison basis:

Results from analysis of surface water are used to compare with QCVN 09:2008/BTNMT –National Technical Regulation on ground water quality.

3. Assessment

Table 2 - 22: Results from analysis of groundwater samples in the project area

No.	Parameter	Unit	Ben Tre sluice-gate		Thu Cuu sluice-gate		An Hoa lock		Tan Phu sluice-gate		QCVN 09:2008
			NN1-1	NN1-2	NN2-1	NN2-2	NN3-1	NN3-2	NN4-1	NN4-2	
1	pH	-	6.7	6.7	7.4	7.5	6.8	6.7	7.2	7.2	5.5-8.5
2	Hardness	mg/l	215	216	255	256	205	204	245	246	500
3	Salinity level	0/00	0	0	0	0	0	0	0	0	
4	Total suspended sediments (TSS)	mg/l	29	28	35	38	40	42	38	38	1500
5	DO	mg/l	4.2	4.2	4.5	4.6	4.5	3.9	4.6	4.7	
6	NH4+	mg/l	0.06	0.06	0.05	0.05	0.05	0.06	0.07	0.07	0.1
7	NO2-	mg/l	0.3	0.3	0.2	0.2	0.08	0.09	0.09	0.09	1
8	SO42-	mg/l	189	188	181	180	182	185	178	180	400
9	Al3+	mg/l	0.4	0.45	0.5	0.55	0.5	0.6	0.6	0.55	
10	Fe	mg/l	1.6	1.8	2.2	2.3	2.7	2.8	2.4	2.5	5
11	Zn	mg/l	1.2	1.3	1.1	1.2	0.9	0.8	1.3	1.4	3
12	Pb	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.01
13	Hg	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.001
14	As	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.05
15	Ecoli	MPN /100ml									
16	Coliform	MPN /100ml									

Source: Results of environmental factor sample analysis, October 2014.

Table 2 - 23: Results from analysis of groundwater samples in the project area

No.	Parameter	Unit	Ben Ro		Vam Nuoc Trong		Cai Quao		Vam Thom		QCVN 09:2008
			NN5-1	NN5-2	NN6-1	NN6-2	NN7-1	NN7-2	NN8-1	NN8-2	
1	pH	-	7.3	7.2	6.5	6.6	6.8	6.7	6.3	6.4	5.5-8.5
2	Hardness	mg/l	255	260	301	303	288	286	225	226	500
3	Salinity level	0/00	0	0	0	0	0	0	0	0	
4	Total suspended sediments	mg/l	41	42	450	460	457	460	437	440	1500

	(TSS)										
5	DO	mg/l	4.2	4.3	4.4	4.3	4.5	4.4	4.0	4.1	
6	NH4+	mg/l	0.07	0.06	0.08	0.07	0.03	0.03	0.04	0.04	0.1
7	NO2-	mg/l	0.07	0.07	0.09	0.09	0.09	0.09	0.08	0.09	1
8	SO42-	mg/l	166	167	201	202	242	241	202	200	400
9	Al3+	mg/l	0.7	0.75	0.8	0.8	0.7	0.8	0.7	0.8	
10	Fe	mg/l	3.1	3.2	3.0	2.9	2.8	2.9	2.7	2.6	5
11	Zn	mg/l	1.2	1.2	1.1	1.1	0.8	0.8	0.8	0.8	3
12	Pb	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.01
13	Hg	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.001
14	As	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.05
15	Ecoli	MPN /100ml									
16	Coliform	MPN /100ml									

Source: Results of environmental factor sample analysis, October 2014.

Analysis results from a number of positions show that, there is no sign of pollution in groundwater environment of the study area; the analysis indicators are within the allowable range.

e Soil environment

Sampling locations:

Table 2 - 24: Locations for soil samples

No.	Location	Code	Coordinate	
			N	E
I	Ben Tre lock			
1	Soil in Ward 8	Đ1-1	10o14’139’’	106o23’471’’
2	Soil in Nhon Thanh commune	Đ1-2	10o14’780’’	106o23’108’’
II	Thu Cuu sluice-gate			
1	Soil in Thach Phu Dong commune	Đ2-1	10o08’267’’	106o24’744’’
2	Soil in Phuoc Long commune	Đ2-2	10o08’392’’	106o24’164’’
III	Au Hoa lock			
1	Soil in Giao Hoa commune	Đ3-1	10o17’178’’	106o26’683’’
2	Soil in Long Dinh commune	Đ3-2	10o17’602’’	106o26’334’’
IV	Tan Phu sluice-gate			
1	Soil in Phu Duc commune	Đ4-1	10o17’523’’	106o12’746’’
2	Soil in Tan Phu commune	Đ4-2	10o17’741’’	106o12’485’’
V	Ben Ro sluice-gate			
1	Soil in the left of Tien Long commune	Đ5-1	10o15’975’’	106o12’014’’

No.	Location	Code	Coordinate	
			N	E
2	Soil in the right of Tien Long commune	Đ5-2	10o15’551’’	106o11’927’’
VI	Vam Nuoc Trong sluice-gate			
1	Soil in Tan Thanh Binh commune	Đ6-1	10o10’906’’	106o20’135’’
2	Soil in Dinh Thuy commune	Đ6-2	10o10’771’’	106o20’302’’
VII	Cai Quao sluice-gate			
1	Soil in the left bank	Đ7-1	10o06’128’’	106o23’503’’
2	Soil in the right bank	Đ7-2	10o06’121’’	106o23’589’’
VIII	Vam Thom sluice-gate			
1	Soil in Thanh Thoi B commune	Đ8-1	10o05’022’’	106o16’845’’
2	Soil in Khanh Thanh Tan commune	Đ8-3	10o05’081’’	106o16’541’’

1. Basis of comparison:

Results from analysis of soil samples are used to compare with:

QCVN 03:2008/BTNMT –National Technical Regulation on soil quality.

QCVN 15:2008/BTNMT –National Technical Regulation on the level of residues of plant protection chemical in soils.

2. Assessment:

Table 2 - 25: Results from analysis of soil samples

No.	Para	Unit	Ben Tre sluice-gate		Thu Cuu sluice-gate		An Hoa lock		Tan Phu lock		QCVN 03:2008
			Đ1-1	Đ1-2	Đ2-1	Đ2-2	Đ3-1	Đ3-2	Đ4-1	Đ4-2	
1	pHKCl	-	5.6	5.7	5.8	5.9	6.2	6.3	6.4	6.5	
2	NH4+	mg/100g soil	1.2	1.22	1.4	1.3	1.1	1.1	1.0	1.1	
3	NO3-N	mg/100g soil	1.7	1.8	1.9	1.8	1.7	1.8	1.7	1.5	
4	Total N	%	0.05	0.054	0.05	0.04	0.03	0.04	0.03	0.03	
5	Total P	%	0.04	0.04	0.03	0.03	0.025	0.028	0.018	0.019	
6	SO42-	%	0.02	0.02	0.025	0.024	0.022	0.023	0.022	0.021	
7	Fe2+	mg/100g soil	78	79	71	70	68	70	68	67	
8	Al3+	mg/100g soil	8	8	7.5	7.6	7.5	7.2	7.1	7.2	
9	Zn	mg/kg dry soil	14	15	14	13	12	13	12	10	200
10	Pb	mg/kg dry soil	2	2	2.1	2.2	1.9	2.1	1.9	1.8	70
11	Hg	mg/kg dry soil	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	

No.	Para	Unit	Ben Tre sluice-gate		Thu Cuu sluice-gate		An Hoa lock		Tan Phu lock		QCVN 03:2008
			Đ1-1	Đ1-2	Đ2-1	Đ2-2	Đ3-1	Đ3-2	Đ4-1	Đ4-2	
12	As	mg/kg dry soil	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	12

Source: Results of environmental factor sample analysis, October 2014.

Table 2 - 26: Results from analysis of soil samples

No.	Para	Unit	Ben Ro		Vam Nuoc Trong		Cai Quao		Vam Thom		QCVN 03:2008
			Đ5-1	Đ5-2	Đ6-1	Đ6-2	Đ7-1	Đ7-2	Đ8-1	Đ8-2	
1	pHKCl	-	5.8	5.9	5.8	5.7	5.8	5.9	6.1	6.0	
2	NH4+	mg/100g soil	1.0	0.9	1.4	1.5	1.6	1.5	1.6	1.6	
3	NO3-N	mg/100g soil	1.7	1.6	2.1	2.2	2.3	2.2	2.4	2.4	
4	Total N	%	0.04	0.04	0.09	0.08	0.08	0.08	0.07	0.075	
5	Total P	%	0.024	0.022	0.032	0.032	0.03	0.03	0.03	0.035	
6	SO42-	%	0.025	0.025	0.035	0.034	0.035	0.036	0.033	0.034	
7	Fe2+	mg/100g soil	66	67	77	76	75	76	75	73	
8	Al3+	mg/100g soil	7.1	7.0	7.5	7.7	7.5	7.4	7.2	7.4	
9	Zn	mg/kg dry soil	11	10	14	15	14	13	12	13	200
10	Pb	mg/kg dry soil	1.7	1.8	2.2	2.3	2.2	2.1	2.0	2.1	70
11	Hg	mg/kg dry soil	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
12	As	mg/kg dry soil	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	12

Source: Results of environmental factor sample analysis, October 2014.

The analysis results showed that soil samples in the project area have no sign of soil pollution by heavy metals, indicators of heavy metals are very low compared with the permissible limits.

Acidity level of soil: pH is indicative of ion H + activity in the soil environment. This is the first simple indicator of acidity most commonly identified. pH affects the metabolic processes of nutrition as well as the usefulness of fertilizer in the soil environment, besides the over use of fertilizers will also opposite effect on soil pH.

Table 2 - 27: Levels of acidity of soil by pH

pH	Classification	pH	pH
<3.5	Extremely acidic	6.1-6.5	Not very acidic
3.5-4.4	Highly acidic	6.6-7.3	Average

4.5-5.0	Very acidic	7.4-7.8	Weak alkaline
5.1-5.5	Relatively acidic	7.9-8.4	Neutral alkaline
5.6-6.0	Acidic	8.5-9	Strong alkaline

Source: USDA, 1983

The results of the analysis showed that soil pH is in the range from 5.6 to 6.5. So the soil range from not very acidic to acidic there is no instances of acid sulphate in the project area. There are many factors of influence when carrying out the study of the causes of land becoming acidic. The cause for low level of acidic for the soil in the project is from the characteristics of the climate of the area when the temperature is high (average value of 27^0C) and high rainfall level (1400-1500mm), which is advantageous for washing away materials. The movement of rainwater from ground to deep underground is mainly from the gravitational pull in a wide range of soluble substances in the soil, especially metal ions alkali and alkaline earth such as Na +, K +, Mg2 +, Ca2 + chemicals making the soil acidic. Other causes may come from the resolution of microbial organic matter producing organic acids causing the soil acidic, especially in anaerobic conditions. The soil samples for monitoring of environmental quality were taken on both sides of the river near the location of construction, the area is prone to flooding during the rainy season it is common for soil to be acidic. After the construction of the project is complete and during operation phase, for the supply of fresh water, the land benefited not only from safe production but the acidic levels of the soils also became increasingly improved.

Nutrients in the soil:

Total N (%): total nitrogen in the soil includes organic and inorganic N, organic forms of nitrogen accounts for about 95% of total protein. Organic matter in the soil usually contains about 5% protein. Hence, the organic matter content in the soil is often accompanied with higher total protein in the soil. The analysis of total nitrogen in the soil for the purpose of evaluating reserves, the potential of nitrogen in the soil. Soil with high total nitrogen content is considered fertile soil, capable of high-yield if protein in soil is well managed.

Table 2 - 28: Assessment of soil in accordance with the total N

Total N (%)	Assessment
< 0.08	Very poor
0.081 – 0.10	Poor
0.11 – 0.15	Average
0.16 – 0.20	Relatively rich
> 0.20	Rich

Source: Kyuma, 1976

The analysis results showed that soil in the area has the nitrogen in the total ranged from 0.03 to 0.09%, from very poor to poor.

Total P (%): P is an element of essential nutrients for plants. P appears in the soil in the form of organic and inorganic, sum of these two types is known as total

phosphorus. Total phosphorus in soils varies considerably according to the type of soil and area.

Table 2 - 29: Assessment of soil according to total P

Total P (%)	Assessment
< 0.03	Very poor
0.04 – 0.06	Poor
0.061 – 0.080	Average
0.081 – 0.13	Relatively rich
> 0.13	Rich

Source: Le Van Can, 1978

The results of analysis of soil samples showed the total P ranged from 0.022 to 0.05%, as assessed in the table above, the majority is classified as poor.

2.1.4.2. Use of MIKE 11 model for simulation of water quality

Distribution of BOD, N, P concentration in surface water

We have selected group BOD, N, P to simulate surface water quality in project area because these are the groups of organic compounds and nutrients representing the living resources, aquaculture and services. MIKE 11 model was simulated using BOD, N, and P in the project area in April, the dry season with the highest level of saltwater intrusion. Distribution of the current state of water quality in the project area are not even, the most affected area is the region around urban areas, densely populated urban areas such as Ben Tre, Cho Lach, Mo Cay, Ba Tri, Thanh Phu, Chau Thanh of the Ben Tre. BOD in the project area ranges from 6-19 mg/l. Concentration of total N in the project area ranges from 0.42 to 1.6 mg/l. Total P content in the project area ranges from 0.1 to 0.21 mg/l. In general, surface water meets the quality standards under the B1-B2 QCVN 08: 2008/BTNMT.

Results are presented in the figures as follows:

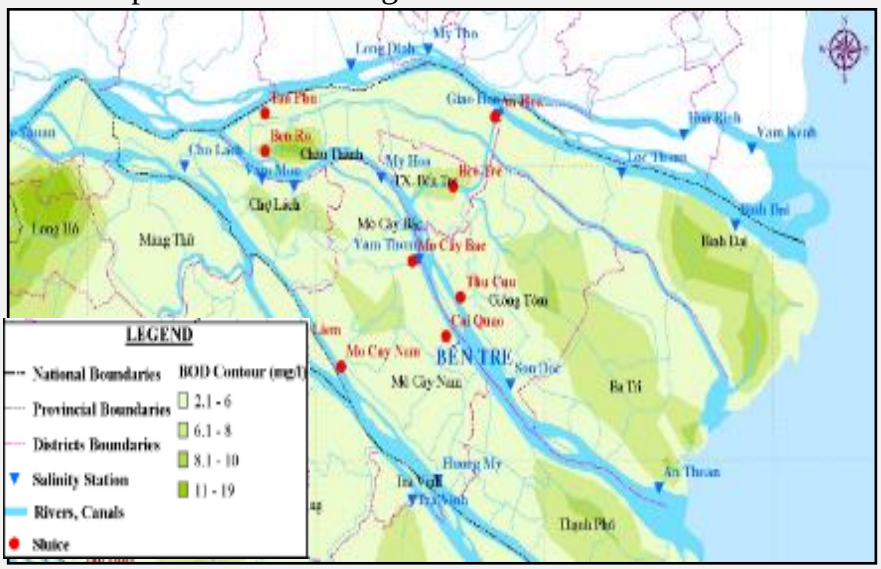


Figure 2 - 18: Concentration distribution of BOD without the project

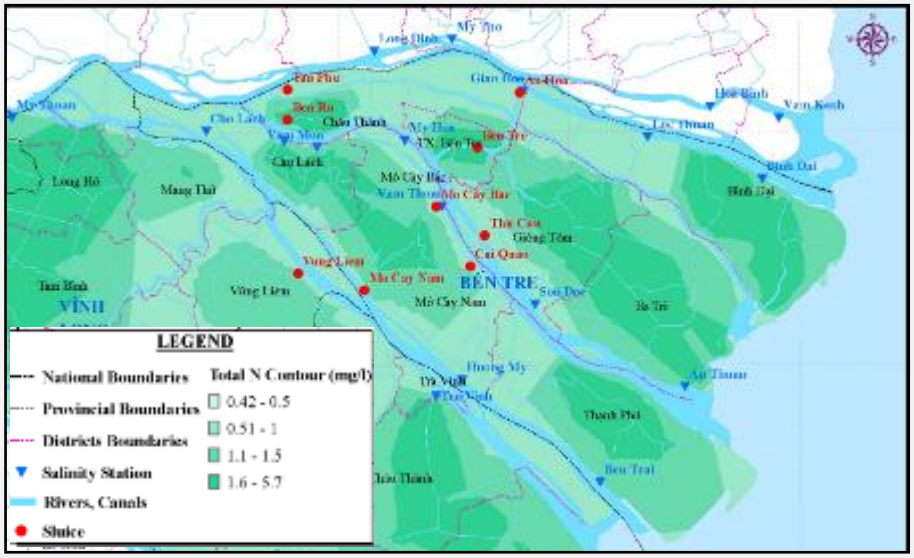


Figure 2 - 19: Concentration distribution of N without the project

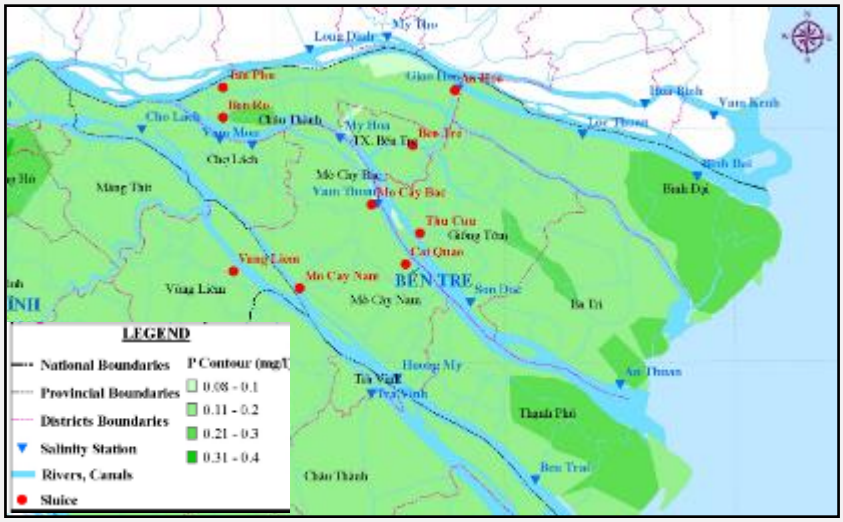


Figure 2 - 20: Concentration distribution of P without the project

1.1.6 Current status of biological resources

The characteristics of the project is the construction of sluice gates to protect agricultural production and people's livelihood in the project area from being threatened by saltwater intrusion caused by climate change, control salinity level and fresh water supply to serve domestic, agricultural production which serve economic development - social to Ben Tre, Vinh Long and Tra Vinh. Thus the biological impacts due to construction and operation of the project in general and of the sub-project in particular are very important.

To assess the current state of biological resources in the project area, in addition to the survey and assessment at the field for each sub-project, the report also referred to a lot of documents and secondary data on investigation and assessments on the status of biodiversity in the 3 provinces, Ben Tre, Vinh Long and Tra Vinh, with focus on water ecosystems in rivers such as the Co Chien River, Ham Luong river, Tien Hau and Mang Thit rivers.

a The status of the ecosystem:

Survey results show that the ecosystem in the area of construction of sluice-gate and locks in the project area of 3 provinces, Vinh Long, Tra Vinh and Ben Tre includes: terrestrial ecosystems and underwater ecosystem.

Terrestrial ecosystems: include agricultural ecosystem, rural residential ecosystem and ecosystem of small and medium urban. This ecosystem type is artificial ecosystem with poor and unstable classification of species, there is no dominant species; the number and species composition is constantly changing depending on the use purpose and economic values.

- Regarding plants, the most notable ones are: In greenand yellow skin coconut. As for fruit-tree, according to fruit-tree Institute of the Northern area, the project area has 20 species that have high economic values as: Chin Hoa durian, Ri6 durian, grapefruit in green skin, Sanh orange, Xoan orange, mandarin orange, Chau Nghe mango, Cat Hoa Loc mango, mangosteen, longan, ...Regarding livestock: common livestock species are those raised for meat and eggs with varieties including: The local chicken (Chinese chicken, domestic chicken, Ac chicken, Noi chicken, Che chicken). The chicken in industrial farming or backyard such as specialized chicken for laying eggs as Goldline 54, Hiline, the fowl of the Corporation such as AA broiler breeding, Tam Hoang backyard chicken; There are two breeds of cows, yellow and Sind bred; The local pigs such as Thuoc Nhieu, are mixed bred with foreign pigs. The quality of pigs in the project area is pretty well focused toward pig farming for lean pork.

*Wetland ecosystem***:** is the ecology of the river, canal (water flow), lakes (still water). This ecosystem can be divided into three specific areas:

- Zone 1: Includes major rivers (Co Chien, Ham Luong, Tien and Hau rivers) and the large canals receiving water directly from the big rivers. Characteristic of this ecosystem is the ecosystem of the Mekong River with domination of aquatic species from the marine origin. The regional nature of the water here always change due to the rotation of the flow, especially fluctuations of salinity in each season. Thus the composition and number of species in this region also have major changes. This region is considered as areas of high biological diversity, but is very sensitive to the environment and constantly changing.
- Zone 2: The low-lying inland region of the districts of the project area with the small irrigation canals was formed for the purpose of serving the irrigation activities in agriculture and small waterway traffic. The nature of the water here is generally regarded as polluted, the shifting currents of this region is poor and the region frequently has to receive water from agricultural waste and wastewater from residential areas and parks around. Thus the number and species composition in this area are rated as poor and unstable, the aquatic species are mostly small (including fish).
- Zone 3: The small ponds in residential areas. Survey results of the entire project area shows, in addition to the system of canals and rivers is, in many

households there are always some small ponds used for many different purposes such as aquaculture or just pond containing effluent and waste from household waste. Scale ranges from small ponds are from 20-1000m2 with from 1-1,7m deep. Water quality in ponds is mostly contaminated by wastes from household (for some aquaculture ponds used for fishery farming, water quality is maintained at a certain level). Thus the composition and number of species in the pond were rated as poor and unstable

b The status of the species diversity of the project area

In the project area, there are no sensitive ecological areas, nature conservation areas and national forests. Also in the project area, there are no rare animals and plants in the Red Book of Vietnam and the world.

According to the report "Plan for the conservation of biodiversity in Ben Tre period 2010 – 2015", in the project, there are abundant species. Specifically:

Higher plants: there are 381 species of 68 families, 32 orders mainly under two branches, polydpodiophyta and Magnoliophyta. However, some species of exotic plants are imported from foreign countries or in countries in the region to meet the high demand for ornamental plants, shade trees for houses, restaurants, parks, streets; herbal extraction, and diversification of fruit trees.

Animals: There are 121 species of 52 families, 21 orders for 4 classes of animals (mammals, bird class, reptiles and amphibians), in which there is mainly the class of birds. The species commonly encountered in areas with projects such as:

- Birds: Primarily includes species such as storks, chao chao birds, passerine finches, doves, hoes, ducks, chickens, geese ... The number of birds with the possibility of no longer being present in the locality as recorded are 9 species (representing 5.17% of the total number of bird species recorded). And over 32 species of birds (accounting for 18.4%) have the risk of being threatened because their numbers are less and less
- Farming animals such as cats, dogs, cows, buffalo, goats, pigs and animals. are housed and grazing in the household and are common in areas of the project
- Reptiles: Common species such as frogs, geckos, lizard, cobra, viper green iguanas, reptiles ... Those likely to no longer present in the local area are estimated at about 10 species and 10 reptile species are at risk of being threatened (because their numbers are less and less). Group of amphibians is relatively stable.

Regarding the components of each species by ecosystem:

*Grassland and shrubs ecosystem***:** Mostly exists along the river and within the infield. The statistical results showed 6 species and 35 families and most of them live in the form of shrubs, low and sparse. There are not any animals and they are mostly reptiles such as frogs, snakes, lizards, etc.; relatively common species of grasses and aquatic species, most have fallen to the lowest level and they are in the poor categories.

*Water ecosystems in the estuaries***:** According to the results of the statistical properties of fisheries in Vinh Long, Ben Tre and Tra Vinh: 123 phytoplankton species in 7 sectors, mostly concentrated in silica and algae industry and groups marine with saltwater origin. The average density reached 173/individuals/liter; zooplankton includes 51 species of zooplankton in coastal areas averaged 12,300 individuals/m3

(variates from 2300-37000/m3); benthic organisms (small) in the estuaries are plentiful but there is a sharp decline in the number and species composition due to the decline in water quality and salinity intrusion by changing species composition in ecosystems.

- Population of fish – shrimp for economic purpose and other fishery species: they are seen in the brackish estuary –it is the area with saltwater and there are 61 species of fishes, of which 24 species belong to 9 families of fishes adapted to brackish waters, 18 species belong to 8 families of sea fishes migrating into brackish water region, 16 species of fishes of 7 families migrating to brackish and freshwater, 3 species of fish from 2 families of freshwater fishes migrating to.
- Economic fishes include 24 species of the families such as anchovies, Lycothrissa, Plotosidae, Australian fish, Mullidae, Latidae among others.
- Because there are so many estuaries in the project area, there are nearly 20 species of sea shrimp, in which the commonly seen species are: silver card (Penaeus indicus), shrimp (P. mergenensis), striatum (P. monodon), silver shrimp land (Malapenaeus ensis), silver shrimp technology (M. lysianssa), Pink (M. munatus), Tiger (Parapenopsis harwickii). Besides the fishes and shrimps, there are also abundant resources of clams.

*Water ecosystem in the freshwater vicinity***:** This area includes the Cho Lach District, North Cay, South Cay, Giong Trom, Chau Thanh, Ben Tre City. The average salinity levels of the waters of rivers and canals, ponds, ditches are approximately the same, the salinity of the irrigation dam is higher, but it is also low at the level of 1.22 ‰.

- The structure of the group of species consuming natural food is typical of freshwater near the estuary. Besides, the penetration of the tide also complement the vicinity of 20 native marine algae (accounting for 19.05% of the total algae and 36% of species of diatoms), and 3 species polychaete; they are good food for shrimp and fish.
- The economic shrimp, fish: Of 69 known species in the vicinity of freshwater, economic fish accounts for 30% (21 species). The economic freshwater fishes that are quite popular in the area include: snakehead, copper eel, climbing perch, colorful speckled, Lat fish, catfish, white, sesame, red he, shark catfish. The other economic fish such as fish warts, mullet, saltwater fish are fishes migrating into freshwater region. The characteristic economic fishesof the brackish waters vicinity are: Thalasseleotrididae Xenisthmidae, Kraemeriidae, Pseudapocryptes elongatus. In addition to fish, in the project area, there are eight species of the family of freshwater shrimps, Palaemonidae, with high economic value.

*Inland ecosystem***:** vegetation, including abundant crops with the rice, there are many species; for rise only, there are 312 varieties of rice, including 22 early season varieties, 144 for middle seasons, 146 as late season varieties; fruit crops such as peanuts, maize, sugarcane, mangoes, mangosteens, citrus sugar, coconut, Chukrasia tabularis ... are suitable with the conditions of the region and they have good economic value. Planted species in the locality project area can be divided into groups such as:

- Group that is sensitive to saltwater: durian, rambutan, sweetmeats, mangosteen ... salt water in a very short time was enough to influence growth and development, particularly salinity level os 1‰ can cause fire for leaves, reduced vitality;

- Weak salt-tolerant plants Group: cocoa, rice, corn, beans ... cam only withstand salinity from 1.4‰ to 2‰; Theaverage salinity tolerant groups: orange, tangerine, grapefruit, lemon, tomato, cucurbits ... can tolerate salinities from 2-3‰.
- Salinity tolerant group: mango, Sapo, coconut can withstand salinity of 2-5‰ . In the same crops of different varieties, there are different salt tolerance levels, specifically green grapefruit is more salt-tolerant than pomelos. Soil rich in organic matter or organic based fertilizers have the ability of limiting the influence of salt.

Given the trend of increasing saltwater intrusion, coconut trees are very suitable for farming in areas with brackish water, saline soil during the dry season. During dry season, salt water intrusion is deep in the inland area, only coconut trees have resistance to saltwater intrusion.

Aquatic resources are diverse in terms of species, about 281 species of fish, the most abundant are carp, catfish; the brackish water and freshwater shrimps that have high economic value and thus frequently been fished and cultured by people in the area.

Giant river prawn (Macrobrachium rosenbergii) is one of the important and popularspecies in freshwater, especially in the Mekong Delta. Although the prawnis species are crustaceans that can live in freshwater as well as brackish water environment (with salinity from 0 to 10‰), during its larval stage, it tends to depend on the degree of brackish water. When moving through stages such as plankton and mature, the prawn lives in freshwater.

The giant river prawn can be reared year round. However best spawning season of the prawn in Mekong Delta focuses on two time from April to June and from August to October. The prawn matures in freshwater and the species achieves sexual maturity, great delivery and birth eggs in freshwater also, during brooding, they tend to swim toward brackish water from 6-18‰. Salinity is best for larvae stage is 10-12‰. In the later stage, the prawn needs the salinity level of less than 6‰. Breeding prawn and mature prawn grow best in freshwater environment, however, the prawn can grow in 2-5‰ salinity level faster than 0‰. Therefore, prawn can be adopted throughout the year in the area of freshwater and brackish water (salinity <6‰).

With the current salinity level in the project area under observation, salinity levels result ranged from 0-3‰, which is a good environment for freshwater prawn farming in the model in ditches of the coconut garden.

Giant tiger prawn**:** The prawn can tolerate salinity level from 3-45‰; the best salinity level 15-20‰. If the salinity level is higher than 35‰, the prawn will stop eating causing difficulty to mature.

White leg shrimp**:** The shrimp can tolerate salinity level from 2-40‰; the most optimal level is 10-25‰.

Table 2 - 30: Cá chủ đạo và đặc điểm

Phân loại	Loài	Hình thức di cư sinh sản	Tầng sống	Tốc độ	Chiều dài max (cm)	Bề ngang max (cm)	Ghi chú
Loài bắt gặp (Không có trong sách đỏ)	 oilia lindmani	Mặn-ngọt	Tầng trên	Nhỏ	20	6	hải sản (thức ăn)
	 ossogobius aureus	Mặn-ngọt	Tầng trên	Nhỏ	27	5	
	 isodonophis boro	Mặn-ngọt	Tầng đáy	Nhỏ	100	3	hải sản (thức ăn)
	 Macrobrachium mammillodactylu	Ngọt-mặn	Giáp xác	Trườn			hải sản (thức ăn)
	 Macrobrachium rosenbergii	Ngọt-mặn	Giáp xác	Trườn			hải sản (thức ăn)
	 Macrobrachium mirabile	Ngọt-mặn	Giáp xác	Trườn			hải sản (thức ăn)
Loài đã ghi nhận (Sách đỏ)	 nguilla marmorata	Ngọt-mặn	Tầng đáy	Nhỏ	150	8	
	 Andontostoma chacunda	Mặn-ngọt	Tầng trên	Nhỏ	17.5	10	
	 angasius krempfi	Mặn-ngọt	Tầng trên	Lớn	100	34	

Nguồn: Đoàn khảo sát JICA B-SWAMP (2016)

Birds

Vam Ho Bird Sanctuary in Ben Tre province is to protect birds and other varieties near Ba Lai sluice gates in surveyed areas. This is said to be unique ecosystem including birds, fish, reptiles and insects in this area. The main birds as storks and cauldrons nesting on the shrubs and feeding in the protected area around them. Therefore, there are few impacts on the avian fauna, which habitat in the natural protected areas, where is located in more than 35km from the closest proposed sluice gate due to construction and operation of the sluice gates.

On the other hand, birds living in this survey area may search for food on the rivers, canals or the mudflats in the survey area.

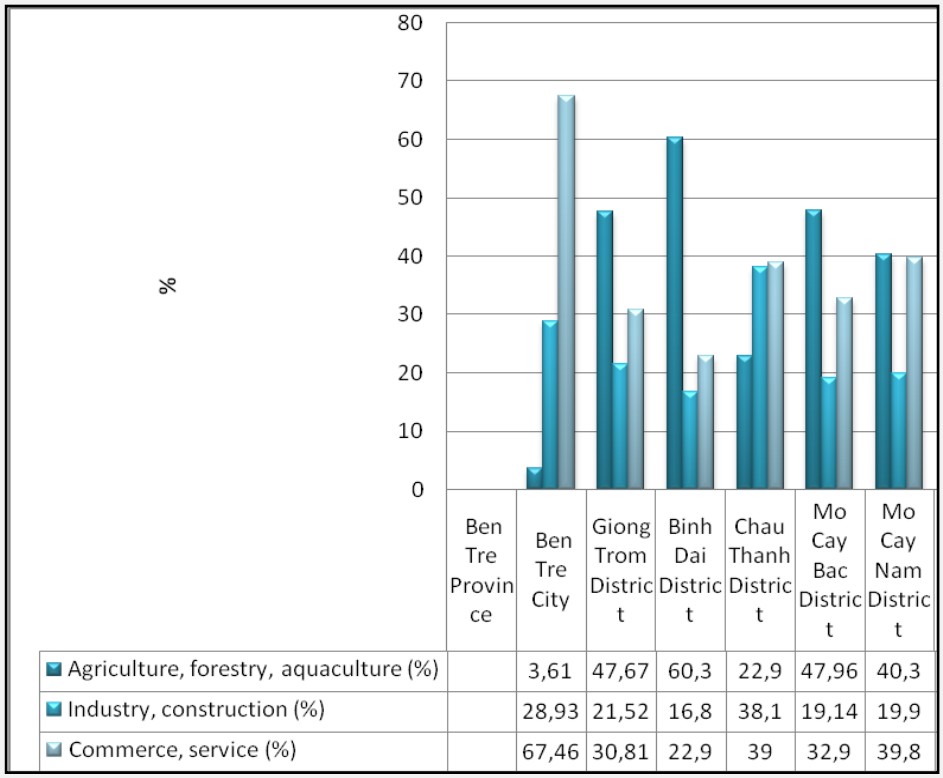
1.2 SOCIO-ECONOMIC STATUS

1.2.1 Economic status

1. Economic structure of the project districts

Agriculture, forestry and fishery play a key role in the economic structure of the project districts. Six out of the total nine districts, namely Giong Trom, Binh Dai, Mo Cay Bac, Mo Cay Nam, have the highest proportion of agriculture, forestry and fishery among the three economic sectors of the districts. Among those, the district that has the highest proportion is Binh Dai (60.3%), are geographically far from the major urban centers such as Ben Tre City. As for the districts and cities that are nearer to the large urban centers such as Ben Tre City, Giong Trom, Chau Thanh, the percentage contributing to the economic structure of the business and services sector is higher. Of which, the proportion of business and services sector of Ben Tre City is the highest, accounting for 67.46% due to good conditions of infrastructure and output market to develop commodity economy. The economic structure of the project districts and city are presented in the chart below.

The economic growth rates of the districts are relatively equal, from 10 percent to 13 percent in 2013.



	Ben Tre Province	Ben Tre City	Giong Trom District	Binh Dai District	Chau Thanh District	Mo Cay Bac District	Mo Cay Nam District
Agriculture, forestry, aquaculture (%)		3,61	47,67	60,3	22,9	47,96	40,3
Industry, construction (%)		28,93	21,52	16,8	38,1	19,14	19,9
Commerce, service (%)		67,46	30,81	22,9	39	32,9	39,8

Figure 2 - 21: Economic structure of the project districts

Source: District socio-economic reports, 2013.

2. *Land use status of the districts and communes*

According to statistics result on Rural, Agriculture and Fisheries (2011), the rate of annual crops areas in the Mekong Delta is the highest in the country, reaching 56.2%. Crop land areas in Ben Tre annual made up of 4.1%. Compared with other provinces in Mekong Delta, Ben Tre province has advantage in development of fruit trees, farmland area reached 75.2%. Comparing the rate results of each type of land between Mekong Delta and other regions of the country are shown in the figure below.

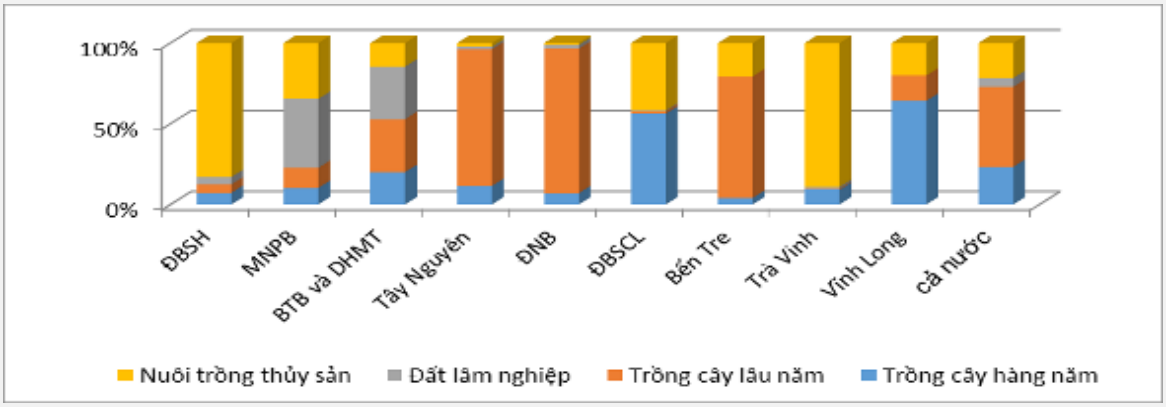


Figure 2 - 22: Land use for agriculture among total land area (%)

Source: Survey of rural, agriculture and fisheries 2011

There are differences in of land use structure in Ben Tre province comparing with Mekong Delta provinces. The proportion of land used for annual crops in total

agricultural land areas of the Mekong Delta region (56.2%) is higher than other regions in the country. Meanwhile, in Ben Tre province, the proportion of perennial crops, mostly fruit trees, predominates in the structure of agricultural land, forest and aquatic products of the province, about 75%. Comparason of current land use of Ben Tre province with Mekong Delta region and other areas are shown in the figure below

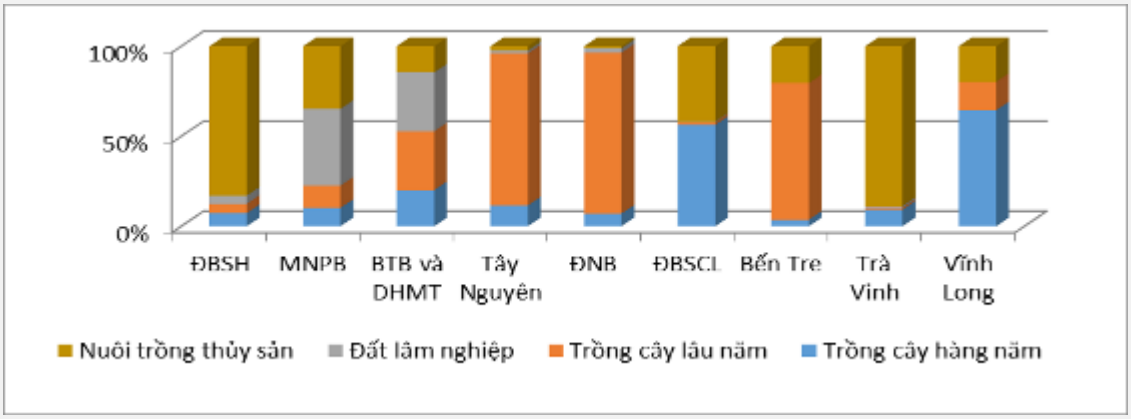


Figure 2 - 23: The rate of land use for agricultural to total area of agricultural land (%)

Source: Survey of rural, agriculture and fisheries 2011

As for six districts/city in the project area, on the whole, most of the land area of these districts are used for the purposes of agricultural production. Out of the total natural land area of 223,458.3 ha of eight districts and one city, 147,981 ha are used for agricultural production, accounting for 66.3%. In each project district/city, the land area used for agriculture occupies from 70% to 80% of the total natural land area. Among the nine project districts/city, only Binh Dai District has the forestry land area of 2,854 ha, making up a small proportion of 6.7% of the total natural area of the district and 1.2% of the total natural land of the whole project area. Forestry land in Binh Dai District covers the area of protection as well as production forests. At the work constructions, there is no work built on the forest area of Binh Dai District. Details of land types of the project districts are shown in the below table.

Table 2 - 31: Land use status of the project districts

No.	District	Agricultural land area (ha)	Forestry land (ha)	Specially used land (ha)	Residential land (ha)
1	Ben Tre city	5.082	-	649	507
2	Chau Thanh	16.444	-	934	1.072
3	Cho Lach	10.563	-	366	653
4	Mo Cay Nam	16.865	-	735	1.046
5	Mo Cay Bac	12.988	-	428	751
6	Giong Trom	24.617	-	1.268	1.130
7	Binh Dai	15.308	2.854	1.936	849

No.	District	Agricultural land area (ha)	Forestry land (ha)	Specially used land (ha)	Residential land (ha)
8	Ba Tri	21.515	1.531	2.728	1.006
9	Thanh Phu	20.599	2.670	1.583	715
	Total	143.981	7.055	10.627	7.729

Source: Statistical Yearbook of Ben Tre, 2015.

As for the project communes, the total natural land area is 17.799,7 ha, of which the perennial crop area accounts for the largest, which is 12.084,1 ha, equivalent to 67.8% of the total natural land area of all project communes. The communes in the districts and city where their land is less intruded by salinity have larger area of perennial crop land, which are Ben Tre City, Chau Thanh, Giong Trom, Mo Cay Bac, Cau Ke and Binh Khanh Dong Commune of Mo Cay Nam District.

Rice growing area does not account for significant proportion in the total natural land area of the project communes. The total rice and rain-fed crop area of the project communes is 1.896,97 ha, occupying 10,66%. Six out of 14 communes have rice growing land area, namely Phu Hung (Ben Tre City), Thach Phu Dong (Giong Trom District), Giao Hoa, Tan Phu (Chau Thanh District), Khanh Thanh Tan (Mo Cay Bac District), Dinh Thuy (Mo Cay Nam District). The remaining communes and wards do not have land area used for rice cultivation. Tendency to shift from paddy land to perennial crops due to the advantage in terms of economic value of the fruit trees in the process of agricultural land use in the study area is one of the causes for the low percentage of rice growing area. Especially in Ben Tre province, the coconut area in the province is leading in the country and thus formed coconut-growing concentrated area in all project districts. Although the consumption value is not high, coconut products are more diverse with more professional and organized trading system than other types of horticultural products. Moreover, with favorable natural conditions for growing coconut trees, as well as some other fruit trees, people in the project area select such types of trees rather than rice on their agricultural land area.

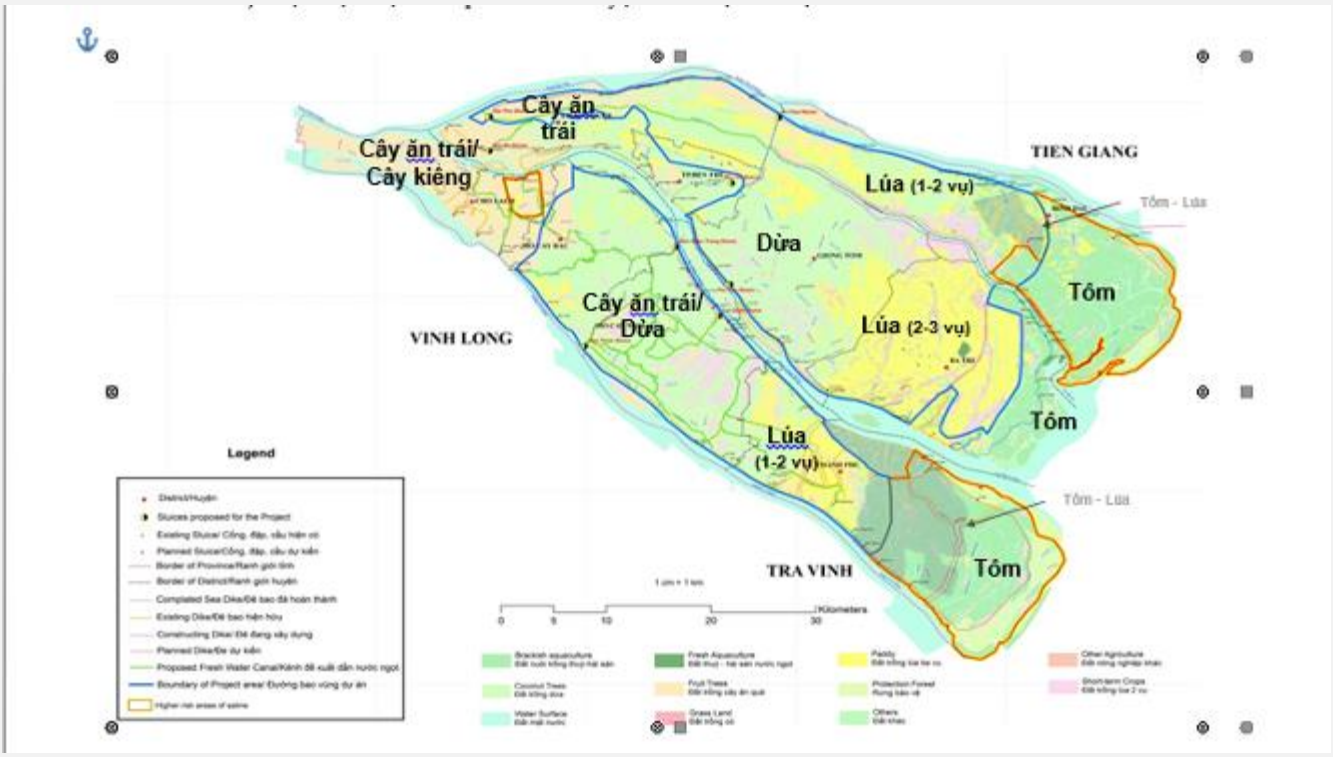


Figure 2 - 24: Land use status and distribution of key crops production in Ben Tre province

Source: Ben Tre DONRE (2016)

Survey team JICA B-SWAMP (2016)

There are some communes where its land is almost dominated by coconut gardens, namely Phu Duc, Phuoc Long, Thanh Phu Dong, Thanh Thoi B, and Dinh Thuy. In contrast, fruit gardens (excluding coconut) make up the majority of the agricultural area in some communes like Tien Long and Tan Phu. The most popular fruit crops are pomelo, durian, rambutan, mango and longan. Rice cultivation is diminished significantly in most communes, except Long Dinh and Phu Hung. In some areas, farmers also grow some different crops in coconut garden, including cacao, banana and some fruits. In general, the diversity of crops reflects the impact of saline intrusion on local agriculture, as most of fruit species are not saline water-tolerant, leading to the predominance of coconut in a large number of communes.

The total area of water surface and aquaculture land of the project communes is 1,806.78 ha, accounting for 7.8% of the total natural land area of the communes. On average, each commune has from 50 ha to 80 ha of water surface and aquaculture land.

13 out of 14 communes do not have forestry land. Only Long Dinh Commune of Binh Dai District has 374.99 ha of forest land including protection and production forests. However, project's works are not located in this forest area.

Details of each type of land in the project communes are shown in the table below.

Table 2 - 32: Land use status of the project communes

Unit: ha

No.	Commune	Total land area	Total rice and crop growing area	Perennial crop area	Forestry land	Aquaculture and water surface land	Residential land	Unused land
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	Ben Tre City	2157,19	623,1	1320,84	0	5,43	174,2	33,62
1,1	Ward 8	225,4	0	151,31	0	0,66	66,42	7,01
1,2	Nhon Thanh	926,32	0	860,04	0	2,5	37,17	26,61
1,3	Phu Hung	1005,47	623,1	309,49	0	2,27	70,61	0
2	Giong Trom Dist.	2649,29	0,02	2341,22	0	152,3	129,53	26,22
2,1	Thanh Phu Dong	1193,26	0,02	1012,22	0	119,5	61,52	0
2,2	Phuoc Long	1456,03	0	1329	0	32,8	68,01	26,22
3	Chau Thanh Dist.	5354,15	20,04	4183,36	0	204,63	200,47	745,65
3,1	Giao Hoa	636,36	20	480	0	126	10,36	
3,2	Phu Duc	1060,39	0	992,65	0	6,56	57,91	3,27
3,3	Tien Long	1220	0	1089	0	52	71	8
3,4	Tan Phu	2437,4	0,04	1621,71	0	20,07	61,2	734,38
4	Mo Cay Bac Dist.	2939,57	27,33	2674,75	0	95,1	142,39	0
4,1	Khanh Thanh Tan	1225,94	27,33	1112,1	0	28,1	58,41	0
4,2	Tan Thanh Binh	1713,63	0	1562,65	0	67	83,98	0
5	Mo Cay Nam Dist.	3929,6	1226,48	1551,65	0	989,98	161,49	0
5,1	Dinh Thuy	1437,72	1226,48			146	65,24	
5,2	Binh Khanh Dong	684,59	0	641,85	0	0,74	42	
5,3	Thanh Thoi B	1807,29	0	909,8	0	843,24	54,25	0
6	Binh Dai Dist.	769,9	0	12,3	374,99	285	34,912	62,75
6,1	Long Dinh	769,9	0	12,3	374,99	285	34,912	62,75
	TOTAL	17799,7	1896,97	12084,1	374,99	1732,44	842,992	868,24

Source: Statistical data provided by CPCs, 2014.

Remarks: The area in the Column 3 is the total land area of the communes in the project area;

3. Agricultural, forestry, and aquaculture production activities

a) Agriculture

The primary agricultural activities of the project districts are fruit tree growing, livestock husbandry and shrimp farming. The main fruit trees grown in these districts are coconut, orange, longan, green-skin pomelo, durian, rambutan, cocoa and sugar-crane. As for salinity-intruded districts such as Binh Dai and Mo Cay Nam, the number of households planting fruit trees is not high as some types of trees such as

durian, rambutan and mangosteen are not suitable with the brackish water environment. Although orange, pomelo and longan, etc. can live in the brackish environment, the productivity is low. The number of households growing coconut trees is high as coconuts can live in fresh water environment and at the same time are able to withstand salinity during the intrusion period. The average yield of coconut trees is 100 million to 150 million coconuts per year per district. The price of dried coconut in 2014 has increased by seven to eight times compared to 2013, creating favorable conditions for people to have output consumption market and invest in developing coconut trees in the area.

As for the inland districts such as Chau Thanh, Giong Trom, Ben Tre City, and Tra On, apart from coconut growing area, the other fruit trees including orange, longan and green-skin pomelo are strongly developing and become popular in the district areas. Some green-skin pomelo growing areas are recognized GlobalGAP standard such as in Nhon Thanh Commune and Ben Tre City. The prices of pomelo, orange and longan are stable and high. In general, the farmers in the area have favorable conditions to develop fruit tree growing. The prices of some fruits in 2013 are higher than 2012 such as thick-skinned orange and longan; for example, the prices of thick-skinned orange is from VND8,000 to VND14,000 per kilogram, Nam Roi pomelo is from VND16,000 to VND20,000 per kilogram, dimocarpus longan is from VND9,000 to VND11,000 per kilogram and rambutan is from VND 6,000 to VND8,000 per kilogram.

Two-crop rice system, Winter-Spring (dry season) and Summer-Autumn (rainy season), is only possible when there is sufficient irrigation water during dry season. Three-crop rice farming is also applied in the upper area of Tra Vinh Province. In the areas where the rainfall is high but water supply is limited, farmers can only grow rice during rainy season. The rice area in the districts is not large because the seasonal salinity intrusion is not suitable for growing rice. Therefore, the rice yield is low, from 1,000 to 3,000 tons per hectare on average.

Looking at the trend of planted areas as a proportion among the major categories: paddy, fruits, other crops, coconuts including cacao, and aquaculture, coconut and cacao and aquaculture have an increasing trend in the past five years from 2010 to 2014. Especially, the share of coconut and cacao has increased 5 percent points from 26% to 31%, while the share of the paddy area has decreased 6 percent points from 36% to 30%. Paddy is no longer the most popular crop in the province. In fact, planted areas of spring, autumn, and winter paddies have decreased 14%, 17% and 19% in the same period, respectively.

Instead, statistical data show that only the planted area of coconut has significantly increased (12,281 ha) in the past five years, while other crops have decreased, especially paddy (13,634 ha). It was also confirmed by field surveys that farmers in mid-stream areas tend to convert from paddy to coconut, attracted by the high market price of coconut these years and relatively high tolerance to saline water than paddy. In addition, labor intensity is also an important factor. It is higher in paddy production for land preparation, trans-planting, weeding in the water, and harvesting, as compared to coconut production which in general requires major labor works just in

harvesting. Also, the scattered configuration of paddy fields makes it difficult for agricultural mechanization.

Table 2 - 33: Planted Area of Agriculture and Aquaculture

Type of Crop	2010	2011	2012	2013	2014	Change (2010-2014)	
Paddy	80,228	76,962	75,863	72,237	66,594	-13,634	-17%
Fruits	32,050	30,174	28,435	27,545	27,392	-4,658	-15%
Coconut and Cacao	57,893	63,348	66,684	68,211	70,174	12,281	21%
Other crops	10,772	8,543	8,059	11,212	13,204	2,432	23%
Crops Total	180,943	179,027	179,041	179,205	177,364	-3,579	-2%
Aquaculture	42,490	43,073	43,234	44,796	47,065	4,575	11%
Total	223,433	222,100	222,275	224,001	224,429	996	0%

Source: Statistical Yearbook, Ben Tre Statistical office (2014) | Unit: ha

In general, the total area of fruits planted has decreased in this period from a total of 32,050 ha to 27,392 ha (85% of the year 2010). Amongst the fruits crops, there are roughly three groups in terms of the trend: increased in the planted area (Rambutan, and Pomelo), decreased (Longan, and Mandarin Orange), and not much changed (others). As a result, the top three major fruit crops have changed from Longan (19% of the total area planted), Orange (14%), and Pomelo (14%) in 2010 to Rambutan (20%), Pomelo (20%) and Longan (15%).

Table 2 - 34: Planted Area of Fruits

Unit: ha

Type of Fruits	2010		2011	2012	2013	2014		% to 2010
Rambutan	3,941	**12%**	5,010	5,428	5,437	5,557	**20%**	141%
Pomelo	4,422	**14%**	4,144	4,528	4,754	5,372	**20%**	121%
Longan	6,249	**19%**	5,360	4,884	4,609	4,123	**15%**	66%
Banana	2,527	8%	2,664	2,401	2,387	2,076	8%	82%
Orange	4,631	**14%**	3,141	2,634	2,007	1,993	7%	43%
Lemon	1,903	6%	1,572	1,459	1,828	1,897	7%	100%
Durian	1,860	6%	1,848	1,843	1,780	1,856	7%	100%
Mangosteen	2,219	7%	2,230	1,937	1,670	1,665	6%	75%
Mango	1,328	4%	1,077	761	687	650	2%	49%
Other Fruits	2,970	9%	3,128	2,560	2,386	2,203	8%	74%

Fruits	32,050	100%	30,174	28,435	27,545	27,392	100%	85%
Trend in %	100%		94%	89%	86%	85%		

Source: Statistical Yearbook, Ben Tre Statistical office (2014)

Note: "Proportion (%)" is for the year 2014 and "% to 2010" is also for the planted area in 2014.

According to DARD, a decrease in the total planted area of fruit attributes to conversion from longan to fresh-type coconut trees. As discussed, fruit trees and coconut trees are planted widely in the alluvial soil zone in up- to mid-stream areas. Therefore, some kinds of fruit are converted to more attractive coconut. In terms of the change in the planted area of each fruit type, disease, and profitability are the major factors

Besides farming, livestock production also plays an important role in the local economy. Pig raising accounts for the majority with a total of more than 124 thousand pigs. Followed by goats and cattle breeding with the numbers from few to thousands (Khanh Thanh Tan Tien Long, Phu Hung, Tan Phu). Poultry is also widely raised with a total of 360 thousand chickens, ducks and others in 14 communes. Moreover, there are also some areas used for aquaculture, mainly fresh seafood (fish and freshwater shrimp) or brackish water aquaculture (shrimp). Communes with the largest area for aquacultute are Tan Phu (89 ha) and Thanh Phu Dong (88 ha)

b) ***Cropping pattern and farming systems***

Cropping patterns and farming systems in Ben Tre are quite diversified. Among all, major cropping patterns are illustrated as table below. As shown in the table, there are five major cropping patterns in Ben Tre province, each one may also have some variations. The first cropping pattern is the intensive cropping of paddy, which is common in the midstream to downstream areas of Ben Tre, except for the coastal areas. Yet, three-times-per-year cropping is losing popularity due to the high risk of saline concentration. Thus, since 2016, it is recommended by DARD to shift this pattern to two-times-per-year cropping of paddy plus some short-term crops during the dry season, such as vegetable and grass for cattle raising.

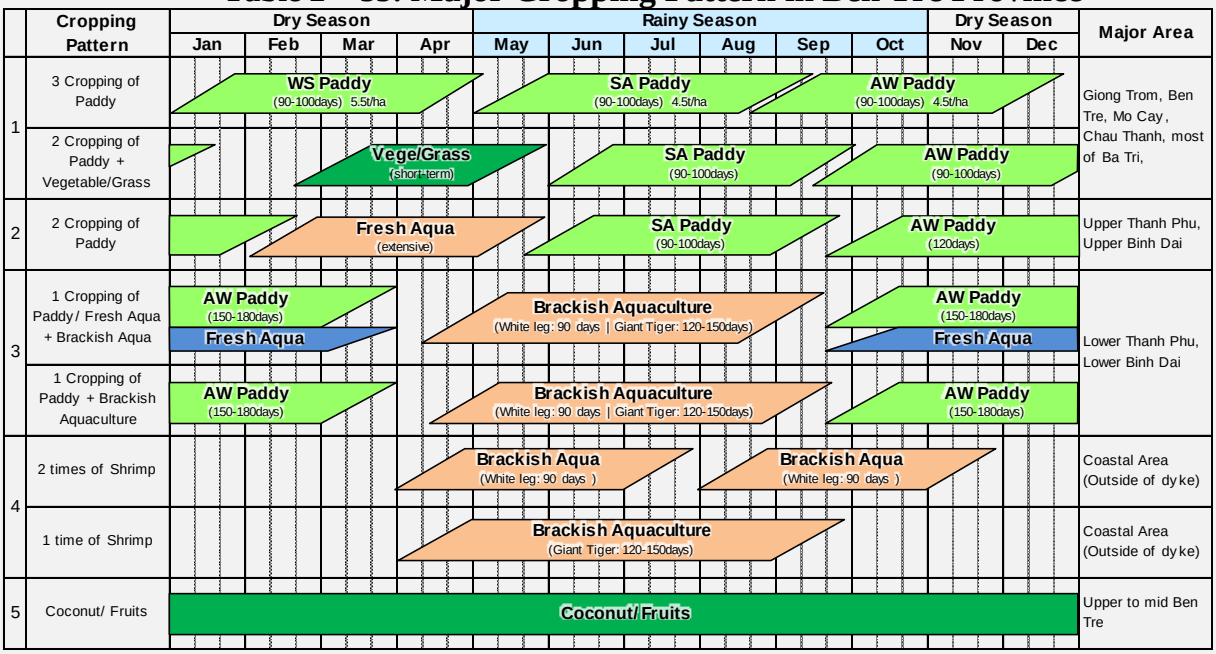
The second pattern is two times of cropping of paddy, sometimes combined with freshwater aquaculture during the dry season, which is enabled by reserved freshwater during the rainy season. Two times of cropping of paddy is suitable, especially where irrigation systems are not well developed. This cropping pattern is popular in the Upper Thanh Phu and Upper Binh Dai districts.

The third cropping pattern is the combination of one-time cultivation of paddy and brackish aquaculture. In fact, this type of cropping pattern only appears in the area where brackish water comes in during dry season, with which farmers have substantially no choice but going into this pattern. As to practice this cropping pattern, leaching of salinity of the field is required for a certain period of time at the beginning of rainy season, which makes it difficult to control the cropping season. Also, productivity cannot be high as compared with three cropping of paddy. One variation is to cultivate freshwater fish in the same field with paddy, which can be managed with a local variety of paddy which is tolerant to disease and thus does not require much application of fertilizer and chemicals. This pattern can be found in lower Than Phu and lower Binh Dai. Note that brackish aquaculture often starts at the end of the dry season as the cultivation of Autumn-Winter paddy with the local variety extending to the middle of the dry season.

The fourth pattern is brackish aquaculture in coastal areas, outside of dikes, of Binh Dai, Ba Tri and Thanh Phu districts. One pattern of this is to conduct two times of shrimp culture per year with white leg shrimp, which requires a relatively shorter growing period (3-4 months). Cultivation of Giant Tiger Shrimp is recommended to be managed only one time per year as to reduce the risk of disease.

The fifth pattern is the cultivation of perennial crops: fruit trees and coconut trees throughout the year. Fruit cultivation is popular upstream of Ben Tre, such as at Chau Tanh and Cho Lach whereas coconut cultivation is more in the midstream of Ben Tre. Yet, fruit trees and coconut trees are often mixed in the same agricultural fields for diversification.

Table 2 - 35: Major Cropping Pattern in Ben Tre Province



Source: Agriculture and Fishery Extension Center, DARD Ben Tre (2016)

Note

* For SA paddy, acid tolerance is preferred as it is cultivated at the beginning of rainy season when acidity tends to be slightly high.

* For AW paddy, occurrence of warm is not severer than SA paddy; however, it is cloudy, thus, about same level of yield as SA paddy is expected.

* The crop yield is based on dried paddy (15% in moisture)

* For repeated cultivation of shrimp, at least one month of furrow period should be made.

* Fresh water aquaculture can be managed with local variety of paddy, as it does not require so much application of fertilizer and pesticide.

* Fresh water aquaculture can be managed even during dry season when saline concentration is high if enough amount of fresh water can be secured during rainy season.

* Nowadays, two times of shrimp culture is gaining more popularity (roughly 80% of extensive brackish aquaculture).

* In terms of brackish shrimp culture alone, 10,700 ha are intensive and semi-intensive (30%), 25,000 ha is extensive (70%) in 2015.

c) ***Forestry***

Among the total of six districts/city in the project area, only Binh Dai District has forest land including protection and production forests. The forest area is managed and protected well by the District People's Committee as well as other concerned agencies. There is a good combination between protection forest and production forest development. The DPC regularly carries out information campaign, advocacy, inspection and control of forest fire prevention and illegal soil excavation from forest lands. The DPC has cooperated to announce the Forest Protection and Development Planning in the district in the 2012 to 2020 period.

d) ***Aquaculture***

The aquaculture in the area of the project includes both freshwater and brackish water aqualculture. Freshwater aquatic products are freshwater fishes, shark catfish, basa fish, giant freshwater prawn while brackish aquatic products include black tiger shrimp, whiteleg shrimp, and some brackish water fishes (Asian seabass, eel, etc.) and other aquatic species (crab, oyster, arca). Shrimp farming accounts for 80% of the area for aquaculture (Ben Tre statistic year book 2015). In this area there are many other types of farming, mollusc farming such as clams (Meretrix spp) and cockles (Anadara sp) is also relatively common.

Brackish water shrimp (Penaeus monodon) is cultured in the entire coastal area of the Mekong Delta in the condition of frequent salinity intrusion. The table below summarizes the aquaculture productivity in the Mekong Delta compared to the rest of the country. It clearly shows that the productivity of aquaculture in the Delta is significantly higher than those of other regions. In fact, the gross output of fishery (3,408,292 tons) and aquaculture output in particular (2,262,906 tons) of the Mekong Delta respectively account for 56.6% and 70.3% of the national outputs (6,019,732 tons and 3,215,918 tons). Of which, the shrimp output of the region (441,254 tons) contributes 78.7% of the country's shrimp production (560,499 tons). Particularly, in the project area, Ben Tre is the province that has the largest fishing and aquaculture output with 169,353 tons of fish and 53,589 tons of shrimp in 2013.

Table 2 - 36: Aquaculture output (2013) in Mekong Delta and other regions

Unit: ton

Region	Aquatic output (ton)	Aquaculture output (ton)	Fish culture output (ton)	Shrimp culture output (ton)
Red River Delta	737.461	520.671	371.397	17.815
Northern mountainous area	99.143	88.924	86.748	338

North Central and Central Coastal area	1.316.728	207.207	102.263	76.773
Central Highlands	33.751	29.155	29.079	7
South-eastern	424.356	107.055	72.649	24.313
Mekong Delta	3.408.292	2.262.906	1.689.456	441.254
Ben Tre	391.616	233.641	169.353	53.589
Nationwide	6.019.732	3.215.918	2.351.592	560.499

Source: Statistical Yearbook of Vietnam (2013)

According to the socio-economic reports of the project districts in 2013, of the total natural area of the districts, 22,383.23 ha are used for aquaculture and concentrated in district that is near the sea, Binh Dai District. Aquatic products in the district include Scampi with 5,162.99 ha accounting for 20% of the total aquaculture area in all project districts. Fresh water aquaculture covers 2,861.55 ha, occupying 11.1%, in eight out of nine districts in the project area (except for Ben Tre City). Giant tiger prawn accounts for 9,833.7 ha, which is equivalent to 38.33%, and is only concentrated in Binh Dai District. 4,797.02 ha are used for white-leg shrimp culture, making up 18.6%, and 99% of them are concentrated in Binh Dai while only 1% is in Giong Trom District. Oyster farming accounts for 2,050 ha and 7.9% of the total aquaculture area, which is concentrated only in Binh Dai. Blood arca (Tegillarca granosa) and brackish water fish are also two products that only Binh Dai District has. Of which, blood arca culture accounts for 828 ha, equivalent to 3.2% and brackish water fish farming covers 129.4 ha, occupying 0.5% of the total aquaculture area. Therefore, Binh Dai is the only district that keep brackish water species. The remaining districts mainly keep freshwater fishes and scampi in the coconut gardens.

Hence, it can be realized that the construction of culverts will be beneficial for the project districts due to freshwater reserves and increase in productivity of freshwater aquatic species in most of the project districts.

Detailed statistics on aquaculture area of the project communes are shown in the table below.

Table 2 - 37: Details of aquaculture area in the project districts

Unit: Ton

No.	Area	Total aquaculture area (ha)	Year 2013							
			Scampi farming in coconut gardens	Fresh-water aquatic species	Giant tiger prawn	White leg shrimp	Oyster	Blood arca	Brackish water fish	Others
1	Ben Tre City	103	64,89	0	0	0	0	0	0	38,11
2	Giong	1116	656	415	0	45	0	0	0	0

	Trom									
3	Binh Dai	18004,23	107,6	303,54	9833,7	4752,02	2050	828	129,4	0
4	Chau Thanh	1100	300	800	0	0	0	0	0	0
5	Mo Cay Bac	380	230	149,9	0	0	0	0	0	0
6	Mo Cay Nam	1680	680	1000	0	0	0	0	0	0
TOTAL		22383,23	2038,49	2668,44	9833,7	4797,02	2050	828	129,4	38,11

Source: Socio-economic reports of the project districts, 2013.

Brackish shrimp farming accounting for 80% of the aquaculture area is divided into 2 main farming patterns: intensive and extensive farming. These two pattern can be divided into 4 types: intensive, semi-intensive, advanced extensive and extensive. In Ben Tre, aquaculture advanced extensive and extensive account for 72%, intensive aquaculture accounts for about 27%, and semi-intensive accounts for less than 1% of the aquaculture areas.

4. Industry and Construction

In terms of industry and small and artisanal industry: There are more than 9,000 industrial and small and artisanal industrial establishments operating in nine districts/city in the area. The value of production in 2013 is estimated at VND 11,489 billion and the sector has attracted more than 70,000 labors. The economic downturn still affects the businesses and manufacturing facilities, especially is the field of coconut processing. A number of manufacturing industries in the field of processing have the advantage of local labor such as garments, knitting, embroidery, which find many contracts help solving employment issues for several local labors. The products produced in the districts undergoing stability and growth include: Coconut products, garment processing, weaving, carpentry and manufacturing products for construction. The key products of the region are coir fiber, coco peat, coir net, coconut jelly, garments, etc. that meet and even exceed the targets. Small establishments (from 10 to 30 employees) in the districts are strongly developed (as satellites) and engaged in garment processing for the enterprises in Ho Chi Minh City.

In terms of construction: The districts have gradually improved their infrastructure, and promoted economic and social development in the districts. Many important works such as transportation, markets, and administrative structures have been completed and put into use.

5. Trade and Services

Trading activities are basically stable and continue growing. Goods meet the demands for production and consumption of people. The estimated values of goods are increased compared to those in 2012. The key agricultural products in the districts such as dried coconut, live pigs are stable and profitable and the purchasing power of the population has increased significantly. Revenues of essential goods, consumption goods, materials for livestock foodstuff, construction materials, interior decoration, etc. have risen remarkably.

Market management, inspection, business control are regularly carried out. Market development is receiving investment interests from many funding sources.

Import and Export: Despite many difficulties, the enterprises have been active and taken initiative to find, maintain and expand markets for key commodities such as seafood processing, industrial garment, coconut candy, coir fiber, fresh coconuts, etc.

Tourism: Ben Tre City with the advantage as the center of the province is the destination for tourists to visit and from here can go to other areas of the province. Moreover, several people have visited Ben Tre to attend seminars and conferences held in the center of the province; therefore, the businesses have actively invested, developed and expanded a range of fully-equipped hotels and restaurants. In 2013, it is estimated that there were 744,800 visits to Ben Tre City. Giong Trom District has developed a Con Oc Ecotourism Development plan in Hung Phong Commune for the 2013-1015 period and vision towards 2020. In addition, in the communes, Homestay, a form of tourism is also developed to attract tourists to visit and stay in the area.

6. Waterway transportation

There are two types of transports in the Mekong delta maritime area, one being transportation by water, while the other is transportation by road. According to "JICA Project for Climate Change Adaptation for Sustainable Agriculture and Rural Development in the Coastal Mekong Delta (2013)", the transportation by water in the Mekong delta is much different from transport in other regions in Vietnam. The transportation by waterway in the Mekong delta is about 70% while other regions show less than 30% of it in statistical data without air transport in 2009. This region was developed with water transport on a natural channel primitively, and colonial government and the Vietnamese government have continued to develop artificial channels. The government also develops road networks, however transport by water still covers the main part.

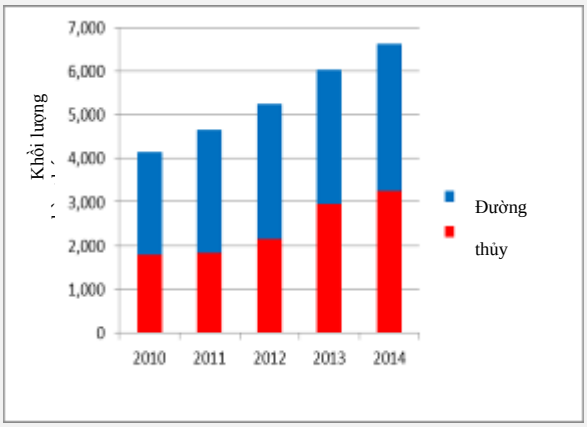


Figure 2 - 25: Transition of Cargo Transportation Amount

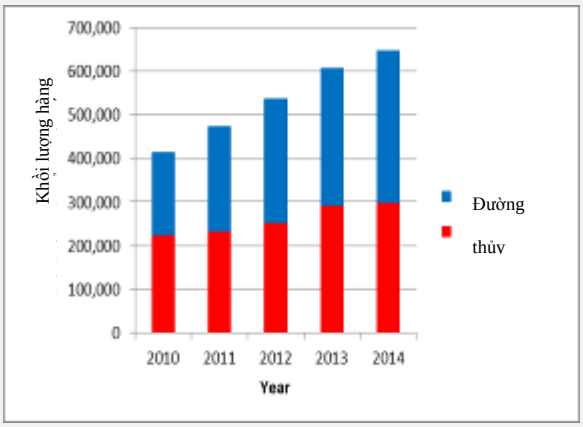


Figure 2 - 26: Transition of Cargo Transportation Traffic

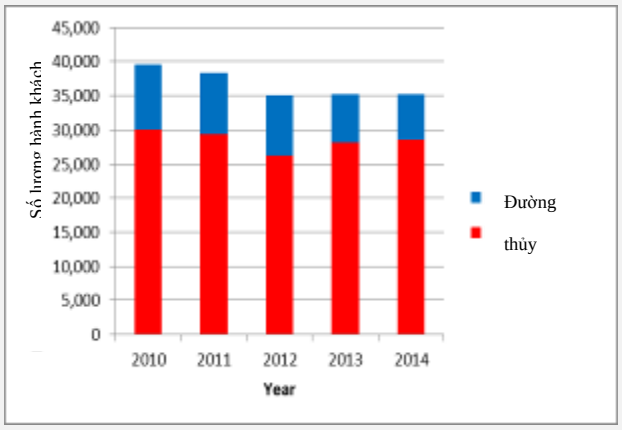


Figure 2 - 27: Transition of Number of Passenger

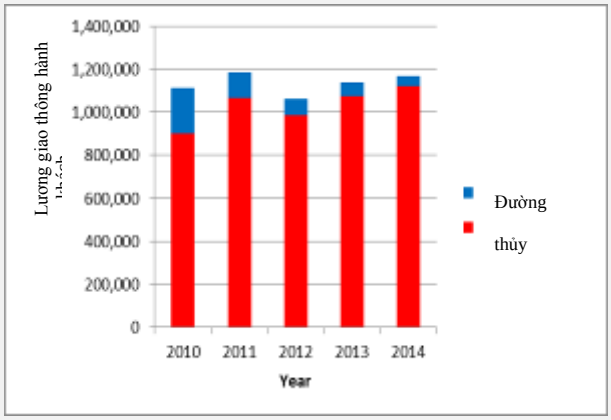


Figure 2 - 28: Transition of Traffic of Passenger

Source: Statistical Year Book Ben Tre 2014, Ben Tre Statistical Office (2015)

Trends of cargo transportation in Ben Tre in recent years show increasing tendencies; the cargo transportation is mainly composed of two (2) methods; one is by an inland waterway while the other is by road. The freight transportation amount by the inland waterway in the Ben Tre province shows more than the amount by road. Road freight transportation has been abruptly increasing from 2012 and is almost half of the total freight volume of 2014. However, the inland waterway still has important roles in freight transportation in Ben Tre.

Regarding passengers, road transportation is dominant in Ben Tre in comparison with inland waterway transportation. The number of passengers by the inland waterway transportation has been decreasing gradually. Bridge construction in the Mekong delta may have made an impact on a tendency of the decreasing of passenger numbers. Contrarily, there is much sailing of sightseeing boats because the Ben Tre province is a tourist spot. The waterway is still in an important position in this area.

Under the impacts of East Sea tide, in My Tho, Cua Dai and Ham Luong Rivers a dense network of canals is formed and tend to develop in the direction of the North-South, dividing Ba Lai region into many small areas. Especially great Ben Tre-Giao Hoa River was formed connecting Cua Dai and Ham Luong rivers, creating a very important waterway traffic in the area and provinces.

Along the Cua Dai and Ham Luong rivers, on average, each kilometer has a canal mouth, of which several mouths of the canals have fairly large width, from 40m to 60m and narrower and shallower inwards.

Ben Tre Province has a relatively developed waterway network, surrounded by four major rivers with more than 200km in length and several other small rivers, which is convenient for inter-regional and regional transportation. The large and small canals in the project area allow boats and vessels of approximately 15 tons access easily to the hamlets and fields. Inland waterway is mainly used to transport agricultural products, construction materials and other goods for people.

Team survey of JICA for Ben Tre water management project conducted investigation in 2016 with water way users. There are totally 4,177 households having boat in 49 communes near 8 sluice gates of the project.

Table 2 - 38: Number of households owning boat in the project are

No	District/city	Number of HH having boat
1	Ben Tre	30
2	Chau Thanh	168
3	Binh Dai	75
4	Mo cay Bac	539
5	Giong Trom	919
6	Mo Cay Nam	2,446
	Total	**4,177**

Source: Survey team JICA B-SWAMP (2016)

1.2.2 Social status

1. Population Composition and Ethnicity

a) Population

The population density of Ben Tre is at the 5th position among the Mekong delta provinces, being as much as 535 persons per km2. The total population in the Ben Tre province is estimated at about 1.26 million; North Ben Tre shares about 60% of it and South Ben Tre shares the remaining 40% of the total population. Ben Tre city has a large population in a narrow area, which results in a high population density, being as much as 1,698 persons per km2. The two coastal districts, Binh Dai in the north Ben Tre and Thanh Phu in the south Ben Tre, rank the lowest and second lowest in population density with a bit over 300 persons per km2, while the Ba Tri district has 522 persons per km2, a slightly lower population density than the Ben Tre city average of 535 persons per km2.

Paddy production and shrimp farming are dominant in the Ba Tri district; there are some residential houses near irrigation canals in the paddy cultivation areas while such houses are rare in the shrimp farm areas. Domestic use water is available along the irrigation canals, so that people in this district can keep their residences along the irrigation canals. The Chau Thanh district has the second biggest population density after Ben Tre city, which is located at the most upstream side in North Ben Tre, and fruit production is dominant.

Table 2 - 39: Area and Population of the Project Area

District/ Region		Area, km^2	Population (2014)	Pop. Density Persons/km^2
North Ben Tre Islet	Ben Tre City	71.1	120,749	1,698
	Chau Thanh District	225.1	164,037	729
	Giong Trom District	313.2	167,203	534

District/ Region		Area, km^2	Population (2014)	Pop. Density Persons/km^2
	Binh Dai District	421.5	130,998	311
	Ba Tri District	358.4	187,161	522
	North Ben Tre Islet	1389.3	770148	554
South Ben Tre Islet	Cho Lach District	167.6	109,387	653
	South Mo Cay District	222.1	145,966	657
	North Mo Cay District	158.2	109,151	690
	Thanh Phu District	422.7	127,553	302
	South Ben Tre Islet	970.6	492057	507
Ben Tre Province		2,359.8	1,262,205	535
Total Mekong Delta		40,576.0	17,517,600	432
Whole Country		330,967.0	90,728,900	274

Source: Source： Statistical Year Book Ben Tre 2014, Ben Tre Statistical Office (2015), Statistical Year Book of Vietnam 2014, General Statistics Office (2015) Survey team JICA B-SWAMP (2016)

b) ***Ethnicity***

In the communes of the project districts, most of the population are Kinh people. However, a small number of households belong to Hoa, Muong, Tay, Khome and Cham ethnic groups living in Thach Phu Dong, Phu Duc, Tien Long, Long Dinh, An Phu Tan, Trung Thanh Tay, Trung Thanh Dong and Tich Thien communes. Most of them are Chinese (Hoa) and Khmer ethnic minority people. There are only one Muong and one Tay ethic minority people living in Phu Duc Commune. In the project area, the ethnic minorities are living in harmony and among Kinh people; thus there is no great cultural difference between the ethnic minorities and Kinh communities. Most of the ethnic minority people here can speak, read and write in Vietnamese. Detailed figures on ethnic people in each commune are described in the table below:

Table 2 - 40: Ethnic minorities in project communes

Unit: people

Commune	Hoa	Muong	Tay	Kho me	Cham
Tanh Phu Dong	87				
Phu Duc		1	1		
Tien Long				10	1
Long Dinh				2	
An Phu Tan	2			5	
Trung Thanh Tay				9	
Trung Thanh Dong				8	
Tich Thien				15	

Source: CPCs, 2014

2. Labor and Employment

a) Labor

The total population of the project communes is 179,396 people, of which approximately 70 percent are in the working age (from 16 to 60) and 30 percent are beyond the working age (under 16 and above 60). Among the total population, 93,000 people are female, accounting for 51.8 percent and 86,396 people are male, occupying 48.2 percent. Similarly to the sex ratio of the total population, of 70 percent of population in the working age, 51.8 percent are females while 48.2 percent are males. Data on the labor force of the communes are shown in the Table 2-37 below.

Table 2 - 41: Labor force of the communes in the project districts

Unit: people

#	District	Population				Population in the working age (16-60)			Population beyond the working age (<16; > 60)	
		Total	Female	Male	Total	F	M	Total	F	M
1	Ben Tre City	29.807	15.272	14.535	19.464	10.020	9.444	10.343	5.252	5.091
2	Giong Trom Dist.	21.558	11.637	9.921	17.604	9.312	8.292	3.954	2.325	1.629
3	Chau Thanh Dist.	36.850	18.942	17.908	28.766	14.755	14.011	8.084	4.187	3.897
4	Mo Cay Bac Dist.	24.266	12.867	11.399	17.073	9.198	7.875	7.193	3.669	3.524
5	Mo Cay Nam Dist.	31.119	15.861	15.258	20.622	10.514	10.108	10.497	53.47	5.150
6	Binh Dai	6.494	3.312	3.182	4.748	2.422	2.326	1.746	890	856
	Total	**150.094**	**77.891**	**72.203**	**108.277**	**56.221**	**52.056**	**41.817**	**21.670**	**20.147**

Source: Socio-economic survey data provided by CPCs, 2014.

b) Employment

In the project communes, the proportion of households engaged in agriculture is quite high in the occupational structure of each commune, especially the communes in Binh Dai, Cau Ke, Vung Liem, and Chau Thanh districts, accounting for 70-80 percent of total households in each commune. As the project is not located in the area that has forest coverage, there is no household engaged in forestry sector. Trade, industry and handicraft, construction, business and services are developing strongly in Giong Trom, Mo Cay Bac districts, Ben Tre City, and Mo Cay Nam District. 30 to 40 percent of the total households in the project communes working in these sectors are from the above listed districts. Only 0.7 percent of households in Ben Tre City are engaged in fishery sector. In other project communes, there is no household involved in fishery. Detailed proportions of each sector in the project communes are presented in the following table.

Table 2 - 42: Occupational structure in the project area

Unit: %

No.	District	Agri-culture	Forestry	Fishery	Industry & Handicraft	Construction	Trade	Services	Others
1	Ben Tre City	44,3	0	0,7	4,8	0,0	2,1	19,4	28,7
2	Giong Trom Dist.	68,2	0	0,0	10,0	1,8	6,8	0,2	13,0
3	Chau Thanh Dist.	82,9	0	0	4,1	0,1	11,6	1,2	0,1
4	Mo Cay Bac Dist.	74,6	0	0	0	0	0	25,4	0
5	Mo Cay Nam Dist.	29,7	0	0	3,9	0	13,7	6,2	46,5
6	Binh Dai	84,9	0	0	0	0	0	15,1	0

Source: Socio-economic survey data provided by CPCs, 2014.

3. Income, Poverty, and Gender

a) Income sources

With the proportion of agriculture accounts for the highest in the economic structure, the main income source of the households is from agricultural sector. As most of the districts have salinity-contaminated soil, the area for growing rice is not large. Income from cultivation of the households is mainly from growing fruit-trees, especially coconut, orange, pomelo, longan, rambutan, durian, mangosteen, etc. As for freshwater districts such as Chau Thanh, Tra On, Mo Cay Bac, Ben Tre City, the above listed fruit-trees have been grown broadly. As for the districts with salinity intrusion such as Giong Trom, Binh Dai, Vung Liem, Mo Cay Nam, and Cau Ke, the main fruit-tree is coconut. Income from livestock is mainly from cattle, pig, and poultry. Income from aquatic products is primarily from culture of giant freshwater prawn in coconut canals in the districts with high salinity intrusion and from catfish in the districts with large freshwater area.

b) Living standards of households in the project area

The living standards of the households in the project communes are relatively high and even. Most of the households are classified as above-average, from 40 to 50 percent of the households in the project communes. The poverty incidence is low, mainly below 10 percent. The communes with the lowest poverty rates are Nhon Thanh, Phu Hung, Giao Hoa, Dinh Thuy, Tich Thien, Trung Thanh Dong, and Trung Thanh Tay, less than 5 percent in each commune. The communes with the highest poor household rates are Phuoc Long (19.8 percent), Khanh Thanh Tan (12.4 percent), and Thanh Phu Dong (9.6 percent).

Table 2 - 43: Living standards of the households in the project communes

	Commune/ District	No. of HHs	Poor HHs		Average HHs		Above-average HHs		Rich HHs	
			No. of HHs	Percent %	No. of HHs	Percent %	No. of HHs	Percent %	No. of HHs	Percent %
	Total	37644	2859	7,6	8515	22,6	18041	47,9	8229	21,9

	Commune/ District	No. of HHs	Poor HHs		Average HHs		Above-average HHs		Rich HHs	
			No. of HHs	Percent %	No. of HHs	Percent %	No. of HHs	Percent %	No. of HHs	Percent %
1	Ben Tre City	7093	231	3,3	2306	32,5	3010	42,4	1546	21,8
1.1	Ward 8	1828	16	0,9	23	1,3	1252	68,5	537	29,4
1.2	Nhon Thanh	2050	55	2,7	308	15,0	978	47,7	709	34,6
1.3	Phu Hung	3215	160	5,0	1975	61,4	780	24,3	300	9,3
2	Giong Trom District	5487	797	14,5	1084	19,8	2156	39,3	1450	26,4
2.1	Thanh Phu Dong	2827	271	9,6	359	12,7	1318	46,6	879	31,1
2.2	Phuoc Long	2660	526	19,8	725	27,3	838	31,5	571	21,5
3	Chau Thanh District	9318	575	6,2	2071	22,2	5049	54,2	1623	17,4
3.1	Giao Hoa	1004	46	4,6	70	7,0	711	70,8	177	17,6
3.2	Phu Duc	2140	130	6,1	556	26,0	982	45,9	472	22,1
3.3	Tien Long	2550	158	6,2	239	9,4	1722	67,5	431	16,9
3.4	Tan Phu	3624	241	6,7	1206	33,3	1634	45,1	543	15,0
4	Mo Cay Bac District	6865	698	10,2	592	8,6	3885	56,6	1690	24,6
4.1	Khanh Thanh Tan	3016	374	12.4	295	9.8	1303	43.2	1044	34.6
4.2	Tan Thanh Binh	3849	324	8.4	297	7.7	2582	67.1	646	16.8
5	Mo Cay Nam District	7406	427	5.8	2226	30.1	3130	42.3	1623	21.9
5.1	Dinh Thuy	3012	103	3.4	942	31.3	1054	35.0	913	30.3
5.2	Binh Khanh Dong	1898	159	8.4	899	47.4	670	35.3	170	9.0
5.3	Thanh Thoi B	2496	165	6.6	385	15.4	1406	56.3	540	21.6
6	Binh Dai District	1475	131	8.9	236	16.0	811	55.0	297	20.1
6.1	Long Dinh	1475	131	8.9	236	16.0	811	55.0	297	20.1

Source: Socio-economic survey data provided by CPCs, 2014.

Table 2 - 44Poverty Rate of Ben Tre Province by District

Unit: %

District	Total	Urban	Rural	Compare to province
Ben Tre City	1.30	0.84	1.85	0.27
Chau Thanh	4.02	2.10	4.07	0.60
Cho Lach	5.05	4.74	5.08	0.75
South Mo Cay	5.75	7.29	5.62	0.83
North Mo Cay	8.24	0.00	8.24	**1.21**
Giong Trom	5.92	6.24	5.90	0.87
Bihn Dai	7.74	6.46	7.83	**1.15**
Ba Tri	9.23	6.42	9.40	**1.38**
Than Phu	10.86	10.99	10.85	**1.60**
Whole Province	6.48	3.72	6.79	1.00

Source: Statistical Year Book Ben Tre 2014, Ben Tre Statistical Office (2015)

c) ***Average income***

The average income per capita in the project districts is relatively high, at around VND 1,700,000 per person per month to VND 2,500,000 per person per month. Of which, the highest income per capita is in Ben Tre City and Chau Thanh District. Giong Trom, Mo Cay Bac, Vung Liem, and Binh Dai districts have the lowest income per capita, ranging from VND 1,700,000 to VND 1,800,000 per person per month.

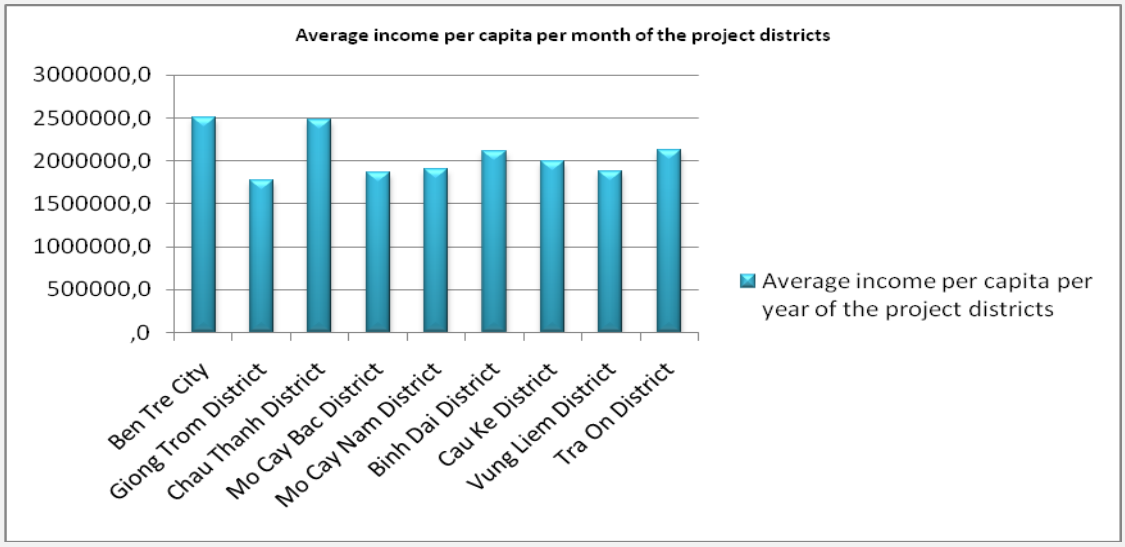


Figure 2 - 29: Income per capita in month

d) ***Gender issues***

The public consultation results show that there is no inequality issue between women and men in the project area. Labor division in the family is traditional, that is women mainly do housework including cooking, cleaning house, washing clothes, going to the market, etc. while men are in charge of bigger family issues.

In terms of educational level, the survey results show that women have lower level of education than men.

About 30 percent of the communal leaders are women. However, the key and decisive positions with high power are often undertaken by men. Most of the women are member of the Communal Women's Union and participate in the women's movements of the communes.

Most of the household heads are male. However, there is no great difference observed between male-headed and female-headed households in their accessibility to social services such as health, education, credit, loan and household economic development.

Consultation results also show that women have demands to be recruited in the project activities. They can participate in the activities such as mason, cleaning, cooking, and other works depending on the recruitment of the contractors.

4. Access to services, communications, and clean water

a) Electricity, communications, and clean water

- ***Clean water***

Water supply for urban area

The Water supply in the Ben Tre Province is conducted by two organizations, namely, the 'Ben Tre Water Supply One-member Limited Liability Company (WSC)' and the 'Center of Rural Water and Environment Sanitation (CRWES) Ben Tre Province'. The former is responsible for the water supply in the urban area and the surrounding area of Ben Tre City, and the latter is under Ben Tre DARD and responsible for the water supply in the rural area.

The water supply area covered by WSC is shown in the following figure, and four (4) water supply plants are being operated, namely, Son Dong, Huu Dinh, Cho Lach, and Luong Quoi. There are two (2) water-pumping stations to take and send water to the water supply plants. The designed water supply capacity is 52,800m3/ day in total.

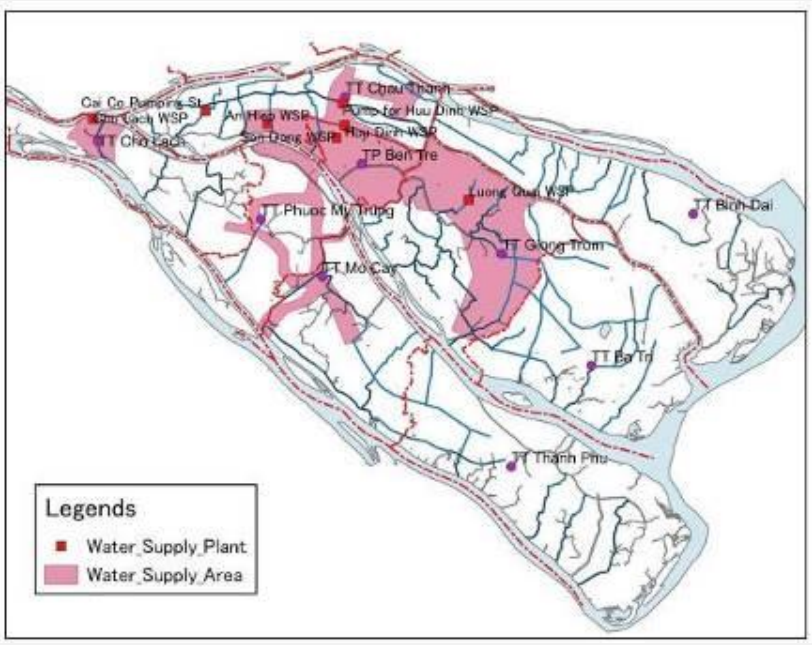


Figure 2 - 30: Location Map of Water Supply Plant and Water Supply Area in Ben Tre

Source: JICA B-SWAMP Survey Team (2016)

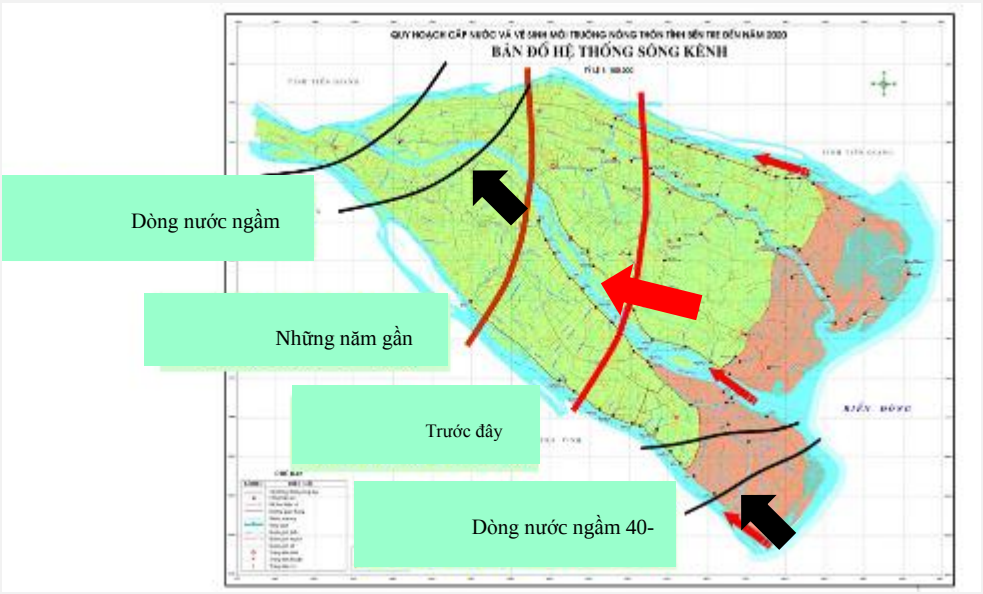


Figure 2 - 31: Change of Saline water intrusion Area in Ben Tre Province

Source: JICA Survey Team (2016); Center of Rural Water and Environment Sanitation Ben Tre Province (2016)

Groundwater use is not so dominant in the Ben Tre Province while surface water comprises the majority of the water resource. Fresh water available from surface water in the dry season is getting worse so that people's selection of options will be quite limited, such as, surface water, groundwater, and stored rainwater during the rainy season.

	
This well derives from an unsafe water source with wild weeds, and is also going to be dried up	Rural people prepare fresh water for dry season

Figure 2 - 32: Water Shortage Situation in Dry Season in Ben Tre Province
Source: Center of Rural Water and Environment Sanitation Ben Tre Province

The Center of Rural Water and Environmental Sanitation under DARD is in charge of the water supply in the rural area of the Ben Tre Province. The Center is implementing a national campaign entitled, "Treated Water and Rural Environmental Sanitation" (NTP3), and it is in the stage of 2016-2020 of a short-term plan. The Center owns and operates forty-two (42) water supply plants and provides water in the amount of 1,583 m3/h to 51,383 households in a rural area as shown in figure 2-32. Seventy-two (72) water supply plants supply the treated water to more than 80,000 rural households with a total capacity of 2,624 m3/h.

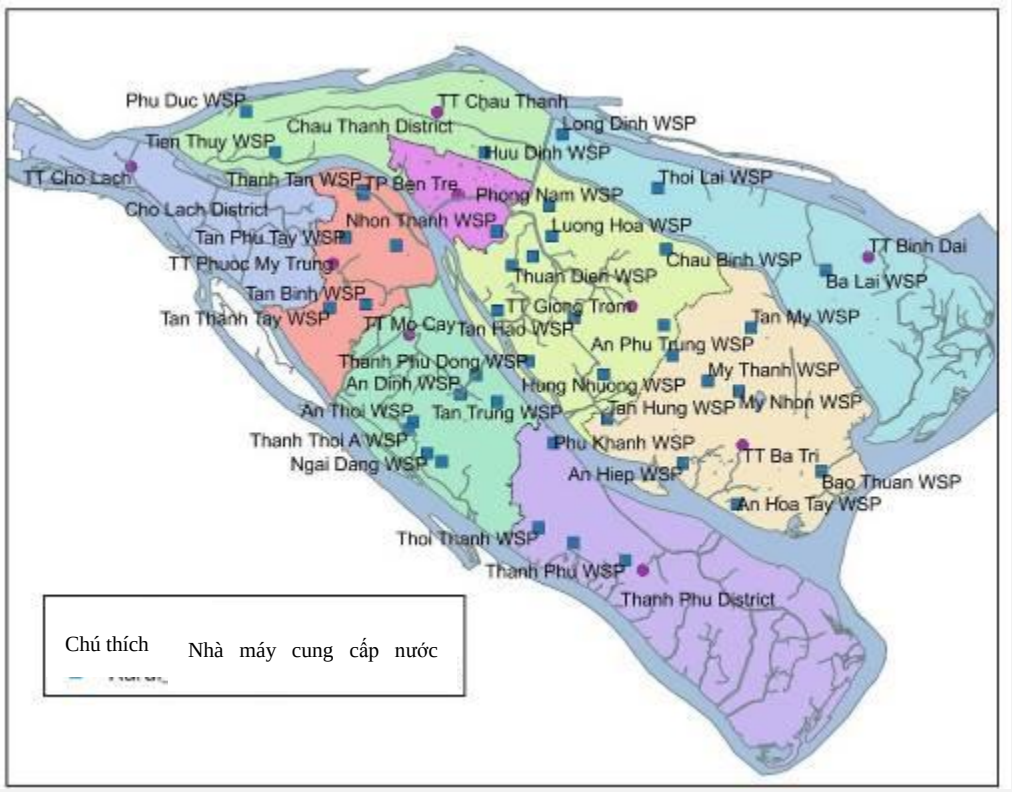


Figure 1.2.1 Location Map of Water Supply Plant in Rural Area by CRWES
Source: JICA Survey Team (2016); Center of Rural Water and Environment Sanitation Ben Tre Province (2016)

In the Binh Dai District in north Ben Tre, the Ba Lai River is the main source of the rural water supply, but saline water intrusion into the Ba Lai River occurs during the dry season upstream from the Ba Lai Barrage. As a result, fresh water cannot be taken from the river. In the Chau Thanh District, fresh water cannot be taken from rivers and canals because of saline water intrusion during the dry season, too.

In south Ben Tre, the saline water intrusion area has been moving north. Currently, water is taken from water intake and supply plants in the middle of south Ben Tre and sent through pipes, but salt water has already reached to the intake point.

Currently, clean water system has not covered all households in the communes in the project area. Except for Ward 8, Nhon Thach Commune of Ben Tre City, Giao Hoa Commune of Chau Thanh District with the percent of households using tap water of more than 80 percent and Long Dinh Commune of Binh Dai District with 46 percent, the remaining communes in the project districts have low percentages of households with access to tap water, less than 30 percent of the total households. In the communes where not many households can use clean water, most of the households, equivalent to more than 60 percent in each commune, have to use water from natural sources such as rivers and rainwater. Water sources from canals and rivers are important sources for households to use for cooking, drinking and other domestic purposes. A small number of households use rainwater for daily cooking and drinking. The specific data on the number of households using different water sources in the project area are presented in the below table.

Table 2 - 45: Domestic water sources of the households in the project communes

Unit: household

	District/Commune	Tap water	Drilled well	Dug well, earth well	River, stream, lake, pond	Rain-water	Others
I	Total	11.022	1.013	1.452	18.135	6.222	0
1	Ben Tre City	5.119	0	0	1.944	30	0
1,1	Ward 8	1.828	0	0	0	0	0
1,2	Nhon Thanh	600	0	0	1.450	0	0
1,3	Phu Hung	2.691	0	0	494	30	0
2	Giong Trom District	923	0	0	2.332	2.232	0
2,1	Thanh Phu Dong	495	0	0	2.332	0	0
2,2	Phuoc Long	428	0	0	0	2.232	0
3	Chau Thanh District	2.222	542	1.143	5.396	215	0
3,1	Giao Hoa	803	0	0	201	0	0
3,2	Phu Duc	486	371	1.143	125	215	0
3,3	Tien Long	153	0	0	2.397	0	0
3,4	Tan Phu	780	171	0	2.673	0	0
4	Mo Cay Bac District	1.681	151	0	4.581	452	0
4,1	Khanh Thanh Tan	603	151	0	1.810	452	0
4,2	Tan Thanh Binh	1.078	0	0	2.771	0	0
5	Mo Cay Nam District	384	320	309	3.882	2.511	0
5,1	Dinh Thuy	215	20	85	2.012	680	0
5,2	Binh Khanh Dong	158	0	0	1.740	0	0

	District/Commune	Tap water	Drilled well	Dug well, earth well	River, stream, lake, pond	Rain-water	Others
5,3	Thanh Thoi B	11	300	224	130	1.831	0
6	Binh Dai District	693	0	0	0	782	0
6,1	Long Dinh	693	0	0	0	782	0

Source: Socio-economic Survey data provided by CPCs, 2013.

100% of the households are using electricity from national grid.

b) ***Health***

Averagely, each commune has a solid or semi-solid health station. All of the stations have at least one doctor, one physician, two to three nurses, one nurse's aide, one pharmacist, etc. The average medical examination visits are from 10,000 to 20,000 per year. The common diseases in the area are flu, dengue fever, hand-foot-mouth, digestive diseases, pinkeye, and scarlet fever due to the characteristics of the hot and wet tropical climate area where epidemics easily occur.

Table 2 - 46: Number of health staff and health centers in communes involved in the project

No.	District	Solid / semi-solid health centre	Doctor (people)	Medico (people)	Nurse (people)	Aid-man (người)	Pharma-cist (people)	Nursing staff (people)	Patient visit health centre
I	Total	15	17	37	19	13	8	6	86349
1	Ben Tre	3	2	5	4	2	1	1	2192
2	Giong Trom	2	5	5	3	4	2	3	26567
3	Chau Thanh	4	4	11	4	4	2	0	17512
4	Mo Cay Bac	2	2	8	4	1	2	2	11104
5	Mo Cay Nam	3	3	6	2	2	1	0	23174
6	Binh Dai	1	1	2	2	0	0	0	5800

Source: CPCs, 2013

The entire project districts have 38 cases of drug addiction and 87 cases of HIV infection. All of the drug addicts are concentrated in Ben Tre province, mainly in Ben Tre City which is the big urban center with many cultural exchanges, socio-economic development activities. Similarly, the number of people infected with HIV is also concentrated in the project communes in the province of Ben Tre, mainly in Chau Thanh (45 people), Mo Cay Bac (22 people), and Ben Tre City (20 people).

Table 2 - 47: Number of drug addiction and cases of HIV infection in project area

Unit: People

No	District	Drug addicters	People with HIV
I	Total	38	87

1	Ben Tre	22	20
2	Giong Trom	0	0
3	Chau Thanh	6	45
4	Mo Cay Bac	7	22
5	Mo Cay Nam	3	0
6	Binh Dai	0	0

Source: CPCs, 2013

5. Education

Among 14 communes, two communes have high schools, which are Tan Thanh Binh Commune of Mo Cay Bac District and Thanh Phu Dong Commune of Giong Trom District. All schools have relatively good infrastructure (solid or semi-solid). Averagely, each school has from 10 to 15 classrooms. The number of primary school students in the project communes is 11,538; the number of secondary school students is 7,965 while the number of high school students is 833. The drop-out rate is low, 0.4 percent of the total students in each commune.

Table 2 - 48: Number of schools at all levels of communes in project areas

Unit: School

No	Dítrict	Kindergarten	Elementary	Primary	High school
	Total	15	16	11	2
1	Ben Tre	3	3	2	0
2	Giong Trom	2	2	2	1
3	Chau Thanh	4	4	2	0
4	Mo Cay Bac	2	3	2	1
5	Mo Cay Nam	3	3	3	0
6	Binh Dai	1	1	0	0

Source: CPCs, 2013

6. Culture, Religion, and Belief

Ben Tre, Tra Vinh, and Vinh Long provinces lie in Southern region, the inhabitation of many groups. The largest is Vietnamese, followed by Khmer, Hoa (Chinese), and Cham ethnic groups. During the coexistence process, cultural exchanging relations have been shaped among the ethnic communities mentioned above. The relations are clearly observed especially in religion and belief. Most of the popular religions in Mekong River Delta are present in Ben Tre, Tra Vinh, and Vinh Long including Buddhism, Catholicism, Protestantism, Caodaism, Hoa Hao, Coconut Religion, etc. In terms of influence as well as number of followers, the most notable religions are Buddhism, Catholicism, and Caodaism.

Regarding traditional festivals, in addition to the major holidays of the country, in the project districts, there are traditional festivals of Khmer people such as fruit

festival, Golden Rice Fair, etc. In Tra On district, the major annual festivals that attract several people from other areas are Marshall Vanguard's Tomb (Lăng Ông Tiền quân Thống chế) in Thien My Commune took place on January 4 according to Lunar Calendar with around 2,400 visitors and Khmer Festival took place in lunar October, March, and August.

CHAPTER 2
ENVIRONMENTAL IMPACTS ASSESSMENT

2.1 IMPACT ASSESSMENT

Each project phase requires different environmental assessments. The EIA task is to create an initial environmental background and assess the project's impacts on the environmental resources that need to be elaborated for each project activity. The method and extent of environmental impact assessment are considered in the following aspects:

- Direct- indirect impacts;
- Long-term and short-term impacts;
- Accummulative impacts- non-accumulative impacts;
- Severe, moderate, slight, insignificant impacts;
- Positive-negative or adverse impacts;
- Reliable-unreliable impacts;
- Impacts that can (not) be minimized, or unknown.

The assessment of the impacts likely to occur on the environment due to the implementation of the project is based on the components/items, technical process, project activities, and environmental characteristics in the project area. Impact assessment is carried out in each stage of the project as follows:

- Site preparation phase
- Construction phase
- Operation phase

The project implementation will cause some potential impacts on the environment in and around the project area. These impacts can be temporary during each project phase and/or continuous during the existence of the project.

Interactive impacts often occurring consist of two types: impacts caused by day-to-day activities and impacts caused by incidents. The first type is related to the normal operating activities of the project while the second is involved unexpected events from the incidents. During the assessment process, the level of impacts on the environment will be determined based on the following criteria:

Severe impacts on the environment

- Altering ecosystem and activities, causing long term damages (which can last for 10 years or even longer), the ability to restore is very low;
- Affecting human health.

Large impacts on the environment

- Altering ecosystem or activities on a large scale, causing moderate impacts (lasting more than 2 years); however, it can be restored within 10 years;
- Might cause impacts on human health;

- Causing financial losses for the users or the public.

Medium impacts on the environment

- Altering ecosystem or activities on a local scale and in a short time. Can be restored easily. The impact level is similar to present changes but can generate cumulative impacts;
- Might (not sure) cause impacts on human health; might cause obstacles to some users.

Small impacts on the environment

- Changes only occur in current variation range but can be monitored and/or identified;
- Might affect activities but not obstruct the users or the public.

Insiginificant impacts on the environment

- Changes cannot be identified or measured based on the basic activities;
- Insignifcant impacts on health or quality of life.

No impact on the environment

- Do not cause interactive impact and thus change does not occur.

Positive impacts on the environment

- Definitely will improve the quality of the ecosystem or facilitate the socio-economic development in macro or micro level;
- Might benefit the local residents.

The impact assessment is conducted on the basis of the developmental phases (preparation, construction and operation) of the project; the assessment will be specific for each source and each object on the basis of the construction volume of the project. The assessment according to the implementation phases include:

- Environmental impact assessment during site clearance phase;
- Environmental impact assessment during construction phase;
- Environmental impact assessment during operation phase.

2.1.1 Impact assessment during site clearance phase

3.1.1.1. Impact generating source

Sources causing impacts, affected objects and degree of impacts during the site clearance process are summarized in the Table 3-1 below:

Table 3 - 1: Sources of impacts, affected objects and reasons for causing impacts by the project during site clearance process

No.	Activities generating impacts	Affected object	Reasons
1	Site clearance, acquisition of assets attached to land	Land Resource	The total land area acquired for the Project is 173,085 m^2 including 61,697 m^2 of public land managed by 14 CPCs and 106,174 m^2 of households comprising agricultural, commercial and residential land (for construction site, workers' camps and disposal site).
		Air environment	Clearance and transport of trees with a total of 3,214 trees of different types and products which can cause impacts on the

No.	Activities generating impacts	Affected object	Reasons
			quality of air environment in the area. Demolition and transport of materials might generate noise, vibration, smoke and dust.
		Soil environment	Clearance and site preparation, if not combined with the technical measures, will result in the risks of coastal erosion and soil erosion in the area in case of heavy rain.
		Water environment	Storm water runoff and decomposing dead plant material are the main cause of pollution of rivers and streams in the area. At the same time, oil leak and waste oils from machines, if not collected and discharged properly, will be the primary reasons for water pollution in the area.
		Ecosystem	Site clearance activities might cause impacts on terrestrial ecosystem and aquatic ecosystem due to the cut down and clearance of the site. However, such impacts are not signigicant and only occur in the scope of site clearance for the project.
2	Resettlement	People	A total number of 160 affected households (AHs) will lose productive land. The number of households who would lose 20% or more of their productive lands is 71 HHs. In the project-affected area, 30 houses of 27 households in 9 communes will be affected on residential land, houses and relocation. A total of 22 HHs would lose residential land and shall be displaced. In which, 14 DHs have large enough remaining self-owned land to reconstruct their houses (on-site relocation), while the other 8 DHs will have to resettle in other places. Total areas of affected houses is 3,525.7m^2, in which 2,321 m^2 of residential land is acquired permanently.
3	Demining	People	There is a risk of unexploded ordnance in the subproject area where the fierce battle in the Vietnam War occurred. Although many years have passed, farming activities are still carried out normally and there is no record of any recent related accidental case, this impact has been identified as unknown until a conclusion of a technical agency is made.[2]
4	Impacts related to design	Community-Environment	- In design, the choice of appropriate Site will (i) minimize adverse impacts on livelihoods and production activities of the local communities as well as on environment and avoid waste of land resources; (ii) minimize erosion of river and channel banks; (iii) reduce construction volume. - Positive effects on road connections for the area.

[2] UXO demining and learance will be undertaken by the Project Owner through contract with a specialized agency according to the National Technical Regulation QCVN 01:2012/BQP on UXO demining and clearance that took effect since January 1 2013. Through consultations with local authorities, in general, there is no accident related to UXO in the area of 11 headworks; however, An Hoa work should be paid attention.

3.1.1.2. Impacts assessment:

1.1.1.2. Assess the suitability of the project location with natural environmental conditions, socio-economic conditions and project implementation area

Ben Tre province is located at the east side of the Mekong Delta; the total area is 2,360 km^2; with a total population of 1.26 million; and thus, the population density is 532 persons/ km2. The population density of Ben Tre Province is the fifth highest in the Mekong Delta. The Ben Tre area is of polder area bordered by three (3) big Mekong tributaries namely Cua Dai, Ham Luong and Co Chien. The residents access these tributaries for domestic use and irrigation. This area is one of the most affected areas by saline water intrusion in Vietnam. Ben Tre province is expected to be affected by high level of saline water that could affect not only paddy production, but also fruit production. In fact, the damage cost was estimated as the highest among seven (7) coastal provinces based on the salinity introduction simulation.

Ben Tre water management Project was prepared based on the Master Plan of "The project for climate change adaptation for sustainable agriculture and rural development in the coastal Mekong Delta in Vietnam", which was completed in April 2013.

The objective of the targeted Project is "to ensure water distribution with adequate salinity level through water sluice gate construction and thereby achieve agricultural development and improvement of people's livelihood in Ben Tre province". This objective will be achieved by the construction of sluice gates at eight (8) sites (Northern Ben Tre: five (5) sites, and Southern Ben Tre: three (3) sites) and procurement of the monitoring equipment.

In the northern part of Ben Tre, fresh water is to be diverted from the gates at Tan Phu and Ben Ro. Other gates (An Hoa, Ben Tre, and Thu Cuu) are closed during the dry season to prevent saline water intrusion. The dredging of canals has been already completed for the portion from Tan Phu and Ben Ro; thus, these canals provide enough capacity to deliver the water right after the construction of the sluice gates.

In addition, this Project was selected and proposed as an optimal option which combines structural and non-structural measures, mainly due to a lesser option for resettlement and land acquisition based on the comparison with other options.

In case of the option of the middle-scale sluice gates construction, it is assumed that the impacts will be confined within the Ben Tre province. It is possible to control the saline contents within the province by enclosing it with small and middle-scale sluice gates, consisting of sandbank within the Mekong River. It may be easy to prepare a land use plan for sea level rise relevant to climate change and fluctuation of river water volume in the Mekong River. However, it is expected that the natural environment could be conserved, although ecosystems of mangroves, wetland areas, and agriculture fields may be partially disturbed.

The location of the sluice construction site had been determined through the comparative study taking into account the function required, workability, economy,

and so on, based on the topographic and geological survey result as well as social and natural investigation.

The scale and hydraulic dimensions of sluices were decided upon in order to meet the required functions of the sluice gates, which were to supply the fresh water necessary for agricultural production and domestic use, to prevent salt-water intrusion, to drain surplus inland water, and to secure the social environmental demand, such as waterway traffic. Specifically, the structural dimensions and elevation were designed using the result of simulation for the purpose of obtaining the necessary capacity of flow at the sluices.

3.1.1.3. Impacts assessment:

a. Impacts on land use, resettlement and income of the households

The project is implemented in 14 communes of five districts and one city of Ben Tre province. The construction of works system of the project causes land acquisition impacts in 13 communes in the project area.

There are two types of land acquisition to serve the project which are permanent acquisition and temporary acquisition. Permanently acquired land is the area recovered to construct headwork and components related to sluice gate system. Temporarily acquired land is the area recovered to serve the purposes of (i) material gathering site; (ii) workers' camp; (iii) temporary impacts during construction period. After completion of the works, the temporarily acquired area shall be returned to the people/local communities.

Impacts on land:

The total land area acquired for the Project is 173,085 m^2 including 61,697 m^2 of public land managed by 14 CPCs and 106,174 m^2 of households comprising agricultural, commercial and residential land.

Affected land areas of 4 categories based on land use purposes which are annual crop land, residential land, commercial land and other land (transportation land, unused land). In particular, the affected land area is annual crop land makes up for the largest proportion (55.94%). Details are presented in the following table:

Table 3 - 2: Tác động tới đất

No.	District/ commune	Type of land (m^2)				Total (m^2)
		Annual crop land	Residential land	Commercial land	Other land	
	I. Ben Tre					
1	Nhon Thanh	3.854,0	300,0	-	-	**4.154,0**
2	Phu Hung	2.826,0	447,7	6.885,0	7.393,7	**17.552,4**
	II.Binh Dai					
3	Long Dinh	9.002,7	643,3	147,0	18.469,0	**28.262,0**
	III. Chau Thanh					

4	Giao Hoa	7.656,5	-	-	7.843,5	**15.500,0**
5	Tien Long	12.185,9	120,0	-	423,1	**12.729,0**
6	Tan Phu	9.918,9	-	-	5.447,1	**15.366,0**
7	Phu Duc	1.231,4	-	-	3.654,0	**4.885,4**
	IV. Giong Trom					
8	Phuoc Long	1.901,3	-	150,0	2.342,7	**4.394,0**
9	Thanh Phu Dong	4.150,0	50,0	400,0	38,0	**4.638,0**
	V. Mo Cay Bac					
10	Tan Thanh Binh	9.971,1	-	-	3.154,9	**13.126,0**
11	Khanh Thanh Tan	6.809,5	320,0	-	11.010,5	**18.140,0**
	VI. Mo Cay Nam					
12	Dinh Thuy	6.879,3	380,0	-	2.650,7	**9.910,0**
13	Thanh Thoi B	14.009,9	240,0	1.500,0	195,1	**15.945,0**
14	Binh Khanh Dong	6.426,8	120,0	-	1.938,2	**8.485,0**
Total		**96.823,3**	**2.621,0**	**9.082,0**	**64.560,5**	**173.086,8**
Percentage (%)		***55.94***	***1,51***	***5,25***	***37,30***	***100***

Source: RAP, 2016

A total number of 160 affected households (AHs) will lose productive land. In which, 89 households (HHs) are lightly affected with less than 20% of their productive landholdings to be acquired. The number of households who would lose 20% or more of their productive lands is 71 HHs. These households are defined by the Project as severely Ahs.

2.321 m^2 of affected residential land belong to 30 households in 10 communes will cause relocation and resettlement for these households.

Structures and assets attached to land: The total number of households whose structures and houses are affected is 30 with the total affected area of 2,321 m^2.

In terms of house types, among these 30 affected houses, 23 houses are fourth-grade-dwelling type with the similar characteristics – tiled roof or corrugated iron roof, brick wall, concrete foundation and 15 are temporary houses (bamboo and thatch houses). A total of 22 HHs would lose residential land and shall be displaced. In which, 14 DHs have large enough remaining self-owned land to reconstruct their houses (on-site relocation), while the other 8 DHs will have to resettle in other places.

Impacts on trees and crops: Since most of the area acquired for the project is garden land, the number of affected trees is relatively high with a total of 3,214 trees. The numbers of trees affected in descending order according to each type are as follows: 980 coconut trees, 844 banana trees, 392 durian trees, 295 green-skin pomelo trees, 243 rambutan trees, 214 longan trees, 173 pot plants, 73 mango trees. There is no crop affected by the project.

Impacts on business and income: There are four companies who are renting land for business purpose in the area of Phu Hung Commune, Ben Tre City. These enterprises are affected on houses and thus have to relocate. Apart from impacts on houses, the relocation also causes business interruption; therefore, in addition to the compensation for affected houses and structures, these two companies are entitled to receive assistances for relocation and stabilization in the new places in accordance with the prevailing regulations of the province.

The Project may have impacts on four coconut coir manufacturing enterprises (one in Phu Hung commune, three in Thanh Thoi B commune). Of which, one coconut coir production enterprise is slightly affected as their acquired areas are less than 20%. The other three coir production enterprises are considerably affected with the percentage of land acquired of higher than 50%. These two enterprises may be difficult to continue their operation since the remaining areas are insufficient to sustain their business. Besides impacts on house, relocation may also disrupt to business. Thus, in addition to compensation for value of the lost houses and structures, the level of support for business to relocate and stabilize production at new resettlement place should be done in accordance with the provincial provisions.

Vulnerable households: Among 160 affected households, 16 households belong to vulnerable group in 10/14 communes including five poor households, six social policy-treated HH, 4 lone elderly HHs, and 1 landless HH. There is no affected household who is ethnic minority. In addition to compensation for affected land, assets and trees, these households are eligible to other supports targeted at vulnerable group according to the policies and regulations of the government and PPC.

Psychological impacts on PAPs

When the headworks of the project are built, apart from land loss and relocation as described above, some graves might also be displaced, which will cause negative reactions from the affected households. According to the Vietnamese customs, it is a taboo to relocate the graves of their grandparents, parents and relatives…In addition, the relocation of graves in the new area as well as finding and building a new cemetery will encounter many difficulties due to increasingly shrinking land fund at the present.

Besides, the project implementation will also cause some certain effects such as mechanical population increase (due to the influx of the workers) and transport activities during construction preparation process, which may cause impacts on the daily lives, customs and practices of the local communities.

The implementation of Ben Tre Water management Project is expected to cause some local impacts on people in the project area. The compensation and resettlement impacts caused by the construction of 8 headworks are not severe. The total number of affected households is 160 including those losing agricultural land, residential land, houses and relocating households. As for the households whose land is permanently

acquired, appropriate compensation and livelihood assistance policies will be applied. With regards to temporarily affected area, after completion of the works, the area will be returned to the PAPs/ communities without adversely affecting the land use capacity.

b. Impacts on air environment

Impacts from dust and exhaust fumes

The sources of dust and exhaust fumes during this period are mainly due to clearance and transport of plant biomass, displacement of houses and farms as well as graves out of the construction site.

According to preliminary calculation, the total volume of land acquisition for construction is as follows:

Table 3 - 3: Site clearance volume

No.	Content	Unit	Quantity
1	Clearing plant biomass (fruit-trees)	tree	3214
2	House displacement	HH	22
3	Affecting a part of structure	HH	14

As mentioned above, coconut trees which are mainly affected (980 trees) are those that have economic value with salvageable trunk, branch and leaves. Other trees can also be salvaged on site. Therefore, the amount of waste that needs transporting is only some branches, leaves and roots. The waste amount caused by dismantlement is insignificant, about 150 m^3 spreading over 14 communes. The transport is mainly done by the people, using small boats and light trucks. Hence, the amount of dust and emissions arising from transport is low.

Impacts from noise:

Noise generated during site clearance process are mainly from the following activities:

- Sawing and cutting down trees;
- Dismantling houses and structures;
- Transporting dismantled materials;
- Leveling transport road.

Noise levels from the above listed activities are measured in the Table below:

Table 3 - 4: Noise generated by some machines and vehicles during construction preparation process at the distance of 15 meters

Equipment	Noise level (dB) (15m from the source of noise)
Truck	90
Bulldozer	93
Boat	75
Engine saw	76

(Source: FHA (USA))

The sources that affect the quality of air environment during this site clearance period are mainly due to the transport of biomass, displacement of houses and graves out of the construction site. However, according to the statistical data shown in the Table 3.4, the amount of dust and emissions arising from these activities is quite small; therefore, their impacts on the air quality are not severe.

c. Impacts on water environment

Most of the land area acquired to serve the project is garden land; therefore, the number of affected trees is quite large with a total of 3214 trees. Affected trees will be salvaged by the PAPs themselves for the purpose of consumption and other purposes such as wood, firewood, processing…Besides, the clearance activities will leave some branches, leaves, roots and a small amount of shrubs that cannot be salvaged.

In terms of house types, among these 30 affected houses, 23 houses are fourth-grade-dwelling type with the similar characteristics – tiled roof or corrugated iron roof, brick wall, concrete foundation and 15 are temporary houses (bamboo and thatch houses). A total of 22 HHs would lose residential land and shall be displaced. The amount of solid waste is small with an estimation of about 150m^3.

Cutting trees and clearing plants in the area as well as the displacement of houses and demolishion of structures of the affected households will cause impacts on water environment, especially impacts by stormwater runoff.The stormwater runoff that will sweep soil, rocks, sand, and plant material scattered on the ground to the low-lying areas, rivers and streams and thus contaminate the surface water source in the project area and downstream area. Plant material left are mainly branches and leaves, which are easy to decompose and thus cause bad odor. Hence, when they are swept by the stormwater, organic pollution in water will occur. *However, the runoff level is relatively low because orchards are mainly affected and the number of displaced houses is small.*

Besides, water is contaminated with grease and oil entrained by equipment, machines and vehicles which salvage and transport wood out of the project area. *However, this impact is negligible as oil is only spilled in case of broken down machines, which is less likely to happen.*

The affected surface water in this period is from rivers and canals such as Giao Hoa Canal (An Hoa headwork), Vam Nuoc Trong River, Cai Quao Canal, Thu Cuu Canal, Ben Tre Rriver, Tan Phu River, Ben Ro Canal, Vam Thom River. *However, due to the river self-purification by deposition of sediment load, the water is polluted more in the area close to the cleared site; the further downstream, the lesser pollution.*

d. Impacts on soil environment

During this period, soil environment is affected in the entire 8 headwork area. Due to the clearance and dismantlement of structures (houses, workshops...) as well as the motorized vehicles have ploughed the topsoil layer, thus broken the soil composition. When vegetation cover is lost, rainwater will easily wash the organic humus, soil and sand layers down the low-lying areas, changing the nature of soil. The topsoil layer in the higher area, slopes and two sides of the rivers and streams will be

eroded, exhausted and become barren. Meanwhile, in the lower areas, the riverbed will be deposited with alluvial and organic soil.

Besides, plant material including leaves, branches, shrubs and weeds in the project area, if not collected and cleared, will be easily decomposed and create bad odor, especially in wet conditions, and then contaminate the soil environment. Moreover, coconut trees which are mainly affected (980 trees) are those that have economic value with salvageable trunk, branch and leaves. Other trees can also be salvaged on site. Therefore, the amount of waste that needs transporting is only some branches, leaves and roots. Such impact is evaluated as negligible.

e. Impacts by explosive materials

Since the project is implemented in the former war area, the risks of post-war explosive materials are relatively high. Requirements for UXO clearance during preparation process are mandatory to ensure the safety for people and workers.

f. Impacts on ecosystem and biodiversity

In the project area, there is no environmentally sensitive area such as national forests, nature reserves, and biosphere reserves. Also, there is no species of plants and animals as listed in the Red Book detected. Therefore, the project implementation will not cause any impact on such areas and species.

During the project preparation process, the primary activities are site clearance and preparing construction sites for 8 subprojects. Therefore, the impacts on environment in general and local ecosystem in particular during this period are evaluated as insignificant. The impacts on ecosystem are mainly on terrestrial ecosystem (along two sides of the river where the construction of sluicegates and locks are carried out) and aquatic ecosystem (aquaculture ponds in the scope of land acquisition of the project).

Terrestrial ecosystem:

The species that are mainly affected are shrubs and some types of fruit trees within the scope of land acquisition. According to the statistical results of the Investment Project Report, most of the area acquired for the project is garden land; therefore, the number of affected trees is relatively high with a total of 3214 trees. The numbers of trees affected in descending order according to each type are as follows: 980 coconut trees, 844 banana trees, 392 durian trees, 295 green-skin pomelo trees, 243 rambutan trees, 214 longan trees, 173 pot plants, 73 mango trees. In addition, there are many types of shrubs and grasses that will be cleared such as “muong trau” (cassia alata) “cho de” (Chanca Piedra), purple colocasia “mon dom” (Caladium biocolor), pistia stratiotes, “trinh nu hoang cung” (Crinum latifolium), “cay luoc” (callisia fragans), and different types of weeds, etc.

Aquatic ecosystem:

Out of total acquired land, there are some pond land for aquaculture. These ponds are mostly managed and used by the households, the species living in the ponds are mainly giant freshwater prawn, black tiger shrimp, white leg shrimp, brackish water fishes, freshwater species and other types such as oyster and blood cockle and other aquatic species.

In general, during the construction preparation phase, impacts on ecosystems and other species in the area are unavoidable. However, with the scale and status of the construction site, such impacts are evaluated as negligible and the scope of impacts are limited within the scope of land acquisition (173,086m2) in Ben Tre province.

h. Impacts on public structures, cultural and historic relics

There are some public structures such as schools, churches, and temples near the project area. However, within the project construction area, there is no public structure or culturak and historic relic; therefore, no impact on such area is caused.

2.1.2 Impacts assessment during construction period

3.1.2.1. Impact generating sources:

Activities and sources that cause environmental impacts during the construction phase are described in the table 3-5 below:

Table 3 - 5: Activities and sources that cause environmental impacts during construction process

No.	Activities causing impacts	Affected object	Reasons
1	The operation of the motorized vehicles to serve construction and transport of materials and equipment	Local traffic	Increasing pressure and degrading the existing traffic system. The regular operation of motor vehicles in the construction sites may restrict or impede local traffic, which increases the risk of traffic accidents in the area.
		Water environment, Soil environment, Air, Noise	Oil leaks and oil residue is discharged from motor vehicles and machinery will increase the risk of surface water contamination is the rainy season. Stormwater runoff through the parking lots, motorcycle repair shops, petroleum storages, etc. may cause oil contamination for the surface water, groundwater, soil and air.
2	Material extraction activities to serve the construction, gathering materials in the site	Air environment	Material extraction activities will cause noise and dust in the surrounding area. Dust is gone with the wind in the material gathering areas.
		Water and soil environment	Oil leaks and oil residue is discharged from motor vehicles and machinery will increase the risk of surface water contamination is the rainy season. Increasing the risks of landslide and soil erosion. Stormwater will sweep materials at the gathering sites and thus cause surface water pollution.
3	Construction of project's headworks; Bored cast-in-place, pile driving,	Land use	The use of permanently acquired land area to build headworks of the project and temporarily acquired land during the construction period will alter the current state of local land use (agricultural land, forest land to be shifted to land for construction).
		People	The risks of accidents occurred to workers as well as local

No.	Activities causing impacts	Affected object	Reasons
	foundation treatment; Bridge approach road, filling ring dyke; Building sluicegate system, lock.		communities. Affecting workers' health as they have to work in the environment filled with noise and dust. Restrict the needs and abilities of people traveling through the construction area.
		Water, soil, air, aquatic species	In the construction, excavation, concrete placement, sand blasting, impoundment, pile driving areas, rainwater often sweeps soil, rocks and construction waste into the surrounding rivers and streams, causing turbidity, water contamination and increasing the risks of erosion and sedimentation in the downstream area and thus affecting the ecosystem and aquatic life. Dust and noise arising from pile driving process; emissions from vehicles, equipment and machinery. Oil leaks and oil residue from the machinery without proper collection and treatment will cause soil and water pollution. Limiting the amount of water drainage and water supply, particularly for the works that have impoundment plan such as Tan Phu, Ben Ro… Impounding works restrict the movement/traveling of aquatic species (shrimp, fish…) to and from the main river.
		Waterway traffic	The diversion and impoundment of the sluicegates restrict waterway traffic.
4	Influx of labors/ workers	Water, soil environment, natural landscape and public health	During high time, there are 100 to 200 workers at the construction sites (officials, construction workers). Therefore, domestic waste, if not collected and discharged properly, will not only worsen the beauty of the area but also increase the risks of water and soil contamination (water leaked from landfills carries pathogenic germs which are difficult to handle). Waste water without proper collection and treatment will cause water pollution. Wastewater contains many pathogenic germs, if discharged directly into receiving streams and canals, would cause the spread of infection for people using water in the downstream areas. Food preparation shared-areas can cause the risks of unsafe and unhygienic food.
		Cultural, socio-economic aspects of the locality	The concentration of a large number of cadres and workers on site will disrupt the lives of local people by increasing demand for food, the risk of social evils and conflicts between the residents and workers from other areas ... The formation of the camps often leads to the establishment of restaurants/shops and other entertainment services, which is also a risk of creating social evils in the area.

3.1.2.2. Impacts assessment

a. Impacts on air environment

Impacts from dust and emissions:

According to the project dossier, the total excavation volume is 683,159.6 m^3; this volume is removed using excavator and scooped by dredger (0.7-1.1m^3) and then transported to the landfill or temporary gathering site to be salvaged for aggradation by dump truck (8T).

Table 3 - 6: Summary of construction volume of the headworks

Category	Excavated soil	Backfill soil	Sand	Rocks	Reinforced concrete M300	Reinforced concrete M200	Concrete M150	Concrete M100
Unit	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3
An Hoa Sluicegate	187,043	61,336	103,835	62,155	29,898	516	209	561
Thu Cuu	25,443.2	1,146.8	27,092.9	2,066.7	7,564.4	104.6	1,715	212.2
Cai Quao	25,443.2	1,146.8	27,092.9	2,066.7	7,564.4	104.6	1,715	212.2
Ben Tre Lock	236,848.8	1,111.4	633.1	970.7	6,296.5	211.6	1,445.3	219.4
Tan Phu	11,633	933.1	620.1	950.9	1,326.3	32.5	466	57.2
Ben Ro	15,668	872.2	579.6	888.7	1,326.3	32.5	466	57.2
Vam Nuoc Trong	65,872.9,	2,831.5	448,541.5	26,478.1	11,26.3	55.3	25.1	233.5
Vam Thom	167,951.7,	2,701.1	278,593.5	13,824.4	10,761	53.8	1,172.2	187.7
Total	683,159.60	72,078.90	886,988.60	109,401.20	64,736.90	1,110.90	7,213.60	1,740.40

Source: Project Feasibility Study Report (August 2014)

With the amount and the method of construction, the amount of dust and emissions generated include:

- *Dust generated from excavation of unsuitable material:* the amount of dust is preliminarily calculated as follows:

  $\Sigma_{Fugitive\text{-}dust} = V \times f$ (kg) [I]

  In which:

- V: the total volume of excavated soil: V = 683,159.6m^3
- f: is dust emission coefficient (according to the Environmental Geology document, Vietnam National University-Ho Chi Minh City Publishing House, f = 0.3kg/m^3).

  $\Rightarrow \Sigma_{Fugitive\ dust}$ = 683,159.6m^3x0.3kg/m^3 = 204,947.9 kg of dust

- *Dust and emissions from excavators:*

Diesel fuel consumption ration, pollution load of dust and exhaust from fuel burning activity of the excavators in a work shift are as follows:

Table 3 - 7: Fuel consumption ration and pollution load of excavators

Machine	Consumed fuel (kg/shift)	Pollution load (kg/shift)				
		NO_x	CO	SO_2	VOC	Dust
Excavator	94,5	1,89	0,473	18,9	2,363	0,473

Source: Environmental Geology, Vietnam National University-Ho Chi Minh City Publishing House

The estimation of the excavation and dredging are calculated on average. The ration for each excavator shift is from 1,000 to 1,200 m3 of soil. Therefore, in order to excavate 683,159.6m^3 of soil, approximately 600 excavator shift is needed (estimated 1,200m^3/shift).

Based on the data above, the amount of dust and emissions caused by fuel burning activity of the excavators is preliminarily calculated as follows:

Table 3 - 8: Dust and emissions load of the excavators removing topsoil layer *(kg)*

NO_x	CO	SO_2	VOC	Dust
1.134	283,8	11.340	1.418	283,8

- *Dust and emissions from the vehicles transporting removed organic soil layer:*

In order to transport 683,159.6m^3 of organic soil to the landfill/gathering site by using 8T dump trucks, it requires about 85,000 trips. The average stretch of road of all 8 headworks is estimated within the radius of 1-2 km per trip (averagely 1.5 km); therefore, the total stretch of road is 128,000 km. This volume is calculated as the maximum and in fact may be smaller due to the utilization of quality excavated soil to embank construction road, construction site, land-scape park, and side locks using soil and sand.

During transport, these vehicles generate relatively large amount of dust and emissions including dust from the road, dust and emissions from fuel combustion. According to the rapid assessment method of the World Health Organization (WHO), the amount of dust and emissions arising from the transport process can be predicted as follows:

- *Dust emitted from road surface:* is calculated and forecasted according to the following assumptions:

- Average velocity 35 km/h
- Average load 8 tons
- Average number of wheels 6 wheels/truck

Table 3 - 9: Dust load emitted from road surface during the process of transporting removed organic soil layer (unit: kg)

Effect source	Emission coefficient *(1000km)*	Dust volume emitted *(kg/1000km)*	Total of waste arising *(kg)*
Transporting removed organic soil layer	3,7× f	1.806,2	231,193.6

(Source: WHO – Assessment of sources of air, water, and land pollution - Part 1 - Geneva 1993)

Note: f: factor of arising the secondary dust when truck operates in roads as per formula: $f = v.M^{0,7}.n^{0,5}$ [II] *Where:*

- v: Average velocity of truck (km/h).
- M: Average load of truck (ton).
- n: Average number of wheels per vehicle

Dust and toxic gas emitted from internal combustion engine of the transportation vehicles:

The quantity of dust and toxic gas emitted from vehicles with diesel engine and load from 3.5 to 16 tons are as follows:

Table 3 - 10: Pollutant factors of vehicles with diesel engine and load from 3.5 to 16 tons

Unit (U)	TSP (kg/U)	SO_2 (kg/U)	NO_x (kg/U)	CO (kg/U)	VOC (kg/U)
1000km	0,9	4,2*S	11,8	6,0	2,6

(Source: Aleaxander P. Econompoulos (1993), Assessment of Sources of Air, Water and Land Pollution, Part 1, Rapid Inventory Techniques in Environmental pollution, WHO, 1993)

Note: S – is the weight percent of sulfur in the fuel (S=5%).

Based on the total stretch of road and pollutant coefficients presented in the Table 3-10, the amount of waste of the vehicles transporting removed organic soil emitted into the environment is estimated as below:

Table 3 - 11: Load of emissions from excavated land transportation (đơn vị: kg)

TSP	SO_2	NO_x	CO	VOC
115	2.734	1.510	768	332

- *Excavation and transportation of backfill soil:*

According to the project dossier, the need for backfill soil of 8 headworks is 72,078.9 m3. This volume is dug by excavators and then transported to the construction site with the road length of about 2km using dump trucks. Regarding to this volume and construction method, amount of dust and emission includes:

- *Dust caused by soil excavation:* Amount of this dust is calculated as in formula [II]:

  $\Sigma_{\text{emitted dust}} = 72{,}078.9 m^3 \times 0.3 kg/m^3 = 21{,}623.67$ kg of dust

- *Dust and toxic gas emitted by transport of construction materials:*

The load of air pollutant factors caused by this activity is calculated for all of the 8 headworks to suppliers in the neighboring provinces such as Tien Giang, Vinh Long, Tra Vinh, and Can Tho with the stretch of road of 50km to 80km (average stretch of road of 65km) and the allowable load of the road is 12 tons (10m3/truck). Based on the demands for construction materials, the transport volume can be calculated as below:

Table 3 - 12: Demands for transporting construction materials of 8 headworks

No.	Type of materials	Quantity	Trips (approximately)
1	Different types of concrete	74,801.8 m^3	7500 trips
2	Different types of sand	886,988.6 m^3	88,700 trips
3	Different types of rocks and stones	109,401.2m^3	10,900 trips
4	Different types of steel	19576.5 tons	1600 trips
	Total		*108,700 trips*

Thus, the total stretch of road is: 108,700 trips x 65 km x 2 ways = 14,131,000 km. According to the transportation plan in the design dossier, four sluicegate headworks including Au Ben Tre, An Hoa, Vam Nuoc Trong and Vam Thom account for the most transportation volume, equivalent to 70% of the total volume, using waterway transport. These headworks are located along the tertiary inland waterway which is very convenient for waterborne transport of construction materials and equipment. The remaining headworks are close to the secondary inland waterway; therefore, the materials transport is also quite convenient. Hence, the actual length of road transport is only 30% at the maximum of the calculated above, equivalent to 4,239,300 km.

The amount of dust and toxic gas emitted from this activity consist of:

- *Dust emitted from road surface due to transport of construction materials:*

As per the formula [II] and total stretch of road of 4,239,300 km, the amount of dust emitted from road surface during the transport process is calculated as below:

Table 3 - 13: Loading of emission volume from road surface due to transport of construction materials

Effect source	Emission coefficient *(1000km)*	Dust volume emitted *(kg/1000km)*	Total of waste arising *(kg)*
Transporting construction materials	3,7× f	1.806,2	7,656,481.8

- *Dust and toxic gas emitted from internal combustion engine of the transport vehicles:*

The pollutant coefficients from the internal combustion engine are preliminarily calculated based on the assumption that all of the vehicles used are trucks and the total stretch of road as presented in the Table 3-14 below:

Table 3 - 14: Loading of emission volume from transport vehicles

Loading of emission volume (kg)				
TSP	**SO_2**	**NO_x**	**CO**	**VOC**
3,815	90,410	50,020	25,434	11,021

Besides, the operation of other machines such as welding machine, iron cutting machine, concrete mixer, and so on, during the construction process, will also produce a certain amount of toxic gas into the air environment (SO_2, NO_x, CO, etc.).

Moreover, fetid odor arising from organic sediments, clay sediments and bad smell from H_2S, Mercaptan (HS^-) generated by excavation, dredging and leveling activities.

Impacts of noise

- Noise from vehicles transporting construction materials, machines and equipment.
- Noise during construction period is mainly from the operation of transport vehicles and construction machinery. Noise level of the transport vehicles and construction machinery is calculated per following formula:

$$L_p(X) = L_p(X_0) + 20 \log_{10}(X_0/X)$$

Where:

- $L_P(X_0)$: noise level at distance of 1m from the noise source (dBA)
- $L_P(X)$: noise level at the distance that needs calculating
- X: position/distance that needs calculating
- X_0 = 1m

Table 3 - 15: Maximum noise level from the operation of transport vehicles and construction machinery

No.	Transport vehicles and construction machinery	Noise level at distance of 1m from the noise source		Noise level at distance of 20m from the noise source	Noise level at distance of 50m from the noise source
		Interval	Average		
01	Bulldozer		93.0	67.0	59.0
02	Compressor (roller)	72.0 – 74.0	73.0	47.0	39.0
03	Backhoe excavator	72.0 – 84.0	78.0	52.0	44.0
04	Puller	77.0 – 96.0	86.5	60.5	52.5
05	Land scraper. compactor	80.0 – 93.0	86.5	60.5	52.5
06	Paving road machine	87.0 – 88.5	87.7	61.7	53.7
07	Truck	82.0 – 94.0	88.0	62.0	54.0
08	Concrete mixer	75.0 – 88.0	81.5	55.5	47.5
09	Moving crane	76.0 – 87.0	81.5	55.5	47.5
10	Electric generator	72.0 – 82.5	77.2	51.2	43.2
11	Air compressor	75.0 – 87.0	81.0	55.0	47.0
12	Piling machine	95.0 – 106.0	100.5	74.5	66.5
	National Technical Regulation 26/2010/BTNMT applying for normal areas: 6 AM to 9PM is 70 dBA; from 9PM to 6AM is 55 dBA;				
	According to the MOH standard: noise at the production area 85 dBA for 8 hours of noise exposure				

Source: Mackernize, 1985

The noise level at the distance of 20m from the noise source is lower than the allowable limit (National Technical Regulation on Noise-QCVN 26:2010/BTNMT). In additional, time of this impact is limited, not continuous, away from residential area. Therefore this impact does not cause much influence on surrounding environment.

b. Impacts on surface water environment:

Impacts of dredging

The dredging activity produces about 683,159.6 m^3 of excavated soil from 8 headworks. In general, soil in the project area has good quality and can be used for embankment. However, such activity can affect the quality of surface water in the project area as follows:

- In the dredging area and dredged mud pouring area in water, the turbidity increases, reducing capacity to absorb light, photosynthetic efficiency, and saturation of oxygen in the water. Due to the fluctuation of the water, the dirt will be separated from sludge and diffuse into the different layers of water, causing pollution for the water environment. The slow and non-continuous dredging process may lead to slow recovery of the ecosystem;
- In general, when mud and soil are disturbed, it will strongly affect the quality of water in the dredging area. The concentration of suspended solids will increase dramatically, and the toxic substances in the sludge will be able to dissolve in water and disperse to neighboring water bodies, causing immediate impact on aquatic system (animals and plants) in the dredging area.
- The transport of sludge by boats from the waste sites on two riversides may cause sludge leakage and spillage into the river (especially when there are other vehicles circulating at the same time and raining during transport). Sludge spillage level depends on the amount of sludge transported on boat. Generally, if the amount of sludge on the boat is limited within the allowable load, the amount of sludge overflowed into the river will be significantly reduced. Thereby, the impacts on water environment are small and negligible.

Otherwise (when the boat is overloaded), the amount of overflowed sludge is higher; the impacts on environment thus become more severe, especially when incident occurs leading to shipwreck.

- Illegal disposal of dredged materials: in general, in order to find an appropriate sludge dumping area, it is important to study in detail and properly to meet the requirements with regards to socio-economic, technical and environmental protection aspects. However, even though the sludge dumping site is selected, the incompliance can happen due to the awareness of the transport workers. There are two possibilities that can occur:
    - Dumping sludge at the site that is not included in the planning;
    - Directly dumping sludge into the water environment.

The possibility to discharge sludge on a site that is not included in the planning is unlikely to happen because disposal of sludge needs pump system or clamshell on barges. Moreover, dumping a large amount of sludge on an open site will result in

immediate attention of the surrounding population. Therefore, in fact, this possibility is less likely to happen.

Meanwhile, the direct dumping of sludge into water is likely to happen if the workers do not comply strictly with the regulations of the project. If the sludge dumping location is the area where the river flow rate is strong, it will be very difficult to detect. In this case, the sludge directly discharged into water will cause some following impacts:

- Sludge dumping can cause the deposition of sludge in the surrounding area, altering the depth of the channels and thus may result in the grounding of boats, causing congestion for waterway traffic.
- Sludge dumping increases the concentration of suspended solids in the water, the color and turbidity of the water are also increased. Too high concentration of suspended solids can kill fishes and other aquatic species. Water with high turbidity can also raise the temperature of water by absorbing more solar radiation.
- The content of organic matter in the sludge is greatly high. When sludge is discharged into water, the content of dissolved oxygen in water will decrease as oxygen is consumed for the process of decomposing organic matter in the sludge. The fall in dissolved oxygen level will kill less-sensitive aquatic species and damage the aquatic ecosystem in the area.
- Sludge contains heavy metal ions and other toxic substances. When sludge is directly poured into river water, these hazardous materials will be partly deposited under the mud and partly dissolved into water. The increased levels of toxic substances can make some benthic species die. On the other hand, the toxins can be carried in the bodies of some water species and will be increased along with the natural food chain (the process of accumulation and biological increase). The result may cause harms to the higher animals (including humans) by eating these types of aquatic life. Therefore, sludge disposal management must be planned and followed strictly.

Impacts caused by waste water from construction activities:

- Wastewater from the construction process and maintenance of concrete; water from motorbike and equipment repair and washing points; and water for washing sand and gravel containing hazardous wastes such as cement, oil, grease, and dirt will be greatly toxic to the aquatic environment. However, this type of waste is easily treated; therefore, the degree of impacts is not severe (concrete is mixed by mixer in the camping site and store house and then transported to the construction site by trucks; therefore, a large amount of wastewater is discharged in this area, which is easier to collect and treat).
- Wastewater from mortar preparing and concrete maintenance: At present, there is no ration available to calculate; however, according to the forecast and actual situation at the construction sites, this type of wastewater has small amount and is not enough to form water stream. Most of it will penetrate into the materials and gradually evaporate.
- Wastewater due to washing construction materials including sand, rocks, stones, gravel...and washing equipment for construction such as washing concrete mixer after

each work shift. Based on the construction volume, number of vehicles and equipment for construction and actual construction of many similar works, the volume of this type of wastewater from 8 headworks can be estimated at around 150m3 per day.

The nature of construction wastewater is high sediment content containing some toxic contaminants in cement, concrete additives and relatively high pH level. However, the proportion of sediment in wastewater is quite large, it is easy to deposit.

Impacts of wastewater containing oil:

Waste oil is generated due to maintenance work, washing equipment and dirt on vehicles before going to the main road. The volume of this waste depends on number of traffic vehicles and weather (during rainy season, there are much more mud and dirt, washing is required more often). The standard water amount used to wash a large truck is from 300 liters to 500 liters (according to Section 3.4-Vietnam Standards TCVN 4513:1988).

Based on the demands for transporting construction materials, it is estimated that about 100m^3 of water is needed to wash vehicle per day.

Impacts of domestic wastewater:

Domestic waste water in this phase mainly contains residuum, suspended substances (SS), organic substances (BOD5, COD), nutrients (N,P) and pathogenic micro-organisms. Water expected to use for toilet and daily living of workers at site is about 100 liters/person/day (*according to the World Health Organization, WHO)*. Waste water flow generated is approximately 85% to 95% of supplied water flow *(according to Wastewater Treatment Technology, Science and Technology Publishing House, Hanoi, 2002).* On average, the wastewater flow is calculated as 90% of supplied water flow and the total number of workers in 8 construction sites is 994 people per day during high time. Hence, the amount of wastewater at the maximum during high time is calculated as follows:

$$100 \times 10^{-3} \times 994 \times 90\% = 98.46 \ (m^3/day)$$

Table 3 - 16: Pollutant load in domestic wastewater

No.	Pollutants	Load	Microorganism
		(g/person/day-night)	(MPN/100ml)
1	BOD_5	45 ÷ 54	-
2	COD	72 ÷ 102	-
3	SS	70 ÷ 145	-
4	Oil	10 ÷ 30	-
5	Total N	6 ÷ 12	-
6	Ammonia	2,4 ÷ 4,8	-
7	Total Phosphorus	0,8 ÷ 4	-
8	Total Coliform	-	$10^6 \div 10^9$
9	Fecal Coliform	-	$10^5 \div 10^6$
10	Helminthic eggs	-	10^3

Source: WHO

Based on the total wastewater volume and pollutant coefficients, the loads of pollutants per day on the construction sites are calculated as below:

Table 3 - 17: Pollutant loads per day in domestic wastewater on the construction sites

Sites	Thu Cuu	An Hoa	Ben Tre	Tan Phu	Ben Ro	Cai Quao	Vam Nuoc Trong	Vam Thom
Workers (person)	105	199	165	40	40	105	175	165
Wastewater volume (m^3)	9.45	17.91	14.85	3.6	3.6	9.45	15.75	14.85
BOD_5 (kg/day)	4.73	8.96	7.43	1.80	1.80	4.73	7.88	7.43
	5.67	10.746	8.91	2.16	2.16	5.67	9.45	8.91
COD (kg/day)	7.56	14.33	11.88	2.88	2.88	7.56	12.60	11.88
	10.71	20.30	16.83	4.08	4.08	10.71	17.85	16.83
SS (kg/day)	7.4	13.9	11.6	2.8	2.8	7.4	12.3	11.6
	15.2	28.9	23.9	5.8	5.8	15.2	25.4	23.9
Oil (kg/day)	1.32	2.51	2.08	0.50	0.50	1.32	2.21	2.08
	3.97	7.52	6.24	1.51	1.51	3.97	6.62	6.24
Total N (kg/day)	0.63	1.194	0.99	0.24	0.24	0.63	1.05	0.99
	1.26	2.388	1.98	0.48	0.48	1.26	2.1	1.98
Ammonia (kg/day)	0.25	0.48	0.40	0.10	0.10	0.25	0.42	0.40
	0.50	0.96	0.79	0.19	0.19	0.50	0.84	0.79
Total P (kg/day)	0.08	0.16	0.13	0.03	0.03	0.08	0.14	0.13
	0.42	0.80	0.66	0.16	0.16	0.42	0.70	0.66

Domestic wastewater containing many residuum, suspended solids, organic matter such as BOD, COD and microorganisms (can carry many pathogenic microorganisms), if not collected and treated properly, will contaminate the receiving surface water source. The scope of impacts is 8 construction workers camps; however, the amount of wastewater is not considerable and easy to collect and treat. Therefore, the impact degree is evaluated as small.

Impacts of stormwater runoff:

The stormwater overflowing the area of 8 headworks with the total area of F=21.7 ha (0.217km2) in one year is calculated as per formula: $W_0 = M_0 \times F \times T/1000$. According to the hydrological atlas, the flow module M_0=10l/s/km^2, T = 31,566 x 10^6s.

Thus, the total volume of stormwater runoff calculated yearly on 8 headworks by excluding evaporation and seepage losses is 69,325 m^3. The months with the highest rainfall concentrated in the rainy season, from May to October; the total precipitation ranges from 7,693m^3 (May) to 13,498m^3 (in September). Stormwater runoff carries dirt, dust, oil and other pollutants into the receiving sources.

Table 3 - 18: Total stormwater runoff volume in the project site

	T.1	T 2	T 3	T 4	T 5	T 6	T 7	T 8	T 9	T 10	T 11	T 12	Year
Average rainfall (mm)	0.4	0.7	4.4	38.5	163	207	184	194	286	278	103	9.9	1450
Total storm-water volume (m^3)	18.9	33.0	208	1817	7,693	9,769	8,684	9,156	13,498	13,120	4.861	467	6,9325

Stormwater can be contaminated when flowing through areas containing contaminants such as material storing sites, outdoor construction sites. The nature of stormwater pollution in this case is mechanical pollution (soil, sand, and garbage), organic contamination, oils and grease. Stormwater runoff at this stage has high turbidity due to sweeping mud and dirt from leveling, excavation at the material sites, excavation to construct traffic road.

Stormwater mainly sweeps away pollutants at the construction sites of salinity intrusion prevention sluice gates, sewer locks, traffic roads, management houses, and workers camps.

Table 3 - 19: Concentration of pollutants in the stormwater runoff

Pollutants	Concentration, mg/l
Total N	0.5 ÷ 1.5
Total P	0.004 ÷ 0.03
COD	10 ÷ 20
SS	10 ÷ 20

It is important to take advantage of construction during dry season. During the rainy season, the construction site and machinery as well as workers camp should be arranged properly to minimize the washing of pollutants in stormwater into receiving sources which are rivers and streams in the area.

c. Impacts on groundwater environment:

The volume of domestic solid waste per capita in Vietnam is from 0.35 to 0.8 kg per day *(according to Solid Waste Management, Construction Publishing House)*. Based on the consumption demands, development level of the locality and living conditions in the workers camps, the volume of domestic solid waste per capita is calculated at 0.5 kg per day. The total number of workers on the construction sites during high time is 994 workers. Hence, the maximum volume of domestic solid waste produced during this period is calculated as follows:

$$994 \times 0.5 = 497 \text{ (kg/day)}$$

Domestic solid wastes are easily decomposed and thus produce leachate (bad odor, carrying microorganisms), when penetrating into the ground, it will contaminate

the groundwater source in the area. However, as assessed, such impacts are insignificant because the amount of domestic solid wastes is small and easy to collect and treat as they are only concentrated in 8 camp areas scattered across Ben Tre province.

The foundation cutting and pile driving process can make pollutants permeate through soil, which cause pollution to the groundwater source. Such impacts are evaluated as negligible as the river and canal beds are not deep (about -5 to -6m at the maximum as in Ben Tre sluice gate).

d. Impacts on soil environment:

Construction waste (including cardboard, scrap steel, plastic containers, residual soil and stones, rocks), if not collected and treated, will affect the soil environment. Such solid waste is not hazardous and also easy to collect and handle; hence, the environmental impacts are not significant.

The removed topsoil waste during construction period and backfill soil are also gathered at the dump sites. As land is acquired and used as a temporary and small waste site, when the work is completed, this area will be restored and trees will be planted; therefore, the impacts are assessed as small. However, dumping process can cause landslides and soil erosion and thus contaminate soil in the adjacent area.

Domestic waste from workers camps with the volume of around 600 kg per day are the type of waste which is easily decomposed, generating bad odor. Without treatment, if wastes are directly disposed to the environment, soil will be polluted. However, such waste are mostly concentrated in the workers camps and thus are easy to collect and treat.

Solid waste containing oil is hazardous waste. Although the volume of this type of waste is small, if they are not properly collected and treated but discharged into receiving soil environment, they will cause adverse impacts on soil environment such as hardening soil, killing microorganisms in the soil, and severely affecting vegetation cover.

Wastewater from the construction process contains cement; wastewater due to repair, washing equipment and motorcycles contains toxic elements which are grease and oils. When penetrating into soil, such type of waste will make soil harden.

Stormwater runoff with relatively large flow will sweep away the top soil layer and dissolve some nutrients in the soil, especially when vegetation cover has been cut down. Soil, thus, will be washed and eroded, which causes adverse impacts on the soil quality.

Domestic wastewater contains many impurities, especially the concentration of organic matter is high. Hence, if it is not well managed, when wastewater penetrates into soil, the soil environment will be contaminated. Nevertheless, the wastewater is only concentrated in 8 worker camps scattered across Ben Tre province with inconsiderable volume. The scope of impact, therefore, is considered small.

e. Impacts on local hydrology regime:

Although the construction is divided into two to three batches and construct the culverts one by one to ensure drainage flow during the construction period. However,

the narrowed section of the rivers and streams still affect the flow of the rivers and might cause partial inundation during a short time.

This issue is most likely to happen at the Tan Phu, Ben Ro sluice gate works as the construction of sluice gates in one batch requires to block the river. However, the drainage flow in the two rivers where the work is located is not large. The amount of water needs taking in or flowing out can go towards other river and canal directions.

f. Impacts on ecological environment:

Construction phase is considered to cause the most impacts on the ecosystem in the region, including terrestrial ecosystem and aquatic ecosystem. These effects can include temporary impacts during construction period but also other long-term impacts.

The impacts can be listed as follows:

Impacts on migration, inhabitation and foraging of fishes and aquatic species:

In the course of construction of salinity intrusion prevention works such as sluice gates and locks, the use of machinery is unavoidable. The operation of these machines will cause noise and vibration affecting the habitats as well as migration of species, especially those living in the rivers where the construction activities are carried out.

The species affected by this process are mainly vertebrate species belonging to classes of fish or shrimps living in river (including both freshwater and brackish species).

The diversion method is studied to apply during the installation and construction process. The construction of sluicegates is divided into two to three batches. When the construction activities are carried out in the next batch, water is diverted to the area where the construction is completed in the previous batch to ensure drainage and supply flow. The species, therefore, can still travel and search for food in the river bed during the construction period.

Scope of impact is identified throughout the construction process.

Cause environmental pollution and affect the inhabitation of the species in the aquatic ecosystem

According to design, in order to construct the salinity intrusion prevention sluicegates between rivers, the use of floating platform on which crane is placed for reinforced concrete pile driving and sluice gate foundation treatment at the piers in flow of the rivers are unavoidable. In addition, on the floating platform, there will ve fuel and lubricating oil containers. The refueling and lubricating the crane will be carried out right on the floating platform.

The operation of the floating platform will produce waste containing oils such as dust cloth, oil leakage during crane operation and refueling process, even oil spill incident may happen. The volume of oil leakage cannot be accurately quantified as it depends on the construction plan and method.

The results of construction monitoring of many works on rivers show that oil scum surrounding the floating platform is often observed. The color of oil scum can be

bright or even brown. The spreading scope is dependent on the weather and water velocity as well as riparian vegetation.

The operation of floating platform system will cause direct impacts on the quality of river water as well as the river ecosystem. Specifically, it will reduce the amount of dissolved oxygen in the water, preventing the penetration of light and oxygen from the air into the water. Hence, it will directly affect the species living in the river area where the floating drilling platform operates and then spread downstream. The plankton and benthic species, therefore, have to find other places to live. Other species that cannot or do not move like water plants, some benthos and planktons may die due to lack of oxygen and changing habitat quality. However, these impacts can be controlled if during the construction and operation process, the contractors and consultants closely monitor and have appropriate collection solutions to avoid spillage or leakage of waste into the flow.

However, the scope of impacts caused by this process is considered small (about 20m towards upstream and 50m towards downstream from the pile position) and the duration of impacts is short term during the bored pile construction process at the piers in the river.

Affect the habitats of aquatic species due to soil discharged into river flow during bored pile construction process

Results of the river water quality monitoring results during the survey show that the water quality of the rivers of 8 headworks are already contaminated with suspended solids (SS) compared to the limit specified in the National Technical Regulation QCVN08:2008/MONRE. Therefore, it can be concluded that the process of bored piling will increase the volume of SS in the water.

Reinforced concrete pile construction process will generate a large amount of residual soil. This type of waste is not mixed with betonite and liquidified in form of mud due to continuous pumping of water during drilling process. In the areas where the protection of water resources is highly required, this type of solution is usually pumped out of the river and dumped at the designated sites. However, in many cases, when construction is carried out at large rivers and where the sensitive water users are far from the construction area, mudflow method is used. In the case of the Project, wasting from the bored pile construction will be liquidified into mudflow and discharged directly into the surging flow of the river. To limit the risk of explosion of turbidity at the discharged area, the regulation of mud is necessary so that the river flow from upstream rapidly disperses mud across the large scale and then deposits. With this solution, the impact on the river water quality will be assessed according to the scope of solid pervasion or the limits at which the materials are deposited. In other words, the necessary time for materials to be deposited or limited. The finer the particle, the longer the deposition time and the broader the spreading scope.

To quantify the amount of material deposited and forecast additional solid concentration in water volume, using the method to determine the self-cleaning velocity of particles in the flow. When the self-cleaning velocity is smaller than the flow velocity, particles will deposit. When these particles are not deposited to the

bottom of the river, it will make the river water turbidity increase, thus affecting the habitats of aquatic organisms, especially plankton species such as fishes, shrimp, algae, etc.

However, these impacts are regarded insignificant and only occur during the bored pile driving process on the rivers.

f. Impacts on economic, cultural and social environment:

Impacts on public health:

People working in the area where air is polluted due to dust and noise can be affected as follows:

Dust: Dust causes harm to humans, animals and plants through the respiratory tract, causing pneumoconiosis, bronchitis and respiratory failure. Besides, they also cause swollen eye membranes.

Emissions: Frequently exposed to environment polluted by emissions from engines will cause symptoms related to the respiratory tract.

Noise: According to the Ministry of Health and the National Institute of Labor Protection of Vietnam under Vietnam General Confederation of Labor, noise adversely affects most parts of the human body. The impacts of noise on the human body in different frequency bands can be shown in the following table.

Table 3 - 20: Effects of noise with high noise level on people's health

Noise level (dBA)	Effects on people
0 - 99	Threshold of audibility
100	Significant changes in pulse
110	Stimulation of skin receptors
120	Pain threshold
130 ÷ 135	Nausea, dizziness, vomiting, interference with touch and muscle sense
140	Pain in ear, extreme limit of tolerance
145	Highest level of noise which can be tolerated by human ear
150	Prolonged exposure cause, burning of the skin
160	Minor permanent damage if prolonged
190	Major permanent damage in short time

The scope of impacts of the headwork construction sites is 8 sluicegates. The affected are the workers of the project as well as the local communities surrounding the project sites.

Changes in micro-climate: During this phase, all activities are mainly carried out at the headwork construction sites; therefore, microclimate changes will be clearly observed in this area.

Transport vehicles, loaders, excavators, compactors and cutting and welding activities generate dust, emission gas and heat. Combined with the heat radiating from

the ground, concrete creates a stifling and hot microclimate environment in the summer. The temperature at the construction site is generally 3 - 4^0C higher than the surrounding areas without construction activities.

Those directly affected by this cause will be the workers on site. Hot and stuffy conditions will reduce their productivity and immunity to the environment; hence, workers are more vulnerable to diseases related to weather such as getting sunstroke and rashes.

Impacts caused by the concentration of workers: The worker force needed for the entire project is estimated around 994 people during high time. The concentration of workers on the construction sites can bring strange diseases and increase the contamination risk of diseases from the workers to the local communities. The demands for healthcare of the workers also cause pressure on the local health clinics in terms of medical equipment, medicines and staff.

Besides, if the sanitation environment of the camps is not paid due attention, it will cause impacts on workers' health due to pollutant factors arisen from wastewater and domestic solid waste.

Loss of occupational safety: The occupational accidents may occur during construction and cause injury and death to the construction workers. Also, if there are no safety measures and appropriate warning during the construction process, it can cause death and injury for people living near the construction sites.

Impacts on security, culture and customs of the people in the project area:

Workforce needed for the entire project is estimated at about 994 people at peak times. The influx of these workers to the project area for a period of 2 to 3 years will shape the relationship between project workers, locals and free immigrants moving to the area for business purposes.

The relationships may form a residential community in the project area. In addition to the benefits brought to local, the relationships will cause conflicts affecting culture, practice and customs of the villages, leading to the emergence of social evils affecting the security of the region.

The concentration of workers on the construction sites (about 100-200 people per headwork) and their dependents can lead to conflicts between the laborers and local communities and social evils (drugs, prostitution, etc.), thus causing difficulties to control security, order and social management.

Impacts on the economy and employment of people and communes in the project area:

The concentration of workers on the sites will lead to the increase in demands for food and entertainment services in the area, contributing to promoting the development of trade and services as well as the business and services facilities, which helps solve the employment issues and increase income for local communities.

Employment opportunities for the local labors will be created, contributing to the shift in labor structure in the area. Depending on the capacities, local workers will be recruited to work in some parts of the construction sites. Thereby gradually raise the level of knowledge understanding, which is positive factors to their awareness as well as the cultural life of local communities.

g. Impacts on transport infrastructure

Impacts on road traffic

The transport of construction materials with large volume often causes obstacles to the traffic. The affected are the people participating in traffic on the provincial roads 881÷887, and national highway QL57, QL60 connecting to the areas within the province, national highway QL30 and QL1 connecting to other provinces as these are the main routes to transport materials for the project. During the project implementation, the project owner expects to use the existing traffic road for operation. These are the routes connecting the residential areas and thus have regular traffic flow. Therefore, the transport vehicles and construction activities should avoid peak hours to avoid obstructing the traffic and daily lives of local communities.

Impacts on waterway traffic

An Hoa, Ben Tre, Vam Nuoc Trong and Vam Thom headworks are located along the national tertiary inland waterway that has large waterway traffic demands. As for Thu Cuu, Ben Ro, Tan Phu, Cai Quao, sluicegates, they are all located along the rivers and canals of the Grade-V inland waterway, thus the demands for waterway traffic are not too considerable.

As for An Hoa, Ben Tre, Thu Cuu, Vam Nuoc Trong, Vam Thom, Cai Quao, Vung Liem, Tan Dinh, and Bong Bot headworks that have two to four culverts (or sluice unit), construction is carried out within steel sheet screens in the river-bed. Sluicegate construction is divided into two to three batches; therefore, when the later batch is carried out, flow is led through the construction work that has been completed in the previous batch. With this method, waterway traffic is not affected.

As for Tan Phu and Ben Ro sluicegates, the construction is only carried out in one batch and requires the blockage of the entire river, which also affects the water provision, drainage, and waterway traffic in the construction area. However, the traffic flow through these sluicegates is not high and people can choose other canal routes.

Besides, the unsafe and negligent construction methods of workers can cause spillage of materials into river when boats are traveling on the river, which might cause risks of accidents to the vehicles on the river. Therefore, announcement of the construction schedule as well as the guidance and arrangement of timetable of waterway vehicles will reduce such risks.

h. Impacts on landscape and cultural and historic relics

Around the project area, there is no historic relic, tourist attraction or religious structures such as temples, schools, churches, shrines, etc. Some cultural structures such as churches and schools (Tich Thien Commune, Tan Dinh Sluicegate), Ben Cat Pagoda (An Phu Tan Commune at Bong Bot sluicegate) are located 500m from the sluicegate construction area; therefore, the possibility of adverse impacts is not high.

i. Impacts caused by risks and incidents

Occupational accidents

- In general, occupational accidents can occur at any stage of construction of the project. The causes of the accidents on construction sites are:
- Environmental pollution can cause fatigue, dizziness or fainting for workers.
- During the installation, construction and material transportation process, a lack of focus can cause occupational accidents, traffic accidents, etc.
- Accident due to the negligence of workers, lack of protective equipment, or due to lack of awareness to strictly follow the safety regulations of construction workers.
- The project owner should pay special attention to take measures to ensure labor safety for workers.

Fire and explosion, fuel leakage incidents

- Fire and explosion incidents may occur in the case of transport and storage of fuel, or lack of safety of temporary power supply system, causing loss of life and property during construction. Specific causes can be identified as follows:
- The temporary storage of materials and fuel to serve the construction activities (gas, DO, fuel oil, welding gas, etc.) are sources of ignition. When the incident occurs, it can cause serious damages to human, socio-economic and environment;
- Temporary power supply system for machinery and equipment during construction can cause electrical shock, short circuit, fire, and explosion incident, causing economic loss and labor accidents to workers.
- Project Owner will carry out fire prevention activities, strictly complying with preventive measures against leakage, fire and explosion. Fire prevention is done regularly, thus the possibility of the incident will be limited to the lowest level and the level of impact is not large.
- Incidents occurred on river: Incidents during construction period may happen on river such as:
- Leakage and overflow of sludge into the river due to heavy rain or waves;
- Sludge transport barge wreck incidents;
- Accidents leading to shipwreck.
- The above incidents, if occur, will cause severe impacts on the environment, particularly surface water environment such as increase in turbidity of river water, overflow of sludge and oil into the river environment.

2.1.3 Impact assessment during project operation period

The construction and operation of the irrigation projects will significantly alter the ecosystem, especially aquatic ecosystem. Hence, the positive effects may not happen immediately but after a certain time. In addition to the positive impacts set in the project objectives (fresh water supply, deacidification, alkaline wash, salinity intrusion prevention, drainage, water pollution prevention, etc.), adverse impacts can happen especially during the earlier stage as follows:

Table 3 - 21: Environmental impacts during operation period

	Activity	Cause of impacts	Impacts	Affected objects	Impact duration	Related to waste
1	Salinity control	Closure of salinity prevention sluicegate	- Reduce salinity - Reduce the amount of water in the infield - Change the conditions of natural habitat: aluminum toxicity, deficiency of phosphorus, iron abundance, low microbial activity	- Natural aquatic ecosystem: number, distribution of species - Artificial ecosystem (cultivated area, brackish aquaculture ponds)	Temporary (short term), but repeated during a long period of time	No
2	Increase in freshwater irrigation area	Increased yield of the freshwater varieties	Waste from agricultural byproducts	Pollution of soil, water, air and landscape environment	Long-term (during operation)	Yes
		Increased use of fertilizers, herbicides and pesticides	Growing chemical residues in agriculture. Waste of bottles, packing and containers of chemicals	Pollution of soil, surface water, groundwater and impacts on public health	Long-term (during operation)	Yes
3	Agricultural products increase in terms of both quantity and quality	Improving living standards, improving livestock husbandry and secondary jobs	Wastewater, domestic waste, husbandry and secondary jobs	Soil, water, air environment, rural environmental sanitation	Long-term (during operation)	Yes
4	Salinity control	Closure of salinity prevention sluicegates Open traffic way through sluicegate	Obstructing waterway traffic Increasing road traffic through sluicegate	Surrounding communities and inter-province Air environment Rural environmental sanitation	Temporary for waterway traffic (the closure time is short) but repeated for a long period of time Long-term improvement of road traffic	Yes

Therefore, it is important to have adequate management and operation measures to minimize pollution during this period.

3.1.3.1 Positive effects

a. Socio-economic effects

Impacts on socio-economic development

- Salinity control and irrigation for 204,270 ha of natural land in all nine district-level administrative units of Ben Tre.
- Providing water, drainage, alluvium, deacidification, alkaline wash to serve agricultural production and aquaculture for 110,442 ha of agricultural land among total of 137,224 ha arable land of the whole Ben Tre province towards diversification of crops and livestock. Providing fresh water for production and living of 207,275 households.
- Livestock: Due to the formation of dams, canals, regulating culverts and changes in the flow, a cool climatic sub-region will be created. The vegetation has favorable conditions to grow well, facilitating livestock husbandry. On the other hand, when the project is completed, it will help supply fresh water to the entire project area, thus create favorable conditions for the development of aquaculture in the region.
- Cultivation: The land use will be changed due to restructuring of the crops to suit the new conditions, bringing economic benefits for the people in the project area.
- Domestic life: In addition to the supply of water for agricultural areas of the project sub-region, the project will provide drinking water, industrial water, and irrigation water for the project communes; thereby, increasing the overall efficiency of the project.
- Social life: The project will provide employment opportunities for people in the project area and the surrounding areas.
- Creating jobs and stable production. Increasing agricultural area and output means the growing demands for more labors in agricultural sector.
- The increase in livestock husbandry and aquaculture will attract more labor;
- Creating more jobs in equipment and materials supply services as well as agricultural product procurement and processing services;
- Water is supplied in a more sufficient and stable manner, allowing crop structure and crop yields more stable, reducing the dependence of the crop and yield on weather.
- The construction of dykes, sluicegates, and main canals bring advantages for the irrigation of agricultural land and provision of water for communities in eight districts and one city, thus bringing high economic efficiency. The project contributes to the inland freshwater reserves, contributing to the supply of fresh water for aquaculture of local people. Most of aquatic products in the project area are freshwater fishes and giant freshwater prawns in coconut canals, shrimps living in fresh water. In addition, more than 60% of the project communes still use river water for cooking and other domestic purposes, so the freshwater reserves will supply water and improve drinking water for the people.

- Due to large scope of impacts, the project implementation has the potential to improve the living conditions of the majority of population in the rural areas. This is an opportunity to improve the quality of life of the poor who are landless or have only a little.

Impacts on transportation

- The positive effects on economic activities such as reduced transport costs and increased value of agricultural products.
- Bridges on sluicegates contribute to improving road traffic network of the project communes and districts. Particularly, in Tan Dinh and Bong Bot ferry area, people often travel across the river by ferry, which is time-consuming. The freight will also be faster and reduce transport costs. Especially for the Mekong Delta, several people involved in fruit trading, reduced transport time will make fruits fresher, and the prices thus will be more stable and higher.
- Helping enhance economic activities and improve people's living conditions and accessibility to services such as health care due to improved transport conditions.
- Contributing to the connection of the geographical regions, facilitating the exchange of cultural activities, participation in the great festivals of the people in the region.
- Since the sluicegate designs have locks and culverts suitable for the traffic of ships and boats, the construction of sluicegates thus does not cause significant impacts on waterway traffic.

Impacts of the project on women and children

- When the project is completed, a cool climatic sub-region will be created; therefore, some diseases in children due to lack of water in the dry season will be reduced. The completion of the project will also bring positive effects to the elderly, children and women in the project area.
- The increase in groundwater will help reduce water shortage in the dry season and supply domestic water for people in the area, lessening difficulties for women.
- The traffic and trade among commune, district, and provincial centers will become more favorable. Hence, people can access to healthcare, market and school easier, particularly children and women.
- The living conditions of people in the area will be improved; therefore, material and spiritual lives of children and women will become better, particularly children who can go to school easier.

b. Impacts on agricultural development of the project area

Agricultural development scheme of Ben Tre water management project is developed by the Hydraulic Engineering Consultancy Corporation No. II (HEC II) and approved by the North Ben Tre Project Management Unit under Ben Tre DARD. Summary of financial and economic analyses of the land use at present and in the

future (2020) when the project is in place, comparing some indicators regarding output and output value of the region (JICA 3 Project) are presented in the Table below:

Table 3 - 22: Comparing some indicators before and after the project

No.	INDICATORS	Unit	In 2012	In 2020	Difference
1	2	3	4	5	(5) - (4)
A	**GENERAL CRITERIA**				
I	Agricultural land indicators				
1	Total agricultural land area	Ha	377,310	358,620	-18,690
2	Productive land area	-	313,455	284,294	-29,161
3	Forest land area	-	8,088	15,829	7,741
4	Aquaculture land	-	53,026	56,143	3,117
5	Salt-making land		1,951	1,403	-548
6	Other agricultural lands	-	1,193	950	-243
II	**OTHER INDICATORS**				
1	Total area of cultivated land	Ha	313,455	284,294	-29,161
2	Total area of annual crops	-	171,317	153,202	-18,115
3	Tổng DTGT cây hàng năm	-	432,760	403,116	-29,644
4	Total area of perennial crops		142,138	131,092	-11,046
5	Rice yield		2,042,359	1,861,175	-181,185
6	Corn yield		30,237	106,654	76,417
7	Sweet potato yield		31,013	60,230	29,217
8	Yield of vegetable, beans		829,782	1,410,334	580,552
9	Sugarcane yield		1,047,047	1,067,500	20,453
10	Groundnut yield		22,790	34,442	11,652
11	Coconut yield		480,657	1,015,343	534,685
12	Fruit yield		514,033	905,139	391,106
13	Fish output		205,523	758,895	553,372
14	Shrimp output		51,430	100,563	49,133
15	Output of other aquatic products		25,018	45,489	20,471
16	Total value of cultivation, fishery, forestry	Mil. dong	52,652,856	86,250,493	33,597,637
17	Total production cost	Mil. dong	28,379,757	46,508,359	18,128,602
18	Total profit	Mil. dong	24,273,099	39,742,134	15,469,035
19	Total income	Mil. dong	30,028,438	47,626,020	17,597,582
20	Total demand for labors	1000 labor	54,972	61,709	6737
21	Covert to laborers	people	458,098	514,241	56,144
B	**AVERAGE CRITERIA**				
1	Profit/output value	%	46.1	46.1	-0.02
2	Profit/cost	%	85.5	85.5	-0.1

3	Output value/ha of agricultural land	Mil. dong	139.5	240.5	101.0
4	Profit/ha of agricultural land	Mil. dong	64.3	110.8	46.5
5	Income/ha of agricultural land	Mil. dong	79.6	132.8	53.2

Source: HEC II, 2013

After the project is completed, it will bring about great economic venefits, the value of output will increase by 101.0 million dong, 1.72 times higher than the status quo of 2012. In addition, the profit on one ha of agricultural land will increase by 46.5 million dong and income increases by 53.2 million dong per ha. Therefore, the calculation results when the project is in place are totally consistent with the agricultural development plan of the region.

According to participants in the stakeholder consultation meetings in the communes, the most concerned issues of the farmers in the Ben Tre province are as following:

Table 3 - 23: Most concerned issues of local residents

No.	Concerns of stakeholders	Stakeholders						
		Local authority	Rice farmer	Coconut farmer	Fruit farmer	Husbandry	Aquaculture farmer	Others
1	Lack of freshwater causing low agricultural productivity	****	****	****	****	****	**	**
2	Sluice-gate operation schedule	****	***	***	***	***	***	**
3	Water pollution due to industrial/ agricultural discharge	****	****	****	****	****	****	**
4	Water logging due to closure of sluice-gate	****	***	***	***	**	*	*
5	Develop irrigation canals	***	**	**	**	*	*	*
6	Capital support	***	***	***	***	***	***	*
7	Technical supports to change livelihood activities	**	**	**	**	**	***	**
8	Market of agricultural products	*	**	**	**	**	**	*
9	Detail plan of brackish and freshwater areas	**	**	**	*	*	**	NA
10	Control pest and disease	**	**	**	**	**	NA	NA
11	Impact of the project on fishery resource	***	NA	NA	NA	*	****	**

Source: Survey team JICA B-SWAMP, 2016

c. Impacts on air environment

- Rivers are the results of large-scale climate. On the contrary, irrigation systems created by humans can change the microclimate in areas where the irrigation

systems traverse. When irrigation systems provide additional fresh water for agricultural land, aquaculture land, etc., a new ecosystem is shaped. At that time, the micro-climate in these areas are forecasted to change towards higher humidity (2-3%) and lower temperatures (0.5 - 1°C).

- Soil in the project area is less aluminous. In addition, when the project is completed and put into operation, land use capacity will be increased as the in-field land area has been freshened and washed and there is no sign of alkaline evaporation that causes air contamination. Green area will be increased and the amount of fresh water is always changing and reserved more in the channels. Hence, in the dry season, the evaporation will increase, making the air better and reducing diseases due to heat and dryness for people and cattle.

d. Impacts on surface water environment

When the project comes into operation, surface water sources are added; therefore, water is deacidificated regularly. The quality of surface water thus is maintained stably.

In the dry season, the scarcity of fresh water is also reduced because there is always fresh water added through canals.

e. Impacts on groundwater environment

Fresh water is always added regularly through canals into surface water, over time, surface water will penetrate into the lower layer and improve the quality of groundwater. The increase in groundwater volume will reduce water shortage in the dry season and provide domestic water for people in the area.

f. Impacts on soil environment

Water sources are regulated, enabling the groundwater level rises in the vicinity, increasing moisture in the soil and freshwater resources are maintained all year round. Irrigation canal network increases agricultural land area in the benefit areas of the project and at the same time increases the rotation of land and agricultural production efficiency.

Due to the freshwater supply of the project, the coastal areas of the provinces in the project area can have safe and guaranteed production but also effectively contribute to the deacidification in dry season in the area. The project will also contribute to improving salt contaminated land in some areas of Ba Tri, Binh Dai, and Duyen Hai districts into freshwater area for agricultural development. This is a significant and effective benefit brought by the project to the provinces. Soil improvement impact will be the foundation for many other positive impacts of the project.

In the project area, there are arenosols although the proportion is not high, accounting for 3.7 percent of the total area in the region. However, when freshwater resources are sufficient to provide for the area, it will meet the intensive farming demands and satisfy the needs of the vegetable cultivation area.

g. Impacts on biological resources and biodiversity

As for freshwater fishes: The popular freshwater fishes with economic value are snakeheads, giant snakeheads, eels, snakeskin gourami, bronze featherback, catfish, java barb, tinfoil barb, Hoven's Slender carp, and shark catfish, etc. These are species that will benefit from the operation of the works and help stabilize freshwater area, suitable to the growth of the species.

On the other hand, it is reported that the migratory fish species may enter the waterway and spawn in the dry season when the gates are closed. Among the fish species which migrate from the Mekong River to freshwater in the survey area, some of them area registered as rare species in in the latest IUCN Red List published in 2011. It is also reported that the migration of these fish species may have triggered by the water level rising in the Mekong River at the beginning of the rainy season.

Particularly, giant freshwater prawns are important and popular aquatic species in the project area and will be benefit from the project operation. According to the data collected as well as the assessment of Ben Tre DARD, breeder shrimps and grown shrimps live and grow best in the environment of freshwater; however, with the salinity level of 2-5‰, shrimps grow relatively faster than at the level of 0‰. Therefore, giant freshwater prawns can be kept all year round in the freshwater and brackish water area (salinity level less than 6‰). The provision of freshwater and assurance of freshwater area in the project area after the completion of the works will contribute promoting prawn culture in the coconut canals.

When the salinity intrusion prevention sluicegates are put into operation, the regional ecosystem will be maintained and thus more stable. In the field is maintained and stabilized a freshwater ecosystem with the predomination of preferred species in freshwater. While in the river, there are still changes in ecology and happens according to the penetration of tide. At the same time, more brackish species will appear and the in-field area will become the habitats of the migrating freshwater fishes.

h. Impacts on hydrological regime

When the project is completed and put into operation, the effects on saltwater intrusion and inundation due to flood tide are positive, under the regulatory activities of the sluice gates, the intrusion of salinity into inland canals will be limited. In addition, when the sluicegates supply adequate freshwater for usage, it will reduce the salinity in the rivers.

On the other hand, the project works will bring significant benefits for people in the project area. The completion of irrigation works will remarkably reduce flood and inundation in the area. Flood mitigation will cause positive impacts on the living conditions of people in the project area. Regarding economic aspect, it will minimize the impacts of flood on houses and farms of the people and reduce traffic congestion. Moreover, public health benefits are achieved due to the protection and prevention of water-borne diseases since water quality is improved through regular deacidification and salinity washing and provision of freshwater by salinity intrusion prevention sluicegate system.

3.1.3.2. Adverse impacts

a. Impacts on socio-economic development

- Job/livelihood changing: As freshwater is ensured, some new crops and livestock will be selected to develop, thereby changing the crop and livestock structure in the area. Besides, it will take a certain time for people to be familiar with and learn new techniques, methods and find output market.
- A small fraction of population is physically and economically affected such as losing land, houses, and crops, thus affecting their livelihoods as they have to find new livelihoods and change jobs to adapt to the new conditions.
- It will take time for some relocating households to stabilize and develop livelihoods at the new places. During the early stage of resettlement, these households' income sources and jobs will be more or less affected.
- Although sluicegate system has locks and culverts suitable for ships and boats passing, during the closing of salinity prevention sluicegates, the transport of materials on river of the households will be partly affected; for example, the transport time depends on the closing and opening of sluicegates and the transport time is longer, etc. Some households may shift from waterway transport to road transport, which requires investment in terms of time, money and efforts.

b. Impacts on waterway transportation

Accroding to survey results of Survey team JICA B-SWAMP conducted in 2016 for households using waterway transportation in project area: there are totally 4,177 households owning boats in 49 communes near 8 sluicegates of the project. Results from interview with 1332 among them are described in the table below:

Table 3 - 24: Number of adversely affected households

No	District	Commune	No. of households having vessels (1)	No. of households likely-affected by the project (2)
1	Bến Tre	Nhơn Thạnh	12	10
2		Phú Hưng	18	18
		Total of district	***30***	***28***
3	Châu Thành	An Hóa	12	4
4		Tam Phước	11	1
5		Tường Đa	7	1
6		An Khánh	28	1
7		Giao Hòa	9	9
8		Hữu Định	5	0
9		Phước Thạnh	5	0
10		Giao Long	3	0
11		An Phước	3	0

No	District	Commune	No. of households having vessels (1)	No. of households likely-affected by the project (2)
12		Phú An Hòa	6	0
13		Châu Thành Town	3	0
14		Tân Phú	43	17
15		Tiên Thủy	33	10
		Total of district	***168***	***43***
16	Bình Đại	Long Hòa	17	9
17		Long Định	34	3
18		Vang Quới Tây	11	0
19		Thới Lai	9	4
20		Châu Hưng	2	0
21		Phú Thuận	2	0
		Total of district	***75***	***16***
22	Mỏ Cày Bắc	Tân Thành Bình	75	15
23		Hòa Lộc	127	71
24		Khánh Thạnh Tân	252	140
25		Tân Bình	85	16
		Total of district	***539***	***242***
26	Giồng Trôm	Lương Hòa	147	18
27		Phong Mỹ	22	20
28		Lương Phú	194	50
29		Tân Lợi Thạnh	159	27
30		Phước Long	110	49
31		Phong Nẫm	12	8
32		Lương Quới	5	4
33		Thuận Điền	120	22
34		Thạnh Phú Đông	142	36
35		Mỹ Thạnh	8	0
		Total of district	***919***	***234***
36	Mỏ Cày Nam	Định Thuỷ	296	48
37		Mỏ Cày Town	64	30
38		Đa Phước Hội	103	37
39		An Định	155	63
40		An Thới	102	22

No	District	Commune	No. of households having vessels (1)	No. of households likely-affected by the project (2)
41		Bình Khánh Đông	157	113
42		Phước Hiệp	264	78
43		Minh Đức	543	61
44		Hương Mỹ	189	11
45		Bình Khánh Tây	49	38
46		Thành Thới A	176	74
47		Tân Hội	67	62
48		An Thạnh	122	53
49		Thành Thới B	159	79
		Total of district	***2,446***	***769***
GRAND TOTAL			**4,177**	**1,332**

JICA B-SWAMP survey team, 2016

Transportation navigation:

Table 3 - 25: Estimated number of boats likely-affected by the slucegates

No.	District	Commune	Estimated number of boats likely-affected by the slucegates								GRAND TOTAL
			Bến Tre	An Hóa	Mỏ Cày Nam	Mỏ Cày Bắc	Thủ Cửu	Cái Quao	Tân Phú	Bến Rớ	
1	Bến Tre City	Nhơn Thạnh		5	0	0	0	50	0	0	**55**
2		Phú Hưng	11	6	0	0	0	0	0	0	**17**
		Total of district	***11***	***11***	***0***	***0***	***0***	***50***	***0***	***0***	**72**
3	Châu Thành	An Hóa	2	5	0	0	0	0	1	0	**8**
4		Tam Phước	0	7	0	0	0	0	0	0	**7**
5		Tường Đa	0	1	0	0	0	0	0	0	**1**
6		An Khánh	0	0	0	0	0	0	0	0	**0**
7		Giao Hòa	0	12	0	0	0	0	0	0	**12**
8		Hữu Định	0	0	0	0	0	0	0	0	**0**
9		Phước Thạnh	0	0	0	0	0	0	0	0	**0**
10		Giao Long	0	0	0	0	0	0	0	0	**0**
11		An Phước	0	0	0	0	0	0	0	0	**0**
12		Phú An Hòa	0	0	0	0	0	0	0	0	**0**
13		Châu Thành Town	0	0	0	0	0	0	0	0	**0**
14		Tân Phú	0	0	1	0	0	2	2	1	**6**
15		Tiên Thủy	0	0	0	0	0	0	0	0	**0**
		Total of district	***2***	***25***	***1***	***0***	***0***	***2***	***3***	***1***	**34**
16	Bình	Long Hòa	0	8	0	0	0	0	0	0	**8**

No.	District	Commune	Estimated number of boats likely-affected by the slucegates								GRAND TOTAL
			Bến Tre	An Hóa	Mỏ Cày Nam	Mỏ Cày Bắc	Thủ Cửu	Cái Quao	Tân Phú	Bến Rớ	
17	Đại	Long Định	1	2	1	1	0	0	0	0	**5**
18		Vang Quới Tây	0	0	0	0	0	0	0	0	**0**
19		Thới Lai	3	4	1	1	0	0	1	0	**10**
20		Châu Hưng	0	0	0	0	0	0	0	0	**0**
21		Phú Thuận	0	0	0	0	0	0	0	0	**0**
		Total of district	***4***	***14***	***2***	***2***	***0***	***0***	***1***	***0***	**23**
22	Mỏ Cày Bắc	Tân Thành Bình	0	0	4	12	0	0	0	0	**16**
23		Hòa Lộc	1	2	17	39	0	5	0	0	**64**
24		Khánh Thạnh Tân	0	0	80	7	0	1	0	0	**88**
25		Tân Bình	0	0	3	14	0	0	0	0	**17**
		Total of district	***1***	***2***	***104***	***72***	***0***	***6***	***0***	***0***	**185**
26	Giồng Trôm	Lương Hòa	0	0	0	0	0	0	0	0	**0**
27		Phong Mỹ	4	2	0	0	16	0	0	0	**22**
28		Lương Phú	15	12	2	6	1	2	0	0	**38**
29		Tân Lợi Thạnh	2	7	0	1	12	0	0	0	**22**
30		Phước Long	4	0	0	1	18	0	0	0	**23**
31		Phong Nẫm	2	3	1	1	0	0	0	0	**7**
32		Lương Quới	0	0	0	0	0	0	0	0	**0**
33		Thuận Điền	11	6	2	2	12	0	0	1	**34**
34		Thạnh Phú Đông	2	3	2	1	11	1	0	0	**20**
35		Mỹ Thạnh	0	0	0	0	0	0	0	0	**0**
		Total of district	***40***	***33***	***7***	***12***	***70***	***3***	***0***	***1***	**166**
36	Mỏ Cày Nam	Định Thuỷ	2	0	18	21	0	3	0	0	**44**
37		Mỏ Cày Town	2	3	14	20	0	4	0	0	**43**
38		Đa Phước Hội	0	0	13	18	0	2	0	0	**33**
39		An Định	0	0	0	0	0	0	0	0	**0**
40		An Thới	3	0	14	7	0	2	0	0	**26**
41		Bình Khánh Đông	19	18	18	21	0	61	0	0	**137**
42		Phước Hiệp	2	2	32	47	0	46	0	0	**129**
43		Minh Đức	5	3	24	20	0	44	0	0	**96**
44		Hương Mỹ	0	0	13	0	0	0	0	0	**13**
45		Bình Khánh Tây	4	2	12	9	0	36	0	0	**63**
46		Thành Thới A	0	0	23	7	0	2	0	0	**32**
47		Tân Hội	5	8	33	29	0	6	0	0	**81**
48		An Thạnh	0	0	53	17	0	3	0	0	**73**
49		Thành Thới B	7	5	63	17	0	2	0	0	**94**
		Total of district	***49***	***41***	***330***	***233***	***0***	***211***	***0***	***0***	**864**
TỔNG CỘNG			**112**	**126**	**444**	**319**	**70**	**272**	**4**	**2**	**1.344**

Source: JICA B-SWAMP survey team, 2016

Note: A WU could be affected by more than one sluice gate on his/her route.

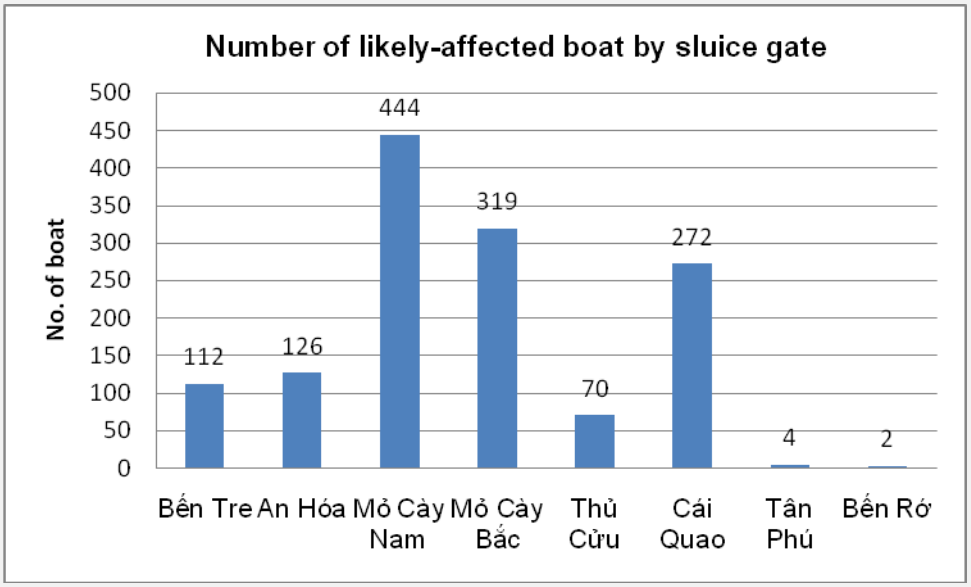


Figure 3 - 1: Estimated numbers of likely-affected boats by sluice gate

Source: JICA B-SWAMP survey team, 2016

i. Boats usage purposes

Table 3 - 26: Estimated numbers of likely affected boats by usage purpose

No.	District / City	Commune	Boat usage purpose						TOTAL
			Fishing	Cargo trans-portation	Passenger trans-portation	Sand exploita-tion	Construction materials transportation	Other	
1	Bến Tre City	Nhơn Thạnh	1	7	0	1	0	0	**9**
2		Phú Hưng	0	6	0	0	8	0	**14**
		Total of district	***2***	***15***	***3***	***5***	***13***	***6***	***44***
3	Châu Thành	An Hóa	1	0	0	4	1	0	**6**
4		Tam Phước	0	0	0	0	7	0	**7**
5		Tường Đa	0	1	0	0	0	0	**1**
6		An Khánh	0	0	0	0	0	0	**0**
7		Giao Hòa	0	2	0	10	0	0	**12**
8		Hữu Định	0	0	0	0	0	0	**0**
9		Phước Thạnh	0	0	0	0	0	0	**0**
10		Giao Long	0	0	0	0	0	0	**0**
11		An Phước	0	0	0	0	0	0	**0**
12		Phú An Hòa	0	0	0	0	0	0	**0**
13		Châu Thành Town	0	0	0	0	0	0	**0**
14		Tân Phú	0	4	0	0	0	0	**4**

No.	District / City	Commune	Boat usage purpose						TOTAL
			Fishing	Cargo transportation	Passenger transportation	Sand exploitation	Construction materials transportation	Other	
15		Tiên Thủy	0	0	0	0	0	0	**0**
		Total of district	***1***	***7***	***0***	***14***	***8***	***0***	***30***
16	Bình Đại	Long Hòa	0	2	0	0	0	0	**2**
17		Long Định	0	2	0	0	0	0	**2**
18		Vang Quới Tây	0	0	0	0	0	0	**0**
19		Thới Lai	0	4	0	0	0	0	**4**
20		Châu Hưng	0	0	0	0	0	0	**0**
21		Phú Thuận	0	0	0	0	0	0	**0**
		Total of district	***0***	***8***	***0***	***0***	***0***	***0***	***8***
22	Mỏ Cày Bắc	Tân Thành Bình	1	11	0	4	0	0	**16**
23		Hòa Lộc	2	28	0	12	8	3	**53**
24		Khánh Thạnh Tân	3	46	0	27	4	0	**80**
25		Tân Bình	0	10	0	3	1	0	**14**
		Total of district	***6***	***95***	***0***	***46***	***13***	***3***	***163***
26	Giồng Trôm	Lương Hòa	0	0	0	0	0	0	**0**
27		Phong Mỹ	3	3	0	0	0	8	**14**
28		Lương Phú	0	15	0	3	0	2	**20**
29		Tân Lợi Thạnh	0	6	0	8	3	0	**17**
30		Phước Long	0	9	0	8	0	0	**17**
31		Phong Nẫm	0	1	0	2	0	0	**3**
32		Lương Quới	0	0	0	0	0	0	**0**
33		Thuận Điền	4	12	0	2	2	0	**20**
34		Thạnh Phú Đông	2	9	0	4	0	0	**15**
35		Mỹ Thạnh	0	0	0	0	0	0	**0**

No.	District / City	Commune	Boat usage purpose						TOTAL
			Fishing	Cargo trans-portation	Passenger trans-portation	Sand exploita-tion	Construction materials transportation	Other	
		Total of district	***9***	***55***	***0***	***27***	***5***	***10***	***106***
36	Mỏ Cày Nam	Định Thuỷ	0	28	0	5	1	0	**34**
37		Mỏ Cày Town	4	19	0	5	2	0	**30**
38		Đa Phước Hội	0	23	0	1	2	1	**27**
39		An Định	0	0	0	0	0	0	**0**
40		An Thới	1	13	0	0	3	0	**17**
41		Bình Khánh Đông	46	14	0	3	0	1	**64**
42		Phước Hiệp	2	47	0	15	10	1	**75**
43		Minh Đức	1	44	0	2	6	0	**53**
44		Hương Mỹ	0	7	0	1	5	0	**13**
45		Bình Khánh Tây	18	16	0	7	1	0	**42**
46		Thành Thới A	1	18	1	0	2	0	**22**
47		Tân Hội	2	49	0	0	4	0	**55**
48		An Thạnh	0	46	1	5	2	3	**57**
49		Thành Thới B	11	50	1	6	2	0	**70**
		Total of district	***86***	***374***	***3***	***50***	***40***	***6***	***559***
TỔNG CỘNG			**104**	**554**	**6**	**142**	**79**	**25**	**910**

Source: JICA B-SWAMP survey team (2016)

Note: A boat could be used for more than one purpose.

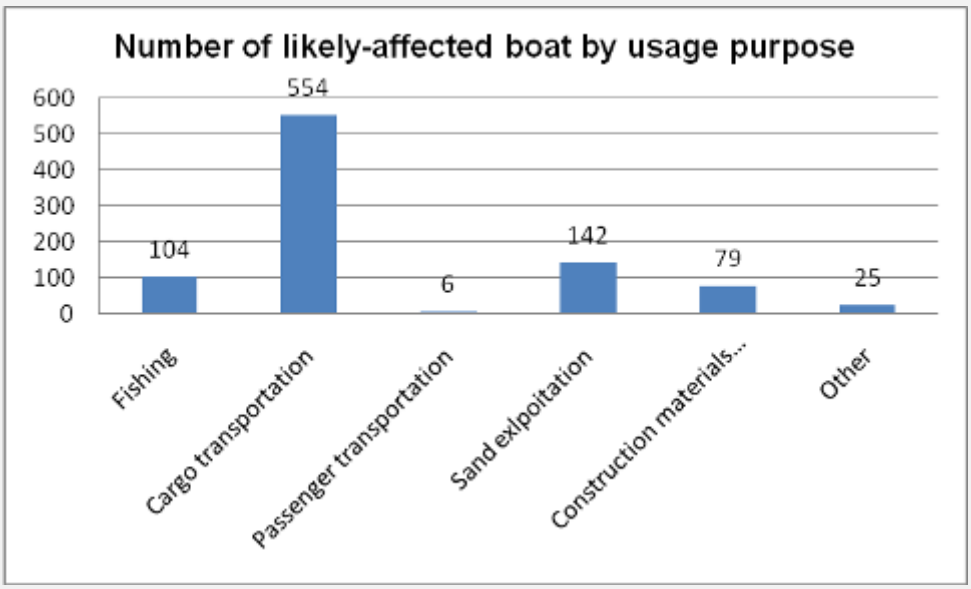


Figure 3 - 2: Estimated numbers of likely-affected boats by usage purpose

Source: JICA B-SWAMP survey team (2016)

iii. Trip frequency

Table 3 - 27: Estimated numbers of likely affected boat by monthly trip frequency

No.	District / City	Commune	Estimated numbers of the likely affected boat by monthly trip frequency		TOTAL
			≥ 15 times	< 15 times	
1	Bến Tre City	Nhơn Thạnh	3	7	**10**
2		Phú Hưng	8	9	**17**
		Total of district	***11***	***16***	**27**
3	Châu Thành	An Hóa	3	5	**8**
4		Tam Phước	7	1	**8**
5		Tường Đa	1	0	**1**
6		An Khánh	0	0	**0**
7		Giao Hòa	8	4	**12**
8		Hữu Định	0	0	**0**
9		Phước Thạnh	0	0	**0**
10		Giao Long	0	0	**0**
11		An Phước	0	0	**0**
12		Phú An Hòa	0	0	**0**
13		Châu Thành Town	0	0	**0**
14		Tân Phú	3	3	**6**
15		Tiên Thủy	0	0	**0**
		Total of district	***22***	***13***	**35**
16	Bình Đại	Long Hòa	2	6	**8**
17		Long Định	0	5	**5**
18		Vang Quới Tây	0	0	**0**
19		Thới Lai	5	5	**10**

No.	District / City	Commune	Estimated numbers of the likely affected boat by monthly trip frequency		TOTAL
			≥ 15 times	< 15 times	
20		Châu Hưng	0	0	**0**
21		Phú Thuận	0	0	**0**
		Tổng huyện	***7***	***16***	**23**
22	Mỏ Cày Bắc	Tân Thành Bình	8	9	**17**
23		Hòa Lộc	31	41	**72**
24		Khánh Thạnh Tân	72	16	**88**
25		Tân Bình	12	5	**17**
		Total of district	***123***	***71***	**194**
26	Giồng Trôm	Lương Hòa	0	0	**0**
27		Phong Mỹ	18	4	**22**
28		Lương Phú	11	27	**38**
29		Tân Lợi Thạnh	10	12	**22**
30		Phước Long	17	7	**24**
31		Phong Nẫm	6	1	**7**
32		Lương Quới	0	0	**0**
33		Thuận Điền	18	16	**34**
34		Thạnh Phú Đông	8	12	**20**
35		Mỹ Thạnh	0	0	**0**
		Total of district	***88***	***79***	**167**
36	Mỏ Cày Nam	Định Thuỷ	35	9	**44**
37		Mỏ Cày Town	20	23	**43**
38		Đa Phước Hội	15	18	**33**
39		An Định	0	0	**0**
40		An Thới	6	20	**26**
41		Bình Khánh Đông	19	118	**137**
42		Phước Hiệp	48	81	**129**
43		Minh Đức	23	73	**96**
44		Hương Mỹ	9	4	**13**
45		Bình Khánh Tây	16	47	**63**
46		Thành Thới A	17	15	**32**
47		Tân Hội	27	54	**81**
48		An Thạnh	33	40	**73**
49		Thành Thới B	44	50	**94**
		Total of district	***312***	***552***	**864**
GRAND TOTAL			**563**	**747**	**1,310**

Source: JICA B-SWAMP survey team, 2016

iv. Load of boats

Table 3 - 28: Estimated numbers of likely affected boat by load

No.	District / City	Commune	Boat burden ≤ 100 ton	No.	District / City	Commune	Boat burden ≤ 100 ton

No.	District / City	Commune	Boat burden ≤ 100 ton	No.	District / City	Commune	Boat burden ≤ 100 ton
1	Bến Tre City	Nhơn Thạnh	8	26	Giồng Trôm	Lương Hòa	0
2		Phú Hưng	5	27		Phong Mỹ	13
		Total of dist.	***13***	28		Lương Phú	16
3	Châu Thành	An Hóa	6	29		Tân Lợi Thạnh	11
4		Tam Phước	0	30		Phước Long	16
5		Tường Đa	0	31		Phong Nẫm	4
6		An Khánh	0	32		Lương Quới	0
7		Giao Hòa	10	33		Thuận Điền	16
8		Hữu Định	0	34		Thạnh Phú Đông	8
9		Phước Thạnh	0	35		Mỹ Thạnh	0
10		Giao Long	0			***Total of dist.***	***84***
11		An Phước	0	36	Mỏ Cày Nam	Định Thuỷ	20
12		Phú An Hòa	0	37		Mỏ Cày Town	6
13		Châu Thành Town	0	38		Đa Phước Hội	22
14		Tân Phú	1	39		An Định	0
15		Tiên Thủy	0	40		An Thới	11
		Total of dist.	***17***	41		Bình Khánh Đông	28
16	Bình Đại	Long Hòa	4	42		Phước Hiệp	51
17		Long Định	2	43		Minh Đức	32
18		Vang Quới Tây	0	44		Hương Mỹ	9
19		Thới Lai	5	45		Bình Khánh Tây	24
20		Châu Hưng	0	46		Thành Thới A	18
21		Phú Thuận	0	47		Tân Hội	21
		Total of dist.	***11***	48		An Thạnh	53
22	Mỏ Cày Bắc	Tân Thành Bình	7	49		Thành Thới B	37
23		Hòa Lộc	16			***Total of dist.***	***332***
24		Khánh Thạnh Tân	37	**GRAND TOTAL**			**530**
25		Tân Bình	13				
		Total of dist.	***73***				

Source: JICA B-SWAMP survey team (2016)

Levels of impacts to waterway use households are determined based on the following conditions:

1) Low household income: Among the waterway users who will frequently pass the sluice gates, those waterway user households with low income would be significantly affected. The poverty line set by the Government of Vietnam (namely, VND 480,000/person/month or VND 2,000,000/household/month) is used as criterion

for the categorization. If such waterway users are currently passing by the planned sluice gate construction site more than fifteen (15) times per month (more than once in two days as average)), then their income would be significantly affected by the construction and operation of the sluice gate, and therefore, they could be categorized as waterway users eligible for support.

2) With or without navigation locks in the sluice gate: Among waterway users who are not categorized as low-income waterway users as mentioned in Step 1) above, waterway users who are currently passing the site of planned sluice gate with navigation locks would not be significantly affected, though it may take a certain more time for he/she to pass the gate during the dry season. Meanwhile, waterway users who are currently passing the site of planned sluice gate without navigation locks would be significantly affected, since they have to use the detour in the dry season.

3) Load of the boats: Among waterway users who are not categorized as low-income waterway users as mentioned in Step 1) above, and are frequently passing the site of planned sluice gate without navigation locks, those waterway users who has big boat(s) with capacity of more than 30 tons may use the detours, and may not be significantly affected. Meanwhile, among waterway users who has boat(s) with capacity of less than 30 tons would have difficulty in using the detours, and would be significantly affected if he/she needs to pass the site of planned sluice gates with frequency higher than the frequency defined in the following Step 4).

4) Frequency of passing: The more frequent passing by waterway transportation, the more adverse impacts to the users. Those who use the waterway each day will have more adverse effects. The results of the survey for waterway users showed that a lot of small vessels passing through the area of slucegates 2 times per day. There are 67 small boats with capacity under 10 tons, and 31 boats among these 67 boats passing through the area of sluicegates more than 15 times per month. These households will be affected significantly during operation stage of the sluicegates.

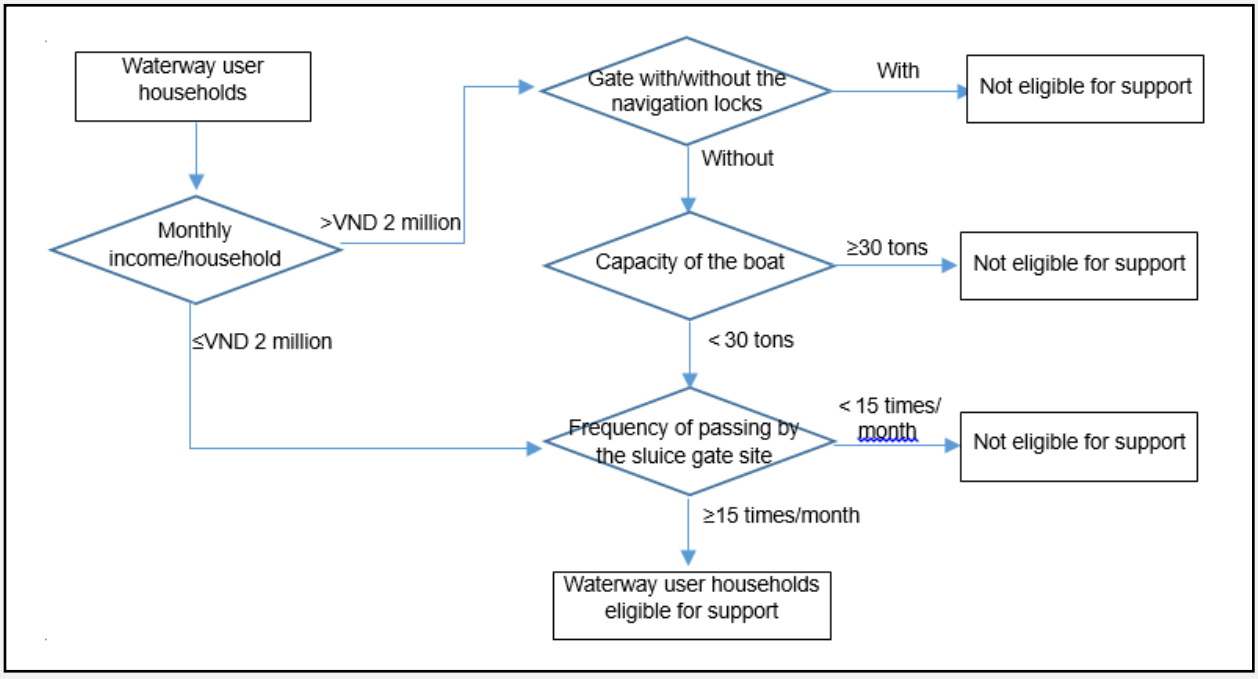


Figure 3 - 3: Classification of affected households by using waterway

Table 3 - 29: Results of categorization of waterway users

(Unit: Household)

District	Commune	Low income waterway user household	Waterway user household passing by the site for a sluice gate without navigation locks	Waterway user household whose boat's capacity is less than 30 tons	Waterway user household that passes by the sluice gate site more than 15 times/month	Household eligible for support	
						Low income waterway user household	
Tp. Bến Tre	Nhơn Thạnh	0	0	8	3	0	0
	Phú Hưng	0	0	5	8	0	0
Chau Thanh	An Hóa	0	1	4	3	0	0
	Tam Phước	0	0	0	7	0	0
	Tường Đa	0	0	0	1	0	0
	Giao Hòa	0	0	2	8	0	0
	Tân Phú	0	5	0	3	0	0
Binh Dai	Long Hòa	1	0	3	2	0	0
	Long Định	1	0	2	0	0	0
	Thới Lai	0	1	5	5	0	0
Mo Cay Bac	Tân Thành Bình	0	0	6	8	0	0
	Hòa Lộc	4	5	13	31	1	0
	Khánh Thạnh Tân	0	1	24	72	0	0
	Tân Bình	1	0	9	12	0	0
Giong Trom	Lương Hoà	0	1	9	9	0	0
	Phong Mỹ	0	16	13	18	0	11
	Lương Phú	0	3	14	11	0	0
	Tân Lợi Thạnh	0	12	7	10	0	3
	Phước Long	0	18	12	17	0	8
	Phong Nẫm	0	0	1	6	0	0
	Lương Quới	0	0	1	1	0	0
	Thuận Điền	1	13	16	18	0	5
	Thạnh Phú Đông	1	12	6	8	0	3
Mo Cay Nam	Định Thủy	3	3	17	35	1	0
	TT. Mỏ Cày	4	4	6	20	1	0
	Đa Phước Hội	2	2	17	15	0	0
	An Thới	3	2	9	6	2	0
	Bình Khánh Đông	4	61	22	19	1	5
	Phước Hiệp	5	46	44	48	1	4
	Minh Đức	4	44	28	23	0	4
	Hương Mỹ	1	0	9	9	0	0
	Bình Khánh Tây	2	36	22	16	0	5
	Thành Thới A	2	2	16	17	0	0
	Tân Hội	8	6	17	27	0	1
	An Thạnh	2	3	28	33	1	0
	Thành Thới B	3	2	31	44	2	0

District	Commune	Low income waterway user household	Waterway user household passing by the site for a sluice gate without navigation locks	Waterway user household whose boat's capacity is less than 30 tons	Waterway user household that passes by the sluice gate site more than 15 times/month	Household eligible for support	
						Low income waterway user household	
	Total	**52**	**299**	**426**	**573**	**10**	**49**

Source: B-SWAMP survey team, 2016

The potential impacts to waterway transportation users are identified include:

- *Impacts on waterway transporters*

In the discussions, the participants whose livelihoods are dependent on transportation of coconut, fruits, constructing materials and other goods expressed their concerns about the impacts of sluice gates on their income. Consistent closure of the sluice gates during dry season would cause difficulties for those regularly commuting through the planned sites for economic purposes. In some cases, the transporters have to wait for several hours to some weeks until the gates are opened, which would considerably affect productivity and turnovers of transportation service. For example, when a customer orders the carriage of building materials to their house, it will take far more time due to the interruption of transporting route by closing sluice gates, making him more reluctant to select the transportation service. Some transporters may choose to travel through different route, which will be more time-consuming and costly. At worst, many transporters will have no alternative route for their transportation, and their livelihoods could totally suspended by the gate closure. The negative impacts not only include reductions in household income, but also unemployment and other social consequences.

- *Impacts on fishermen*

Fishermen are also likely to be impacted by the sluice gates. In addition to the blocking of travelling route, closing the gates also impede the natural flow of rivers/canals. Therefore, some people are concerned by the possibility that the movement of migratory fishes to the breeding and feeding habitat might be interrupted, resulting in the shrinking of fish stocks. Many fishermen, who use the *đáy* system (fishing gear with stationary poles to catch fish moving in the direction of the water flow), are worried that the gate closure will hinder water flow and make their fishing gear no longer working. Finally, the income and living standard of fishermen and their families may be strongly vulnerable to the project.

- *Other impacts*

Besides impacts to boat transporters and fishermen, the project might also have some direct and indirect negative impacts on the livelihoods of local people. Traders and enterprises, similar to fishermen, might be confronted by some difficulties in transactions of goods due to the closure of gates. Farmers, whose agricultural products

are purchased and collected by traders/transporters commuting in the waterway, are probably affected by the higher cost and time of transportation.

c. Impacts on air environment

When the reinforced concrete bridges and bridge approach roads connecting to the existing routes in the area are put into operation, the density of traffic vehicles on the riverbanks will grow, leading to increases in emissions, dust and noise generated into air environment. However, these impacts are negligible as the project area is rural area; hence, the transport needs are not high. Also, traffic vehicles are mainly bicycles, motorbikes that do not cause much emissions.

d. Impacts on surface water environment

The increase in production due to favorable conditions brought by the project in addition to the existing production modes that are slow in applying technological and scientific progresses and increasing use of chemical products (fertilizers, pesticides, etc.) are factors causing surface water contamination.

Along the irrigation system, after completion, it will contribute to the formation of residential areas and economic development, which might cause pollution to water quality in the project area.

Washing, cooking, and discharging wastewater into water sources will also contribute to increasing organic matters in the water, thus affecting the quality of water sources.

In general, the impacts of 11 sluicegates of the project on water quality are small as people are encouraged to preserve and use properly fertilizers and pesticides. Moreover, environmental protection advocacy and awareness raising activities for people are also conducted in the area.

According to the agriucltural development orientation in the area when the works are in place, in 2020, the aquaculture area will increase by 3,117 ha. If the ponds are not managed as planned, in addition to the cleaned pond water that contains a large amount of BOD, COD, and TSS without treatment and directly discharged into the canals and main rivers, water in canals and rivers will be polluted. Particularly, in the dry season, as the sluicegates are closed to prevent salinity, water are not circulated and at the same time still receives a large amount of wastewater from residential areas, fields, aquaculture and processing facilities, etc., the pollutants are not diffused into the river may increase and cause severe pollution, affecting the water quality for production and domestic use. In the rainy season, due to much rain water and the regular opening of sluicegates, the pollutants in the water are diluted. This phenomenon has been observed at Ba Lai sluicegate and dam work.

e. Impacts on groundwater environment

The increased use of chemical fertilizers and pesticides after the project is completed and puts into operation, if not used properly and reasonably, will also affect the quality of shallow layer of groundwater.

As the items of the project's headworks will interrupt the flow of rivers, fields, inundated area, etc. and thus alter the flow and impede the drainage in rainy season. It will not only alter the hydraulic power of the surface water but also change the permeability of water into soil, affecting the groundwater.

f. Impacts on soil environment

According to scientists, the excessive use of chemical fertilizers in agricultural production on the field and in the orchards makes the soil hardened, increasing soil compaction, reducing the softness, absorption of roots and soil, and permeability, leading to the increase in the storage of plant protection substances in the soil environment. In addition, it will reduce useful microorganisms to the soil, weakening the mineralization process in the soil; therefore, in the long term, soil quality will be diminished.

In the areas where aquaculture will be expanded due to advantages such as Binh Dai and Giong Trom, as trees are cut down to build ponds, the coverage will be reduced or completely disappear. Hence, it will affect the habitat of the microorganism decomposing organic matter to create humus, reducing the organic decomposability, gradually depleting nutrients. Along with the accumulation of impurities due to decomposition of waste food and waste from shrimp farming, the soil environment in this area will be polluted. Moreover, the digging of ponds for shrimp culture has unintentionally brought acid source to the surface and the soil will gradually be acidified.

g. Impacts on biological resources and biodiversity

Alter the migratory habits of some fishes and other aquatic species:

In the ecosystem of coastal estuaries, there are many aquatic species, especially fishes and shrimps, often migrate to forage for food sources and spawning grounds. This migration is completely dependent on water quality, food sources as well as habits of each species. When the project is not implemented, many species from the brackish water area of coastal estuaries will migrate landwards into freshwater with river flow and tidal salinity intrusion. At the same time, many freshwater species will migrate to the estuary area to forage for food when freshwater pushes saltwater away. However, when the project is implemented and sluicegates are put into operation, it will affect the habits as well as migration scope of the species:

- *As for brackish species:* As the work is built with the goal to prevent salinity, when salinity level increases, sluicegates will be closed to prevent the intrusion of saltwater into infield area from affecting agricultural production activities. It means that the foraging area of brackish water species such as some fishes, particularly anchovy, seabass, mullet, sillago, etc., that could enter into the fields for foraging under salinity intrusion before are now limited within the downstream area of the sluicegates.
- *For migratory species from saltwater to freshwater areas:* The intrusion of tide adds more food sources as algae, polychaete worms for shrimps and fishs in freshwater areas near estuary. However, when the gates close, food sources of the fishs and shrimps are limited and their migration to the areas outside the

gates is obstructed. Fish species migrating from saltwater into freshwater areas likely to be affected include fish such as warts, mullet, alum fish.

Impacts on aquatic ecosystem in the upstream area

When the project is not implemented (no salinity intrusion prevention sluice gates), salinity level of river water constantly changes according to seasons and extent of saltwater intrusion is completely dependent on the flow regime and hydrology of the river. Meanwhile, salinity is considered an ecological factors that have a very narrow margin limits for aquatic species. So, in these areas, composition and number of species (or biological diversity) is always changing. The infield habitat of brackish species will be lost when the works come into operation. However, these species will exist in the areas outside the sluicegates.

h. Impacts on river sedimentation

When the salinity control sluicegates are closed, water cannot be circulated, the flow velocity on the rivers and canals will be reduced, some areas even become still waters, sediments, thus, have time to deposit. Besides, along with the development of aquaculture as one of the objectives of the project, if the fish and shrimp farming activities are not managed as planned, the volume of sediments caused by pond digging and aquaculture directly discharged into the rivers will increase the elevation of infield canal bottom.

3.1.3.3. Impact assessment from the results of MIKE 11

With the specific purpose of North Ben Tre irrigation system to assess the hydraulic regime and drainage of the project, the research team has conducted the analysis and computation of hydrology and hydraulic regime of the project. MIKE 11 is therefore used as the hydrological and hydraulic analytical and computational tool.

Results are analyzed based on the distribution of water level in the Mekong Delta region under different scenarios. These results are presented on the water level distribution map and highest (i.e. max) water level value at the key positions such as (i) some salinity measurement stations at Cau Quan, Tra Vinh, Huong My, Son Doc, Loc Thuan; (ii) the locations of 8 sluicegates to be built.

a. Assessment of variation of dry season's flow

In case sluicegates are closed (including the expected salinity prevention sluicegates of the project) for preventing salinity intrusion, the water level of the main rivers such as Co Chien, Ham Luong and Cua Dai does not change significantly (tends to increase but not exceed 1cm) with or without project as this area is mainly influenced by East Sea tide.

At Ba Lai River in the upstream of Ba Lai sluicegate, the water level changes significantly due to the closure of An Hoa, Ben Tre, Ben Ro and Tan Phu sluicegates. Normally, without the project, the tidal amplitude in this area ranges from 1 to 2.5m. When the sluicegates are closed, the tidal amplitude is reduced to 0.5-1.5m.

Similarly to the main rivers, when the sluicegate opens, water level on Ba Lai River does not change from the status quo. When the gates are closes, the water level changes significantly.

b. Flow distribution

When the salinity intrusion sluicegates are closed (including the expected sluicegates of the project), the flow through the sluices is no longer available. The water supply in the project area depends on water from upstream area, thus the flow in the area decreases.

As the area is not enclosed, in some areas such as the North of Ben Tre River including Song Ma, Thanh Kieu, Luong Cai canals, the flow will increase highly when the sluicegates of the project are closed to prevent salinity intrusion.

c. Distribution of salinity intrusion and salt concentration

Salinity in main rivers mainly depends on tide and flow in the upstream area. According to the simulation scenarios, salinity will significantly change and intrude when sea level rises, reducing the upstream flow. The computational results show that:

- Salinity intrusion will be stronger in case of changes in upstream and downstream. With regards to climate change, its impacts on the estuaries are almost the same.
- As for the salinity control system in the area between Co Chien and Ham Luong rivers, salinity has intruded Cai Quao and Mo Cay Bac entering into freshwater supply canal, causing difficulties for agricultural production. In Co Chien River, salt concentration of 4 grams per liter has intruded near Mo Cay Nam sluicegate. As for the salinity control system in the area between Cua Dai and Ham Luong rivers, salinity has intruded into Thu Cuu River and even Ben Tre River entering into freshwater supply canal, causing difficulties for agricultural production. In Cua Dai River, salt concentration of 4 grams per liter has passed An Hoa River and entered My Tho. As such, in the present context, the construction of Thu Cuu, An Hoa, Cai Quao sluicegates should be given priority while Mo Cay Bac and Ben Tre sluicegates can be built after.
- Under the scenario of climate change until 2050 and 2100, salinity will intrude deeper into the project area of Ben Tre Province.
- Under the scenario of climate change until 2100 and taking into consideration of the variation of upstream flow, the entire prevention system will be significantly threatened.
- After the 8 head-works are completed and put into operation, salinity will be controlled in most of the project area. However, in the North of Ben Tre River, the estuary canals (Song Ma, Thanh Kieu, Luong Cai canals) from Ben Tre River to Ben Ro River have not been built (small-scale works are invested by the local authorities); therefore, if these are not closed, salinity will intrude into the freshwater area, affecting agricultural production activities.
- The effects of the construction of salinity control works of the project will reduce the intrusion speed on the main rivers. On Cua Dai River, salt concentration tends to increase by 0 to 0.24 g/l. On Ham Luong River, salt concentration tends to increase in the upstream area of Ben Ro sluicegate by less than 0.84 g/l; however, to the downstream area, the concentration reduces

slightly from 0 to 0.4 g/l. On Co Chien and Hau rivers, salt concentration tends to reduce when the salinity control facilities are built. The reduction rates are not much, at Bong Bot sluicegate, the concentration deacreases by about 0.4 g/l and at Vung Liem sluicegate, salt concentration reduces by about 0.22 g/l.

- Hence, it can be realized that the impacts of 8 sluicegates on the salinity in the major rivers are not significant. The salinity intrusion boundary does not change remarkably. Salt in the protection area of the sluicegates are guaranteed when building the works.

When taking into consideration both climate change and reduced upstream flow, the sluicegatesystem of the project is still effective in preventing salinity intrusion, except for the area of Hau River. If upstream flow decreases quickly, the area surrounding Hau River will be affected most significantly; salinity can pass Tan Dinh sluicegate and enter the North of the project area through open canals. However, at that time, building more canals in this area can control salinity for the entire system.

According to the computational and analytical results, with regards to salinity control, the priority given to the sluicegates of the project is in the following order: Cai Quao, An Hoa, Mo Cay Bac, Ben Tre, Mo Cay Nam, Ben Ro and Tan Phu. It is proposed to build three sluicegates in the North of Ben Tre River to Ben Ro River after Ben Tre sluicegate is built. A number of other small sluicegates will be developed by the locality according to the actual production needs of people.

Table 3 - 30: Comparing salinity levels in fields and rivers before and after the completion of headworks *(unit: ‰)*

No.	Locations of sluicegates	Current state		With project		Difference	
		River	Field	River	Field	River	Field
1	Tan Phu	0.63	0.56	0.71	0.38	12.0%	-31.5%
2	Ben Ro	0.72	0.67	1.56	0.44	116.7%	-34.3%
3	An Hoa	10.85	10.57	11.09	1.07	2.2%	-89.9%
4	Ben Tre	4.99	3.69	3.07	0.80	-38.5%	-78.3%
5	Vam Nuoc Trong	8.14	5.90	7.81	0.13	-4.1%	-97.8%
6	Thu Cuu	10.28	7.66	9.88	0.30	-3.9%	-96.1%
7	Cai Quao	10.28	8.89	9.88	0.04	-3.9%	-99.6%
8	Vam Thom	4.08	3.54	3.94	0.04	-3.4%	-98.9%

The above results show that prior to the construction of works, the salinity intrusion is quite high at the area of An Hoa, Thu Cuu and Cai Quao sluicegates, where the salinity level in river ranges from 10.28‰ to 10.85‰ and in field from 7.66‰ to 10.57‰. Particularly at the area where An Hoa sluicegate is expected to be built, the salinity difference in the fields and rivers is very small (10.57‰ and 10.85‰, respectively). As recommended by Ben Tre pDARD, salt-tolerant fruit-tree groups including mango trees, sapodilla, and coconut trees can only tolerate salinity from 2‰ to 5‰. Therefore, in the communes where An Hoa, Thu Cuu and Cai Quao sluicegates are built, including Long Dinh, Giao Hoa, Phuoc Long, Thanh Phu Dong and Binh Khanh Dong communes, it is impossible to grow any fruit tree near the rivers.

After the construction is completed, salt water will be prevented outside the sluicegates; the salinity of water infield will significantly reduce. Salinity will be

decreased by 99.6% in Cai Quao sluicegate area. Infield water thus has salinity to ensure agricultural production (0.04 to 1.07‰). Even for salt-sensitive trees such as durian, rambutan, mangosteen, etc. (when watering salt-contaminated water 1‰, it will stunt growth and cause leaf burn), they can also be planted and developed well in the project communes after the construction is completed.

d. Flood control:

According to hydraulic simulation results, the maximum water level in Cao Lanh is 2.58 m, in Can Tho is 2.17 m and Tra Vinh is 1.76m.

Compared to the current state (Scenario9) and in case of the work completion (Scenario10), the water level of the main rivers in the project area does not increase much, only by 0.01m to 0.04m. In the scenario in 2050 (Scenario11), the water level of main rivers increases by 0.2m to 0.3m. And under the scenario of 2100 (Scenario12), the water level of main rivers will increase by 0.33m to 0.41m.

The infield water levels at some locations are as follows:

Table 3 - 31: Infield water levels according to four scenarios

No.	Measurement station	Simulated water levels in the fields (m)			
		Scenario9	Scenario10	Scenario11	Scenario12
1	Ben Tre	1.70	1.01	1.12	1.25
2	Mo Cay	1.74	1.15	1.25	2.45
3	Cang Long	1.73	1.74	1.96	2.37

Based on the flood simulation results according to different scenarios, flood risk map (FRM) is prepared with terrain data from digital elevation map (DEM) 15mx15m with the highest water level Hmax for the simulation period from July 10 2011 to November 30 2011. The results of FRM development in the project area according to each scenario are calculated as follows:

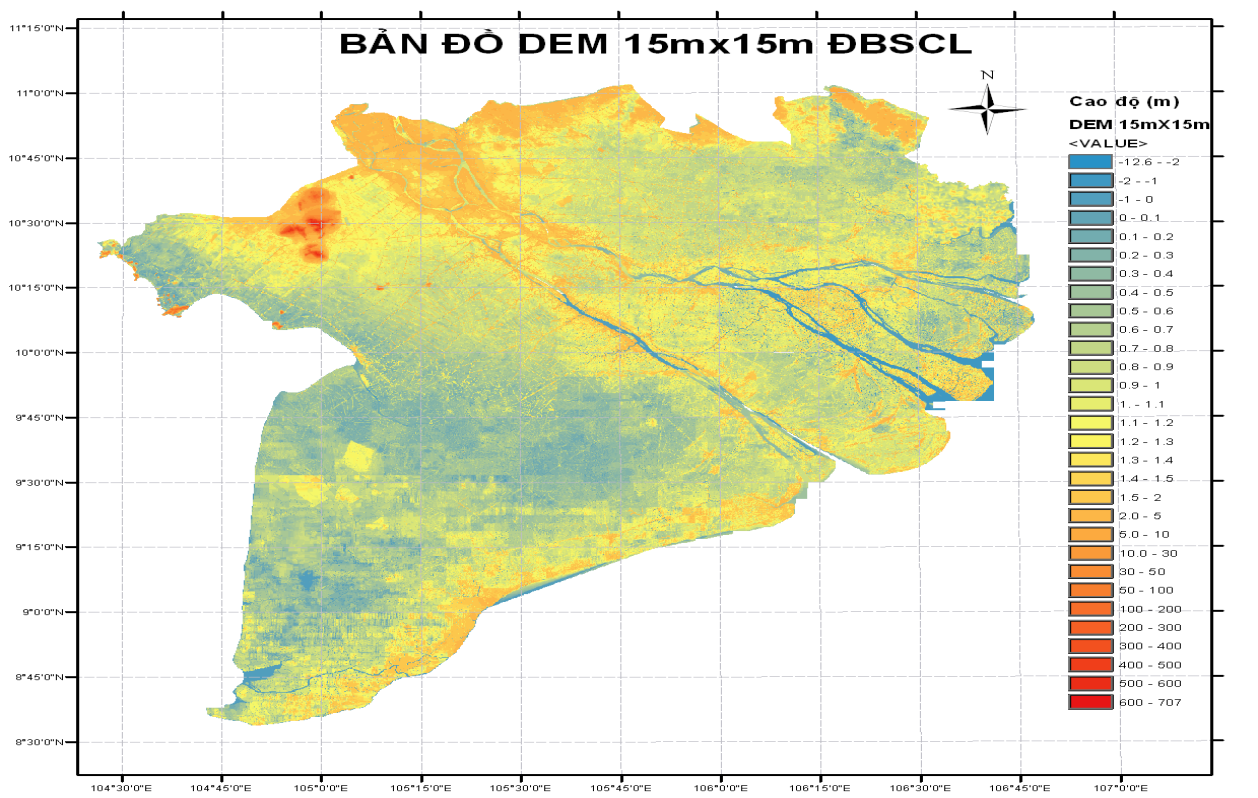


Figure 3 - 4: Mekong Delta DEM 15mx15m

Table 3 - 32: Inundated area according to different scenarios

No.	Inundation depth (cm)	Inundation area (km^2)			
		Scenario 9	Scenario 10	Scenario 11	Scenario 12
1	1-20	575	455	332	205
2	20-40	795	565	398	229
3	40-60	1,087	820	502	282
4	60-80	900	686	789	362
5	80-100	667	494	765	507
6	100-120	486	367	575	832
7	120-140	339	408	427	818
8	140-200	234	576	832	1.475
9	200-300	184	196	149	271
10	300-420	144	126	216	257
11	420-448	0	0	0.10	0.23
12	448-489	0	0		0.0027
	Total area of inundation	**5,410**	**4,693**	**4,985**	**5,237**

The percentages of inundation area according to each scenario are presented below:

Table 3 - 33: Percentage of inundation area according to different scenarios

Inundation depth (cm)	Percent of inundation area (%)			
	Scenario 9	Scenario 10	Scenario 11	Scenario 12

1-20	10.63	9.69	6.66	3.91
20-40	14.69	12.04	7.98	4.37
40-60	20.09	17.47	10.07	5.38
60-80	16.64	14.61	15.83	6.90
80-100	12.32	10.52	15.35	9.68
100-120	8.98	7.81	11.54	15.89
120-140	6.27	8.70	8.56	15.63
140-200	4.33	12.28	16.69	28.16
200-300	3.40	4.18	2.99	5.18
300-420	2.65	2.69	4.33	4.91

The computational results show that in the project area, if the sluicegate and closed ring dyke system is not built, the area facing the risks of inundation, when calculating with 2011 flood, accounts for 74% to 85% of the natural area in the project area. When climate change is taken into consideration, the area with deep inundation risk increases. Under the scenario in 2050 (Scenario11), the area that is deeply inundated from 80cm to 200cm is 2,600km2, accounting for 52.1 percent of the inundated area and 30.7 percent of natural area. Under the scenario of 2100 (Scenario12), the area that is deeply inundated from 80cm to 200cm is 3,632km2, making up 69.4 percent of the inundated area and 56.9% of the natural area.

e. Impacts on water quality

When the works are not constructed: The current distribution of water quality in the project area is not even; the areas which are most affected are urban and densely populated areas such as Ben Tre City, Cho Lach, Mo Cay, Ba Tri, Thanh Phu, and Chau Thanh in Ben Tre province. BOD concentration in the project area ranges from 6 to 19 milligrams per liter. The content of total N in the project area ranges from 0.42 to 1.6 milligrams per liter. The content of total P in the project area is from 0.1 to 0.31 milligrams per liter. In general, the surface water quality meets the B1-B2 standard according to the National Technical Regulation QCVN08:2008/BTNMT.

When the works of the project come into operation: When the construction of works is completed and put into operation, the distribution of water quality in the project area tends to increase due to less water exchange capacity. The areas that are most affected are urban and populated areas such as cities. The BOD concentration is the project area ranges from 6 to 23 milligrams per liter, increasing by 4 milligrams per liters compared to the current level. Total N content in the area is from 0.42 to 2.6 milligrams per liter, increasing by 1 milligram per liter compared to present. Total P content in the project area ranges from 0.1 to 0.46 milligrams per liter, increasing by 1.5 milligram per liter compared to the current level. In general, surface water quality still meets the B1-B2 standard according to the National Technical Regulation QCVN08:2008/BTNMT.

Table 3 - 34: Comparing changes in BOD, N, and P contents before and after work construction

Unit: (mg/l)

N^0	Location	BOD		Total N		Total P		BOD		Total N		Total P	
		Outside	Inside	Outside	Inside	Outside	Inside	Outside	Inside	Outside	Inside	Outside	Inside
1	Tan Phu	3,00	3,64	0,67	0,84	0,11	0,11	2,97	3,82	0,65	0,94	0,10	0,13
2	Ben Ro	7,34	7,30	2,32	2,15	0,21	0,20	7,32	7,56	2,30	2,35	0,20	0,22
3	An Hoa	2,83	3,26	0,62	0,76	0,11	0,11	2,70	4,03	0,60	1,01	0,10	0,12
4	Ben Tre	8,05	6,11	2,39	1,67	0,20	0,16	12,74	9,80	3,73	2,34	0,29	0,20
5	Mo Cay Bac	2,71	4,00	0,61	1,54	0,09	0,12	2,70	5,60	0,56	1,74	0,08	0,15
6	Thu Cuu	2,78	3,53	0,58	0,87	0,11	0,11	2,59	4,61	0,54	1,21	0,10	0,13
7	Cai Quao	2,78	5,55	0,58	1,47	0,11	0,15	2,59	9,61	1,43	2,70	0,10	0,25
8	Mo Cay Nam	3,35	5,90	0,73	1,40	0,13	0,17	3,32	7,00	0,74	1,47	0,12	0,19
9	Vung Liem	3,34	5,39	0,73	1,37	0,13	0,16	3,30	6,32	0,72	1,65	0,12	0,22
10	Tan Dinh	3,27	3,45	0,71	0,76	0,12	0,12	3,17	9,54	0,71	0,78	0,12	0,14
11	Bong Bot	3,56	4,93	0,76	1,24	0,13	0,15	3,29	5,44	0,75	1,76	0,12	0,24

2.1.4 Impacts due to risks and incidents

When the project comes into operation, the environmental risks and incidents that may happen include the following types:

- Damage to sluicegate
- Damage to traffic road
- Road accident

a) Damage to sluicegate

As analyzed above, risks and incidents may arise are the concerns of the project. Risks and incidents happening during operation are mainly derived from subjective causes; sometimes there are objective reasons. The reasons that might lead to risks and incidents are:

- The technical quality of the works is not guaranteed from the beginning;
- Operation of work is not carried out according to regulation;
- Regular maintenance activities do not comply with regulation;
- Not comply with processes in repair and maintenance of sluicegates.
- People lacking awareness of protection of the works;
- Creatures stick to the sluicegate causing difficulties for operation, even causing damage to the sluicegate.

Damage incidents to sluicegates are among the most serious incidents in terms of environment, causing adverse impacts on the ecosystem and socio-economic

activities in the area affected by the incident, especially when the ecological environment has been freshened.

If sluicegate is damaged, salinity from main rivers will quickly enter into the water environment in the fields. Salt water will immediately interact with every aspect of the environment, leading to severe consequences. The spread of salinity in water is controlled by four physical, chemical and biological processes as follows:

- Transmission process
- Spreading process
- Dispersion process
- Dissolving process

Results of four above listed processes change the characteristics of three fundamental environmental components which are water, air and soil environment, and then affect a range of other environmental factors and people; finally, affecting socio-economic activities. Typical impacts caused by the incidents are:

- Affecting flora including rice, crops, fruit trees;
- Causing depletion of freshwater aquatic sources in the area, directly affecting aquaculture of people in the area;
- Causing salt accumulation on the surface, contaminating soil environment, etc.

b) Damage to traffic road

The causes is these incidents can be the following:

- The quality of construction work does not meet technical requirements;
- Maintenance and protection of bridge are not well carried out;
- Due to direct impacts of extreme climate such as large rainstorm, heavy flooding combined with storm, etc.

Basically, the impacts of this incident are similar to those described in case a).

c) Road accidents

Traffic accidents can cause losses of properties and lives. The reasons can be that transport vehicles do not meet technical standards or the drivers do not pay attention or do not comply with traffic safety regulations. Especially when the bridges on 11 sluicegates are completed, the traffic flow will certainly rise. However, these incidents can be completely prevented.

2.2 COMMENTS ON LEVEL OF DETAILS AND RELIABILITY OF THE ASSESSMENTS

The report has conducted analyses and assessment on the environmental impacts in terms of dust, noise, emission gas, wastewater, and solid waste, during preparation, construction, and operation phases of the project. The assessments presented in this EIA Report are based on the legal, scientific documents with high validity and accuracy. Assessments on effect sources are based on the calculations from the actual project and normative documents on the effect sources (WHO).

The formula used for calculation are drawn by the experts in different

specialized fields from experimental works. However, some assessment is at forecast level. Thus during operation process, based on updated monitoring data, these forecasts need to be adjusted.

The level of details and reliability of the methods used are shown in the Table below:

Table 3 - 35: Reliability of the EIA methods used

No.	Method	Reliability	Reason
1	Survey and measurement methodology on site	Relatively high	Coordinating with the local population and local authorities, project planning survey unit, the EIA Team has established an overview of the location, topography, ecology and the factors related to the project.
2	Analysis method in laboratory	High	The environmental indicators ensure reliability as they are measured/analyzed using modern equipment with high accuracy. The analysis is performed by highly qualified and experienced graduates. The sampling locations ensure relative representativeness of environmental components surveyed.
3	Statistics method	High	Series of meteorological data, socio-economic statistics from specialized agencies and units; therefore, the statistical data is highly reliable.
4	Comparison method	Relatively high	Quantitative results of wastes are compared with allowable limits regulated in the National Technical Regulations and Vietnam Standards as the basis to assess the pollution degree.
5	Data inheritance method	Relatively high	The documentation and data are inherited from the references with relative reliability.
6	Sociological survey method	High	Based on official opinions in written document by the CPCs and VFFs of 19 communes in the area, combined with face-to-face interviews with PAHs. So this method has high reliability.
7	Forecast method	Average	Rapid assessment method of pollution sources is mainly based on the methodology which is recognized and widely used like rapid assessment method published by WHO, EPA, IAEA and UNIDO in 1993, and others methods published by environmental agencies/organizations from 2001 to the present. Environmental forecasting method mainly relies on the information collected as well as qualifications and experiences of the experts participating in the EIA, combined with consultations with environmental experts who have several years of experience. Thus, the reliability of the assessments is acceptable.
8	Expert consulting method	High	Consulting specialists in the field of environment who have considerable experience; therefore, the method has high reliability.

2.3 GENERAL ASSESSMENT OF IMPACTS

After analyzing the impacts of the project on environmental factors separately, contents of the effects described above can be seen clearly. To describe the scope and objects of impacts, impact assessment is conducted corresponding to the objects and the impact scope by environmental matrix method.

Environmental matrix method is listing the development activities of the project together with the elements of natural resources and environment may be affected. In this matrix, natural resources and environmental elements are arranged on the vertical axis and the development activities of the project are located on the horizontal axis (see table below).

Natural resources and environmental elements include:

- Physical factors: including water resources, climate, air, soil environment;
- The biological resources (biological factors): vegetation, aquatic systems;
- Social factors, resources and environment (related to human) such as public health, socio-economic, environmental landscape;

The development activities of the project include:

- Activities during the preparation and construction: site clearance, transport of materials, construction, canal dredging and improvement, etc.
- When the project is put into operation: project activities, the effect sources, environmental incidents, etc.

Actions affecting resources and environmental factors will be marked in the corresponding columns of the matrix with the characteristic signs indicating the degree and significance of the impacts. The degree of the impact of these actions are assessed in 6 levels: unknown impact (kr); no significant impact (0); positive impact (+), significantly positive impact (++); negative impact (-); significantly adverse impact (--).

Thus, it can be seen that Ben Tre water management Project when implemented will cause some positive and adverse impacts, in which, the long-term positive impacts are predominant.

All of the impacts listed (specifically in the matrix table below) can be minimized through an environmental management and monitoring program.

The positive impacts of the project are clearly observed in controlling, regulating salinity, improving and expanding cultivation and aquaculture area. Thereby, employment and income opportunities of the people of this region will increase, contributing to poverty reduction.

The project is evaluated to not cause negative impacts on terrestrial ecosystem, species that are rare and threatened with extinction, biodiversity, nature reserves, and protected areas. However, it is concerned that the impacts on the ecosystem and biodiversity of aquatic species are clear and thus appropriate mitigation measures are required both in short term during construction phase and long-term during operation period.

During the construction process, some problems will arise such as dust, noise due to earthwork, machinery, waste materials from the construction site, especially the

problems of residual soil and dredged sludge. However, the above problems will be minimized during implementation process.

Table 3 - 36: Project's environmental impact assessment matrix

Activities	Construction phase				Transition	Operation phase		
	Construction of salinity prevention sluicegates	Influx of workers	Building sluicegates, locks	Filling and excavation activities		Opening and closing sluicegates	Main-tenance	Dredging sediments at the sluicegates
Environ-mental elements								
1. Physical factors								
1.1 Exogenous processes								
Collapse, landslides	0	0	-	-	0	0	Kr	Kr
Sedimentation process of rivers and canals	-	0	-	-	0	-	0	Kr
Soil erosion process	0	0	0	0	Kr	Kr	0	Kr
1.2 Geology, seism								
Minerals	0	0	0	0	0	0	0	0
Groundwater	0	-	-	Kr	Kr	0	Kr	Kr
Induced earthquake	0	0	0	0	Kr	0	0	0
1.3 Soil								
Surface erosion process	0	0	0	0	0	++	0	+
Soil restoration process	0	0	0	+	0	++	+	+
1.4 Cimate								
Temperature	0	0	0	0	0	+	+	+
Humidity	0	0	0	0	0	+	+	+
Noise	-	-	-	-	0	Kr	Kr	-
Air quality	0	0	-	0	0	+	+	0
1.5 Hydrology								
Flow change	Kr	0	Kr	+	Kr	Kr	0	Kr

Activities	Construction phase				Transition	Operation phase		
	Construction of salinity prevention sluicegates	Influx of workers	Building sluicegates, locks	Filling and excavation activities		Opening and closing sluicegates	Main-tenance	Dredging sediments at the sluicegates
Surface water quality	-	-	-	-	0	0	0	+
2Biological factors								
2.1 Vegetation	0	0	0	0	0	-	-	Kr
2.2 Aquatic species	-	-	-	-	0	-	-	-
2.3 Fauna and rare species	0	0	0	0	0	0	0	0
3. Social factors and environmental resources								
3.1 Employment	-	+	+	+	0	++	++	++
3.2 Landscape	+	0	0	0	0	++	++	++
3.3 Transportation	-	0	++	+	+	+	+	+
3.4 Local industrial development	kr	0	+	+	+	++	++	++
3.5 Agricultural and aquaculture development	-	0	-	-	0	++	++	++
3.6 Public heath	0	-	-	0	0	++	++	++
3.7 Residential activities	0	-	-	-	+	++	++	++
3.8 Cultural and historic relics	0	0	0	0	0	0	0	0

Remarks: (0) = No impact; (-) = Adverse impact; (+) = Positive impact; (kr) = Unknown

CHAPTER 3
MEASURES FOR PREVENTION, MITIGATION OF ADVERSE IMPACTS, RESPONSE TO ENVIRONMENTAL INCIDENTS

3.1 MITIGATION MEASURES OF ADVERSE IMPACTS

3.1.1 Design stage

Develop alternatives of the locations and design of salinity prevention structures, locks, traffic dykes, and access roads of 8 headworks to ensure effective salinity control, provision of freshwater, maintain waterway traffic, ensure environmental flow and minimize adverse impacts on the natural habitats of species as well as local communities in the project area.

All of the design dossiers of the project will be in compliant with technical regulations and bidding document/contract requirements. The preparation of bidding document/contract includes environmental impact mitigation measures and environmental monitoring plan.

a) Prevention of unexploded ordnance risks

Ben Tre served as fronts in the war, many bexplosive objects were thrown to the area. It may remains explosive objects remaining from war in the areas under construction. It needs to conduct demining in all 8 construction locations. Project management board must prepare a demining plan and UXO clearance must be conducted by a functional unit before proceeding with construction.

b) Mitigation measures during site clearance

Minimizing impacts on land use, resettlement and income of the affected households

- To survey accurately the land area eligible for compensation and assistance; conduct consultations with stakeholders on issues related to the communities; analyze common and individual benefits of the communities brought by the project;
- To disseminate prevailing policies and regulations of the government as well as Ben Tre, Tra Vinh and Vinh Long PPCs on compensation and assistances for affected land and assets;
- To provide compensation and assistances for affected people with the principles: to contribute to improving the living standards of affected people better than pre-project level and ensure their participation in compensation and assistance process. The resettlement policies applied to the project will harmonize the requirements of JICA (safeguard policies) and GoV's regulations. The principles of resettlement policies of the project include:
    - All those affected, regardless of ownership status, socio-economic status, will be provided with compensation and supports for the loss of property, income and production-business activities at replacement cost and restoration of living standards, income and production capacity to the pre-project level.

  - Land prices to calculate compensation (compensation, assistances) are determined close to the land use right transfer cost in the market under normal conditions. When there is a difference compared to the actual price of land use right transfer in the market, it must be adjusted accordingly.
  - Compensation for affected houses and structures at the value of new construction of houses and structures that have technical standards equivalent to the houses'.

- To disseminate broadly about the economic development and compensation policies of the government to local communities. Disseminate about the implementation in accordance with rights and duties and laws. Disclose compensation rates (details of each affected asset) to the affected people. Disclose and inform accurately the compensation amount of each household.
- To support vocational training for members of the severely affected households due to land acquisition for the project.

Minimizing impacts on air environment

- Gathering and collection of waste due to demolition of works, structures and clearance of trees around the construction sites;
- Spraying water the demolition area to minimize dust;
- Providing regulation on demolition time, site leveling and transport of demolished materials to avoid the resting time of local communities (allowed time is from 6AM to 6PM);
- The transport trucks must have covering canvas.

Minimizing impacts on water environment

- Gathering and collection of waste due to demolition of works and structures and clearance of trees around the construction sites, avoid disposing into rivers and streams;
- Controlling the quality of vehicles and machines participating in demolition and transportation, avoiding oil scattering on the demolition site;
- The material transport trucks must have covering canvas.

Minimizing impacts on soil environment

- Gathering and collecting waste due to demolition of structures and clearance of trees around the project site;
- Limiting the loading and speed of the vehicles and machines participating in demolition and transportation.

Minimizing impacts on ecological environment

- Measuring accurately the scope of site clearance to minimize the number of trees to be cut down;
- It is strictly forbidden for the units responsible for filling to dispose waste including waste soil, plant materials into the flow, especially rivers and canals.
- Collecting and gathering waste due to demolition of structures and clearance of trees around the project site;

- Studying alternative livelihoods for the people engaged in brackish water aquaculture (alternatives are discussed in the section of mitigation measures during operation process of the project)

c) Propose innovation for design plan to reduce adverse impacts

Design for fish pass

- The two canals between the Tien River and Ham Luong River as well as the Ham Luong River and Co Chien River are important canals for the inland waterway. At the same time, these waterways are indispensable for migration of fish between the freshwater area and brackish water area. Therefore, construction of a fish pass is recommended at the four sluices on these canals, namely the An Hoa, Ben Tre, Vam Nuoc Trong and Vam Thom sluices -- together with navigation locks. Regarding the Tan Phu and Ben Ro sluices located in the upper part of North Ben Tre, the construction of sluices will not affect the ecology of fish significantly because these areas are supposed to be fresh water environments throughout the year and out of the biosphere of the target fish, aside from the fact that the duration of the opening gate is longer than the other sluices. The Thu Cuu and Cai Quao sluices are also excluded from the fish pass plan since migration is secured through connection canals.
- The position of the fish pass is selected considering the structural scale of the sluice, fish gathering point, swimming route and behavior of fish.
- To construct the fish pass on the outside of navigation lock is not recommended since the total length of the planned navigation lock is nearly 200m and the length of the fish pass became longer than that, so this layout is not suitable for fish to pass through rapidly. Consequently, the fish pass is planned to be arranged at the space between the abut pier and lock.

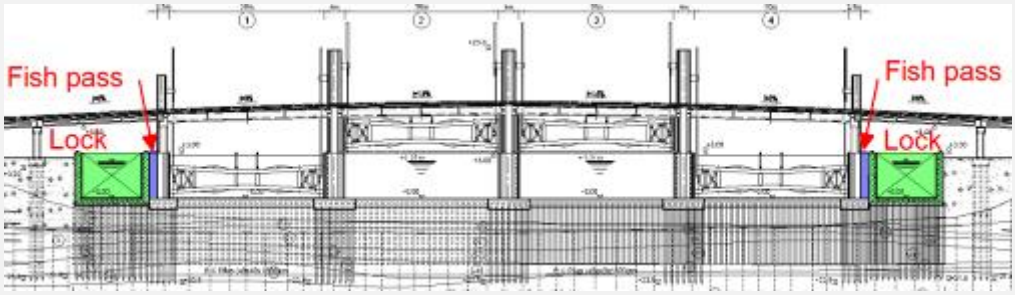


Figure 4 - 1: Position of fish pass（Front view）

Source: JICA B-SWAMP Survey Team (2016)

The design plan to minimize the impact on waterway transportation

- For sluice gates on waterways: To facilitate and shorten the waiting time passing the sluicegates by the most favorable size designing navigation locks, such as to increase capacity of system lowering and filling water in the locks;
- For sluice gates not on waterways: No big boats passing, few small boats have need to pass the sluicegates; It may supplement design of small navigation lock in mechanical form transporting small boats passing the gates; or set operating mechanism to open and close the gates and keep interval time during the day for boats to pass when water levels inside and outside balance

3.1.2 Mitigation measures during construction

4.1.2.1. Overall measures

Construction process is carried out in a relatively long time, the construction site is large; therefore, the project should pay due attention and take effective measures to protect the environment, labor safety and health of the workers as well as people in the area.

As expected, the construction progress of the entire project is divided into two main phases, each phase of about 2 years, of which the number of construction projects are appropriately arranged for each phase. The construction activities include clearance, aggradation and construction of sluicegates, locks, traffic roads and drainage system, etc.

The overall essential measures that the project will apply including:

- Paying special attention to environmental sanitation issues, labor safety and protection of workers' health as soon as the construction design is developed. In order to achieve the targets above, when selecting construction method, the following aspects should be paid due attention:
- Appropriate planning and arrangement of staff, avoiding overlapping between construction phases: clearance of site, uprooting, leveling, dyke foundation reinforcement, road surface reinforcement, etc.
- Applying advanced construction methods, mechanized operation and construction process to the maximum extent;

Regarding construction arrangement, there must be appropriate measures for labor safety and environmental sanitation protection. Specifically:

- Complying with labor safety regulations when planning construction organization such as: earthwork activities, arrangement of machines and equipment, measures to prevent electric incidents; orders of arranging storages, warehouses, material gathering site, temporary camps, etc.
- Labor safety measures when planning construction such as: timing and order of construction to ensure the stability of the parts of the work; sequence of underground construction, arranging reasonable construction route to lessen material and equipment transport and avoid overlapping between phases and work volume, etc.

At the construction site, it is important to ensure:

- Facilities for the construction workers such as canteen, rest places, toilets, bathroom, and health station, etc.
- Appropriate arrangement of transport roads;
- Placing fences to isolate dangerous areas such as transformer station, inflammable materials, deep foundation ditch, area where heavy equipment operates, etc.
- Design to ensure traffic in construction as regulated;
- Design lighting system for the night work area or obscure area;

- Installing anti-noise equipment for the areas with high level of noise such as generator, air compressor, etc.
- Shielding dust-generating areas and watering roads and materials such as sand, stones mixed concrete to reduce dust;
- Building temporary wastewater treatment system (seepage septic tank), regulation on landfill, defecation and disposal of domestic waste that cause environmental pollution are not allowed.

The above measures are basic measures to protect environment, labor safety and health of workers and local communities in the area. During implementation, additional specific measures should be taken to obtain the best results.

4.1.2.2. Mitigation measures during site ground leveling

In order to minimize adverse impacts, when inviting bidding, the project owner will have specific requirements for the awarded contractors and closely supervise their compliance with such requirements. Specifically:

a) Mitigation measures of impacts caused by material transport vehicles and construction machines

- All waterway vehicles transporting sand and foundation sandblasting must register and be licensed. The captains must have licenses as required.
- Sandblasting pipeline of the pumps must have required tightness.
- Drainage and water restoration system of sandblasting must be appropriately designed to avoid impacts on the surrounding residential areas and water environment.
- All trucks must have covering canvas when transporting materials.
- Spraying water on the roads near the construction site where the transport vehicles often pass by; watering frequency: 3 times per day;
- Regulating vehicles appropriately to avoid increasing the density of vehicles in rush hours and noon breaks of workers and local communities;
- All trucks and motorized construction equipment have to meet the criteria set by Vietnam Register (VR) regarding technical safety and environmental safety to be allowed operating;
- Maintaining green coverage in the area, avoiding cutting down to the maximum extent.

b) Mitigation measures of other environmental impacts

- Backfill materials must meet the physical as well as physicochemical standards.
- Do not burry domestic waste, chemicals, waste oil in the project area; do not organize collective kitchens in the project area;
- Having mobile vehicles to serve the sanitation needs of workers;
- Creating sand traps and backfill materials near canal area to minimize the amount of materials washed away into canals due to rain;
- Carrying out leveling from higher to lower positions;
- Carrying out leveling material right after pouring down to reduce the diffusion of materials by winds.

4.1.2.3. Mitigation measures to minimize environmental pollution in construction of sluicegates and road surface structure

The awarded contractors must comply with requirements and be under the supervision of the project owner. Specifically:

- Do not burn materials in the project area;
- Do not gather inflammable materials; they must be transported regularly out of the construction site;
- Chemicals used for construction must be registered beforehand, meet the regulations and subject to examination by the project owner;
- Establishing asphalt mixing stations selected by the construction unit. Asphalt must not be mixed scattered along the route. The stations must be located at well-ventilated area far from people's houses and inflammable environment;
- There must be waste storage equipment and plan for transport and treatment in accordance with the province's regulations;
- Minimize the repair of vehicles and machines in the project site; Repair and maintenance area must be arranged in advance (temporary workshop) and a system must be installed to collect waste oil generated from maintenance activities;
- Mobile toilets must be equipped adequately;
- Residual chemicals and waste oil must be kept in closed containers and transported for proper treatment by specialized agencies;
- There must be fire and explosion prevention and labor safety plans and equipment;
- Using motorized equipment and machines with limited noise level during working hours;
- Equipment and machines must be regularly and timely maintained;
- Screening and soundproof methods are used where necessary.

4.1.2.4. Minimizing noise and vibration

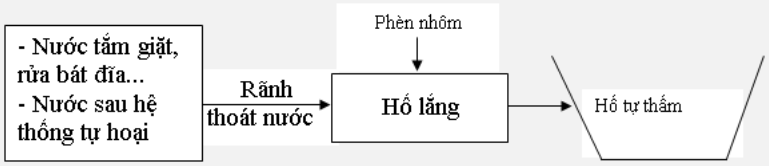
The project area is inhabited, thus construction activities will generate noise and vibration affecting the surrounding area, although this effect arises in a short time. To minimize adverse impact, the project should have a reasonable construction plan. As for construction equipment with high noise level such as driller, excavator, concrete piling using hydraulic hammer, etc., they will not be active during the period from 6PM to 6AM of the next morning.

4.1.2.5. Minimizing pollution due to domestic wastewater

During construction there will be around 1,000 workers on site. With an average water use of 100 liters/person/day, the amount of water used per day is about 100-120 m3. Of which, wastewater volume accounts for 80% of total water use, equivalent to about 80-90 m3/day. To control this water volume, toilets with treatment tanks will be built near the workers' camp. The size of these treatment tanks is designed to fit the number of workers in each construction location (or each package).

After the construction phase ends, sludge in the septic tanks will be sucked up by the vacuum trucks and these septic tanks will be backfilled.

Figure 4 - 2: Domestic wastewater treatment process



4.1.2.6. Mitigation measures of pollution due to stormwater

During the construction process, when it is raining, water runoff on the surface will sweep away soil and cement, which will be scattered and spilled into the surrounding area. In order to minimize this impact, in the project site, temporary drainage ditch and settling tank must be built surrounding the construction site so that during backfilling and sluicegate and road construction process, stormwater will go through temporary settling pond before discharging into canals. Deposited sludge will be dredged during construction phases (periodically) and after completion.

4.1.2.7. Minimizing pollution caused by domestic waste

Solid waste is produced around 600kg per day. The amount of domestic waste must be collected in plastic or wood containers with caps and placed in a convenient location and at canteen of the workers. The transport of garbage cans will be carried out regularly to the landfill (selected by the contractor; the landfill must be at least 500m far from the residential area, and at least 200m far from the workers camp and surface water sources, and should not be in the direction of prevailing winds of the area). Waste collection unit or local environment company is hired to transport and treat according to specifications. In case waste cannot be transported to the landfill (for example, there is no appropriate transport route), it is compulsory to burry waste in the temporary landfill in the project site for sanitary waste burial (a layer of waste, a layer of covering soil and when it is filled, the landfill is covered with a soil layer of 50cm in thickness. The temporary landfill of the project must be arranged in the vicinity of the area generating most waste and at least 500m far from the residential area, and at least 200m far from the workers camp as well as surface water sources, and not located in the direction of prevailing winds of the area. After construction is completed, temporary landfill must be backfilled and returned to ensure landscape of the project area.

4.1.2.8. Minimizing waste oil impacts

Minimizing the repair and maintenance of vehicles and construction machinery in the construction site.

Waste oil generated in the project area must not buried on the spot. They must be collected in suitable containers, usually the kind of 200-liter tank that can be placed in construction area.

Contracting with waste collection unit to collect and transport hazardous waste for treatment.

The management of harzadous waste must comply with the regulations specified in the Circular No. 12/2011/TT-BTNMT by MONRE.

4.1.2.9. Labor safety measures

During construction as well as equipment installment, examination and trial run, the project owner and workers must strictly comply with regulations on labor safety as follows:

- Machinery and equipment must have attached specifications and regularly checked regarding their safety and technical parameters;
- Setting fire-alarming devices and light system and ensuring that the communication system always works well. Workers and operational staff must be trained and practice correct operation; in case of incidents, they must always be in their positions. Machinery and equipment must be operated in accordance with technical guidance.
- During construction, PPE must be equipped adequately for workers on the construction site. Training on labor safety is provided for construction managers and workers.

Besides, it is important to ensure hygienic working environment for workers. On the one hand, ensuring safe working conditions, hygiene, on the other hand, ensuring regulations on lighting and ventilation for workers to adapt to each type and nature of work. In case of malfunction, the operators must be instructed and practice according to safety regulations. The tools and equipment as well as the necessary contact addresses in case of incident should be given clear instructions:

- Water tap, medicine cabinet, and eye washing tool must be arranged on the site;
- Arranging oxygen tank regularly on the site;
- Contac in case of emergency: hospital, fire department, etc.

4.1.2.10. Mitigation measures for dredging activities

As presented above, the issues mainly cause impacts on the environment during the process of dredging and transporting dredged materials to the dumping site are as follows:

- Scatter of dredged materials into surrounding environment due to dredging activity and flow;
- Leakage and spillage of sludge into the rivers due to rain or waves;
- Illegal disposal of dredged materials;
- Risk of shrinking barge because of accidents.
- Therefore, it is important to take appropriate measures to prevent the occurrence of the above mentioned issues.
- In order to protect the environment during dredging and transporting process, the following measures are recommended:

a) Preventing sludge leakage and spillage

In order to prevent the leakage and spillage of sludge into the rivers during transportation process, the following measures can be taken:

- Not transport the volume of sludge over limited barge capacity.
- Use barriers to prevent overflow caused by rainfall.

- Not transport in heavy weather time or in the time when large ships/vessels move.

b) Preventing illegal disposal of dredged materials

In order to prevent and eliminate the possibility of illegal disposal of sludge, the following measures should be applied comprehensively:

- Educate and improve the awareness of environmental protection and regulate specific responsibility to barge-owners and others related.
- Monitor the activities of transport and disposal thanks to regular consideration of journal table of transport (transported sludge volume, time) and of disposal (number of barges enters required disposal area, volume, time...). If there is any difference between transport times of origin site and destination site, activities of investigation will be implemented in the way of integrating with functional agencies.
- Hard punishments will be applied to any person who illegally disposes transported sludge or/and makes sludge overflowed.
- Investor will cooperate with functional agencies to monitor surface water in the river on transport route in order to identify pollution cause by illegal disposal and sludge overflow.

c) Preventing risks of sinking barges and accidents in waterways

Since sludge transportation requires regular transportation by barge on waterways, it is important to make suitable transport plan to prevent to the maximum extent the risks and incidents that can occur.

In order to carry out this work well, since the preparation of transport plan, the contractors should cooperate with the functional agencies to check and monitor waterway traffic timetables of the vehicles on the route in order to limit the density of vehicles on the transport route.

In terms of transport organization, the contractors should take appropriate measures to prevent occupational accidents and ensure environmental sanitation. Specifically:

- Follow strictly regulation of waterway safety during transportation time.
- Barge - owners/operators and others related will be trained in health and labor safety and waterway code. Occupational safety equipment to protect labors will be delivered to related people.
- Regular keep a close watch on hydrological regime in order to identify strong winds, storm or 1ong-term floods. In this case, it is important to pay attention to prevent the risks of collision leading to shrinking barge due to strong wind and flow. It is better to avoid transporting during this time.

d) Measures to protect water environment in dredging

Due to the nature of dredging and sludge transport activities which are carried out in the existing water environment, the possibility to cause contamination of the water environment is quite high. Reasons for water pollution can be the following:

- Dredging large volume with motorized equipment (high productivity), which will stir sludge layers in a large scale. The volume of suspended sludge arisen from this process will quickly disperse with the flow.

- Direct disposal of domestic waste from the dredging barges into rivers.
- Leakage and loss of oil during the process of providing fuel for dredging equipment and transport barge and operation of the machinery and equipment.
- Not cleaning sludge transport barge at the designated area.

In order to protect the water environment from adverse impacts caused by dredging and transport activities, to control and collect waste and minimize the disposal of waste into the environment is the most feasible measure. This measure can be applied following the principles below:

- If using pumps, the operation time is only on incoming tide and sludge must be pumped stirred suddenly after stirred.
- Equipping garbage containers specially used for each transport vehicle (at least two cans on each vehicle). All of domestic waste must be collected in these garbage containers. Periodically these waste will be transported ashore and then disposed at the designated landfills. It is strictly prohibited to leave waste or dispose leftovers into the environment. Waste must be dumped at the designated disposal site when the waste containers are unloaded from barge.
- Do not use water to wash the transport vehicles at the densely populated area to avoid oil leakage, spillage and spreading. In this case, cloth can be used to clean and absorb spilled oil. And these cloths after cleaning must be safely burned on shore or collected into the waste containers to be transported to the designated dumping site for further treatment. These cloths must not be washed in the river for reuse. In rainy months, rainwater easily washes away oil on the barge; therefore, it is necessary to take suitable measures to shield the positions where oil is often spilled on the vehicle and equipment.
- In the dredging area, it is necessary to arrange silt curtains/screens to isolate the part where the dredging activities are carried out with the other parts to prevent sludge spreading into the environment. For example:
- Arranging screens at two sides of the dredging area. The size of mesh is 3x3mm. The net is made by plastic fiber with high durability.
- Spreading the net using plastic float. Using concrete anchor of 300kg in weight.
- The distance from the net to the dredging route is about 100m.
- Arranging each dredging section with the length of 1,000m.

4.1.2.11. Mitigation measures for aquatic ecosystem

- During the construction period, it is important to pay due attention to the existing ecological environment of the flora and fauna in the project implementation area, compare the advantages and disadvantages among the alternatives to select the optimal location for the project so that the ecosystem is less affected.
- Controlling the harmful effects on the natural ecosystem through reasonable and propose use of natural resources. This is an important factor that needs considering.
- Appropriate technical solutions and management to limit the disruption of the ecological balance.

- The disposal sites and material gathering sites should be at a reasonable distance to the river bank to avoid causing landslides and thus affecting regular flow.
- Developing suitable sanitation facilities.
- Actively collecting and treating domestic waste.
- Minimizing impacts on the habitats of reptiles, amphibians and some water birds.

4.1.2.12. Mitigation of social impacts

- Giving priority to use the labor sources suitable to on-site works.
- Cooperating with the local authorities and relevant agencies to organize the following activities:
- Education and awareness raising activities are carried out for the workers in the project area;
- Presenting to the workers about the traditions and customs of the local communities to avoid misunderstanding that might occur between the workers and local people;
- Impacts on people's habit using river water for domestic purposes: It is important to inform to the people living in the area the construction schedule in advance so that they can take and store water to use. In addition, the construction activities should avoid rainy season to avoid making water sources turbid and stormwater runoff contaminating the water sources.
- Closely cooperating with the local authorities to manage workers staying in the area.

4.1.2.13. Mitigation measures for traffic accidents and people's safety

- Arranging traffic alternative and worker to guide vehicles on road;
- *Placing under construction signs and speed limit signs;*
- Placing guide posts on the rivers for the waterway vehicles passing the construction site.

4.1.2.14. Reversion of environment after construction

After completion of the construction, the project owner will revert the environment and implement other measures to minimize the negative impacts on soil, water and air as follows:

- Structures and camps will be removed. The materials that are salvageable will be used or sold. Otherwise they will be treated together with solid domestic waste.
- Environmental treatment facilities such as septic tank (sediment of the septic tank) will be removed. Contracting with local Environment Company to transport to the concentrated landfill.
- Backfilling holes, temporary drainages built during construction period to avoid stagnant water.
- After removing storehouse and camps, planting trees to recreate the environmental landscape as well as to prevent erosion and landslides due to rain.

3.1.3 Mitigation measures during operation

- Setting reasonable operating process, reducing the time to close the sluice gates to a minimum, timely and flexible in operating system. Increasing salinity monitoring

frequency on large rivers including Co Chien, Ben Tre, Ham Luong, paying attention to salinity monitoring during rising tide. Timely detecting freshwater discharge time in the rivers, taking advantage of every opportunity to operate the sluicegates, especially the large sluicegates.

- Focusing on operating the sluicegates in the early months of the rainy season when freshwater is arisen in the basin and washes away the toxic substances in the fields, villages, and water collection areas.
- Dredging and clearing the canals behind and at the start of the sluicegates, ensuring rapid water receiving and drainage under the effects of tidal oscillations when opening the sluicegates. These activities are not in the scope of investment of the project; thus during the operation process, there is a need for additional infield canal dredging program.
- Increasing environmental sanitation in the salinity intrusion prevention area.
- After completing salinity prevention and water freshening in the area, the authorities of three provinces as well as relevant districts and communes should carry out information campaigns to raise people's understanding and awareness of the differences in the environmental process in the enclosed area that is protected from salinity intrusion. Focus should be given to increase people's responsibilities to protect living and farming environment. It is important to control and reduce the discharge of waste and wastewater in the residential area.
- Restoring the environment to its original state in the project area where possible by planting vegetation appropriate to environmental safety.
- Taking soil and water samples at designated locations in order to control environmental management and ensure labor and environmental safety of the project.
- Implementing measures to handle potential acid sulfate soil when digging ponds for aquaculture and being exposed on the surface such as sprinkling with lime, avoiding disposal of alum soil in the inundated area, gathering excavated soil in a clear area with good drainage.
- Regularly checking and maintaining equipment, canal and sluicegate system to minimize unexpected incidents.
- Placing signs, signals or using siren to announce the opening time of the sluicegate to avoid causing accidents for the vehicles on rivers;
- Informing the operation schedule of the sluicegates and locks, using notice boards at the construction area, so that people can arrange their traveling by boats on the rivers during the closure time of the sluicegates;
- Placing the regulation board on the protection of sluicegates to raise people's awareness to protect the works.
- Updating and informing the operation schedule and sluicegate closing time, especially to the water plants along the rivers so that they can arrange their schedule to take water, ensuring water quality for domestic use.
- Reducing and controlling the overuse of plant protection products.

- Regularly inspecting environmental sanitation at production, husbandry, processing and aquaculture facilities.
- Farming in accordance with soil protection process.
- Freshwater supplemented for the project area will facilitate for development of freshwater aquaculture, expansion of the area planting fruit trees like green skin pomelo, rambutan, etc. Increasing farming may result into more discharge into the environment. Proposed mitigation measures are requirement of proper aquaculture and agricultural development planning in new conditions.

Total estimation of mitigation measures for possible adverse environmental impacts.

Table 4 - 1: Total estimated cost of mitigation measures for possible adverse environmental impacts

Impacts	Mitigation measures	Implementing organization	Responsible organization	Overall cost per year (1,000 VND)
Construction Phase				
Air pollution	-Vehicles carrying demolition and construction materials must have waterproof covering tarps to prevent emission. **Covering tarps – *included in construction cost*** -Sprinkling water in the demolition area and the transport roads to diminish dust. *Water sprinkling cost* 10,000 VND/m^3 x 2 m^3/site/day x 8 sites x 100 day/year = 16 million/year - Controlling the quality of vehicles and machinery and periodically maintaining them for limiting excessive exhaust emissions. -All trucks and motorized construction equipment have to meet the criteria set by Vietnam Register (VR).	Construction Unit	ICMB9	16,000
Water pollution	- Prohibiting defecation and disposal of wastes into the river. - Installing toilets at construction sites with temporary wastewater treatment system (septic tanks). *Mobile toilets* *2 toilet/site x 8 sites x 15 million VND/toilet = 240 million VND* *Septic tanks* *1 septic tank/site x 8 sites x 10 million*	Construction Unit	ICMB9	240,000 80,000

	VND/septic tank = 80 million VND *Cleaning fees* *0.128 kg/person/day x 100 worker/site x 8 sites x 150.000 VND/ton x 0.001 ton/kg x 100 day/year = 15.36 million VND/year* - Limiting the runoff discharges of rainwater/water used for washing equipment to the river by building temporary drainage ditch and settling tank surrounding the construction sites.			15,360
Wastes	- Demolition and construction wastes are gathered and segregated at source. - Spilled materials have to be collected and treated as other wastes. *Renting containers for construction wastes and hazardous wastes.* *4 container/site x 8 site x 1 million/container = 36 million* *Waste bins* *2 waste bins x 1.5 million/bin x 8 camps = 24 million VND* *Transportation and treatment fees (according to Decision No. 21/2011/QĐ-UBND by Ben Tre PPC)* *0.6 kg/person/day x 100 worker/site x 8 sites x 360.000 VND/ton x 0.001 ton/kg x 100 day/year = 17.28 million VND/year* - Hazardous wastes, including combustible wastes and waste oil, have to be stored in isolation and to be treated in accordance with the regulations specified in the Circular No. 36/2015/TT-BTNMT issued by MONRE.	Construction Unit	ICMB9	36,000 24,000 17,280
Ecosystems	- The scope of the project site must be measured properly to ensure the minimum cutting of trees, and maintaining the green coverage in the area. (Riverbank protections are conducted all the vegetation clearance sites by the construction). - Prohibiting of illegal wastes disposal on the ecosystem and leakage of materials to rivers /canals. - For the migratory fishes, any escape migratory route in some sluice gate construction sites should be set up.	Construction Unit	ICMB9	
Noise and vibrations	- Anti-noise equipment should be installed for the machinery such as generator, air compressor, etc.	Construction Unit	ICMB9	

	- Construction vehicles and machinery should be inactive for 6pm to 6am. - The schedule of construction vehicles and equipment should be aptly regulated to avoid raising the intensity of vehicles during rush hours and noon. - Periodic maintenance of construction vehicles and machinery, especially ones generating high noise level should be conducted.			
Operation Phase				
Air pollution	- Controlling the quality of vehicles and machinery and periodically maintaining them for limiting excessive exhaust emissions.	DONRE	ICMB9,	
Water pollution	- Operating the sluice gates (opening and closing) timely, properly and in accordance with changes in salinity and water quality. - Dredging canals on a periodic basis. - For the long-term base, developing and launching wastewater management and treatment plans. -Raising awareness of local residents in environmental protection; and setting policies to discourage the release of untreated wastewater and wastes into the canals/rivers. *Awareness raising program* *5,000,000 VND/commune/year x 44 communes = 220 million VND/year*	Sluice Gate Operation Organization Local Government	ICMB9	220,000
Ecosystem	*- Design the gates to minimize the turbulence of water outside the gates and maximize the flow of water.* *- Installing auxiliary structures to facilitate the fish migration.* - Only closing the sluice gates when necessary, keeping the gates open at maximum in sensitive period (e.g. breeding season).	Detail Design Origination Sluice Gate Operation Organization	ICMB9	

3.1.4 Measures to mitigate impacts on waterway users

Taking this into account, the followings measures are proposed to mitigate adverse impacts on waterway users.

1) According to results of scoping and the waterway user survey, the small-scale fishermen and waterway users who are operating in the areas areas to be closed by the sluice gates would be negatively affected in their operations by the gate construction and operation. Impacts in the construction phase may be mitigated by

applying the appropriate construction method.) With aim to benefit local people, including the project-affected waterway users, and promote the development of local economy, the construction of: (1) small-scale markets near the sluice gates, (2) small-scaled ports with cargo loading and unloading spaces beside the sluice gates, is proposed as components of the Project. These markets and ports may help the small-scale fishermen and other waterway users, who operate in the area closed by the sluice gates, in continuing their business activities. According to result of the hearing survey to fishermen, the small-scale fishermen, who are operating in the areas to be closed by the sluice gates, do not have the fixed fishing grounds, and they can easily change their fishing grounds. Those fishermen can change the fishing grounds and continue their business activities by using the markets and ports constructed near by the sluice gates.

2) Possibility to fully utilize the existing social welfare scheme of the Vietnamese Government, such as job finding program, vocational training program, etc., should be examined as a way of support to project-affected waterway user households with low income. The beneficiaries of the existing social welfare scheme of the Vietnamese Government are classified into the eleven (11) categories. They are: the poor; minorities; residents in isolated areas; residents in mountainous areas; farmers; labors of informal sector; unemployed people; people with disabilities; orphans; elderly people and sick people. It is possible to apply this sheme to project-affected waterway user households with low income.

3) It is also important to urge the contractors to prioritize local residents, including the project-affected waterway users, when they employ temporary construction workers during the construction period.

4) At the detailed design stage, dissemination of information on the project plan and project implementation progress, organization of stakeholder consultation meetings, etc., should be continued. Additional surveys on waterway users shall be conducted when necessary.

   Further concrete supports for changing occupation, establishing new business, etc., should be examined and proposed to help households whose livelihood is significantly affected by the project implementation, such as households who loses its means of livelihood.

5) Consultation meeting with local people should be carried out properly and their opinions need to be fully reflected into plan to design and construct markets, ports surrounding the gates.

   During the construction period, in order to mitigate impedance to business activities of waterway users, fishermen, etc., proper construction method should be applied so as the river navigation will not be totally obstructed.

   The acquisition of lands for the construction of markets and ports nearby the sluice gates should be done at early stage of the detailed design. And in order to reduce

economic damages of those waterway users and fishermen, the construction of these markets and ports should be completed and opened to residents as soon as possible;

Maximize the time to open sluigates in appropriate conditions: Proper sluicegate operation mechanism to open the gates as much as possible, but having regard to prevent salt intrusion into field. This mechanism can be applied at low cost based on the principle to open gates for boats to pass when water level outside and inside is balance, there will be no inflow or outflow. Due semidiurnal tide mode of eastern sea, there are 2 times of tide increasing and 2 times of declining per day. Thus, there will be 4 times per day when water level in field and outsite the river is balance. At that time, the gates can be opened for boats to pass freely. Taking advantage of the tidal schedule, it may notice the number of times a specific time to open gates serving waterway.

3.2 MEASURES FOR PREVENTING RISKS AND RESPONDING TO ENVIRONMENTAL INCIDENTS

3.2.1 Preventing Incidents

4.2.1.1. Preventing risks of shrinking barges, vehicles because of accidents

In order to ensure the operation of the project and prevent unfortunate risks from occurring, barges and floating vehicles when participating in waterway traffic must strictly comply with regulation on Inland Waterway Traffic as well as sub-law guiding documents. Paying special attention to the following:

- Do not transport the volume over limited capacity.
- Controlling the vehicles following the regulated route.
- Turning boat with proper technique within the allowed turning area, when necessary requesting the assistance from tow-boat/tugboat.
- Not allowed to move and carry out construction activities at night.
- Berthing to wait for shift change according to technical requirements and at designated places.
- Regularly checking and monitoring the safety of boat hulls, carrying out periodic examination by means of ultrasound or radioscopy to detect cracks or other suspected signs prior to each operation phase.
- Regularly following the announcements of Vietnam Inland Waterways Administration or local Waterways Management companies to know the changes in regulated routes.
- Regularly monitoring meteorological and hydrology forecasting to arrange transportation schedules accordingly, and being subject to the guidance and direction regarding boat schedules of the local Waterways Management companies.
- Arranging the fairway buoy and signal lights at the turning basins to avoid other boats and vessels in the turning area that might cause dangerous obstacles.

- Bargees and sailors are required to have professional credentials and understanding of the inland waterway traffic regulations and other relevant waterway traffic safety issues.

4.2.1.2. Preventing bridge and traffic road incidents

Design phase: Design should comply with Vietnamese standards and regulations on designing irrigation structures. The following principles should be conformed:

- Selecting materials with proper specifications in accordance with technical requirements.
- Carefully calculating to design appropriate bridge structures and bridge approach roads.
- Foundation must be reinforced in accordance with prescribed standards.
- Prior to operation, the project owner should coordinate with the construction inspection agencies to organize thorough examination of the entire route.

Operation phase: During operation process, an appropriate maintenance mechanism for all work components is required.

- Regularly checking and monitoring the operation of mechanical equipment at the sluicegates; if damage or reduced accuracy is detected, carrying out repairs or replacement with new equipment.
- Regularly checking bridge structure and road surface. Timely repairing problems detected.

3.2.2 Measures for incident response and handling

Preventing incident is the prerequisite measure; however, it is not the best and safest measure. Incidents may occur for many different reasons that cannot be foreseen. Therefore, in addition to planning and guiding preventive measures, it is necessary to establish solutions and install equipment and tools to respond and handle incidents.

4.2.2.1. Measures for responding and handling barge shrinking incidents, dredging and clamshell equipment, piling on floating vehicles.

Shrinking incidents will firstly cause waterway traffic congestion, and then sludge and oil spreading on the surface water, especially for vessels containing a large amount of oil such as dredging and piling vessels. Therefore, measures to respond and handle the incidents should focus on solving the following two issues:

- Immediately preventing oil from spreading into water surface on the large scale;
- Proceeding to fish out boats as well as their equipment and goods to not obstruct waterway traffic.

Preventing spilled oil on the water surface when incidents happened with the boats containing oil is a difficult and complex problem, requiring adequate equipment and tools to handle, while these vessels are often not fully equipped with means and tools. Therefore, when incident happens, as for vessels containing a large volume of oil must immediately contact the Southern Center for Oil Spill Response NASOS to rescue in time. Rescue boats are often adequately equipped with facilities such as:

- Incident signal receiving equipment;
- Oil fence boom enough to control the amount of oil spilled in the incident area. Oil fence boom is often in place and put in the oil boom roller on the rescue boat. In addition, mini speed boats must be equipped on the rescue boat to pull oil boom;
- Equipping specialized oil separators with adequate oil absorbent materials and containers to collect oil;
- Equipping at least two sets of pump to suck oil floating on water surface;
- The boat speed must be large enough to be quickly present at the incident area.

  The recue measures will be most effective if there is coordination between the boat having incident and rescue boat.

4.2.2.2. Measures for responding and handling sluicegate incidents

Incidents involved damage to the sluicegate or dyke rupture, causing salinity intruding into the fields. When salinity overflowing incident happens with large scale due to dyke rupture or damaged sluicegate valves, the following steps should be carried out:

- Timely covering and shielding with earth bags and closing sluicegate to prevent saltwater from entering into fields.
- Timely mobilizing equipment and rescue means to the scene to embank and reinforce the damaged dyke section.
- Promptly repairing or replacing malfunctioning valve gate.

CHAPTER 4
ENVIRONMENTAL MANAGEMENT AND MONITORING PROGRAM

4.1 ENVIRONMENTAL MANAGEMENT PROGRAM

Based on the scale and main contents of the Project (Chapter 1), impacts caused by the Project on natural and socio-economic environment (Chapter 3) and mitigation measures of adverse impacts, prevention and response to the environmental incidents (Chapter 4), the Environmental Management Program (EMP) is prepared with the aim to manage the issues of environmental protection during the preparation, construction and operation processes of the Project.

The project will establish the management organizational structure and maintain processes to identify environmental issues in its activities and the possible impacts of such activities in order to identify the factors have or may have serious impacts on the environment. The environmental issues are factors in the project activities that interact with the surrounding environment. The identified environmental issues are considered to set out the targets related to environment and new information will always be updated.

For each phase of the project, the issue of environmental protection will be identified, and on this basis will set out the direction and objectives, as well as the management programs will be implemented to achieve continuous improvements.

4.2 RESPONSIBILITES OF THE STAKEHOLDERS

4.2.1 State-level management agency

- Ministry of Agriculture and Rural Development (MARD) is the agency responsible for investment decision and approving the investment project;
- Ministry of Natural Resources and Environment (MONRE) is the agency responsible for approving the Environmental Impact Assessment Report of the Project.
- Provincial People's Committees of Ben Tre participate in directing the project and are responsible for land acquisition, compensation and resettlement of the project, and directing the activities of Ben Tre Department of Agriculture and Rural Development (DARD).

4.2.2 Project owner level

Central level: Hydraulic Project Investment and Construction Management Board No. 9 (ICMB9) is the project owner responsible for project coordination, and is the direct owner of some work items of the project and other work items assigned by MARD.

Local level: Ben Tre DARD and PPMUsare responsible for organizing the implementation and activities of the components/subprojects of which they are owners. These agencies are responsible for monitoring and correcting the implementation of the project's safeguard policies in the subprojects' area.

4.2.3 Project management level

Central level – CPMU, ICMB9 is responsible for overall management of the project activities, including ensuring the implementation of environmental safeguard policies. CPMU will make management-related decisions to support effective implementation of the EMP, including:

- Preparing TORs, bidding documents, and contracts with contractors about environmental safeguards policies;
- Guiding, inspecting, monitoring and adjusting the EMP implementation of the Sub-projects;
- Managing environmental safeguards monitoring reports of the Sub-projects;
- Organizing training programs on environmental protection implemented by Training Consultant.

Provincial level – At the provincial level, the Ben Tre Provincial People's Committee (PPC) is responsible for the implementation and/or monitoring of hydraulic infrastructure works undertaken in the province. The PPC is also tasked with closely monitoring the progress and quality of work undertaken within its jurisdiction.

Integrated Water Management Units (IWMU) is established under scope of the project to enhance information sharing, and cooperation capacity among stakeholders in integrated water resources management in Ben Tre province.

An **Environmental and Social Monitoring Taskforce** (EMST) will be established by ICMB9 and the proposed Integrated Water Management Units (IWMUs) of the Ben Tre province, for implementing environmental and social monitoring activities during the construction and operation phases of the Project. The EMST should have the following functions:

- Conduct related documentations –standard operation procedures for Environmental Management Plans and other related records;
- Design/plan regular environmental and social monitoring activities during the construction phase and the operation phase of the Project following the environmental and social monitoring criteria provided by the JICA survey team;
- Mobilize local consultants to conduct regular environmental and social monitoring activities during the construction phase and the operation phase of the Project;
- Receive and review technical reports from local consultants; and
- Provide regular reports on environmental and social monitoring activities for the Integrated Water Management Units (IWMUs) of Ben Tre province and ICMB9

Design Consultant: The technical design consultants are responsible for combining the technical solutions to address the potential environmental and social impacts and risks identified in the EIA when possible. The design consultants shall also incorporate the mitigation measures proposed for the construction phase in the EIA into the contracts and construction bidding documents.

Contractor: Construction contractor is responsible for complying with regulations during the implementation under the contract signed with ICMB9, including:

- Preparing detailed safeguards implementation plan to submit to ICMB9 for review and approval prior to the commencement of civil work;
- Fully and timely disseminating information regarding construction activities;
- Complying effectively with safeguard policies during construction process;
- Cooperating with PPMU to solve complaints and grievances.

Construction Monitoring Consultant (CMC): is recruited by ICMB9 and on behalf of the ICMB9 will conduct day-to-day monitoring and recording of the contractor's compliance with safeguard policies. The responsibilities of CMC are:

- On behalf of the ICMB9, performing daily monitoring of the compliance with safeguard policies of the construction contractor;
- Preparing monthly report on the compliance with safeguard policies of the contractor to submit to ICMB9; this report will serve as basis for contractors to pay environmental protection fee;
- Reporting to ICMB9 emerging issues if any during construction process.

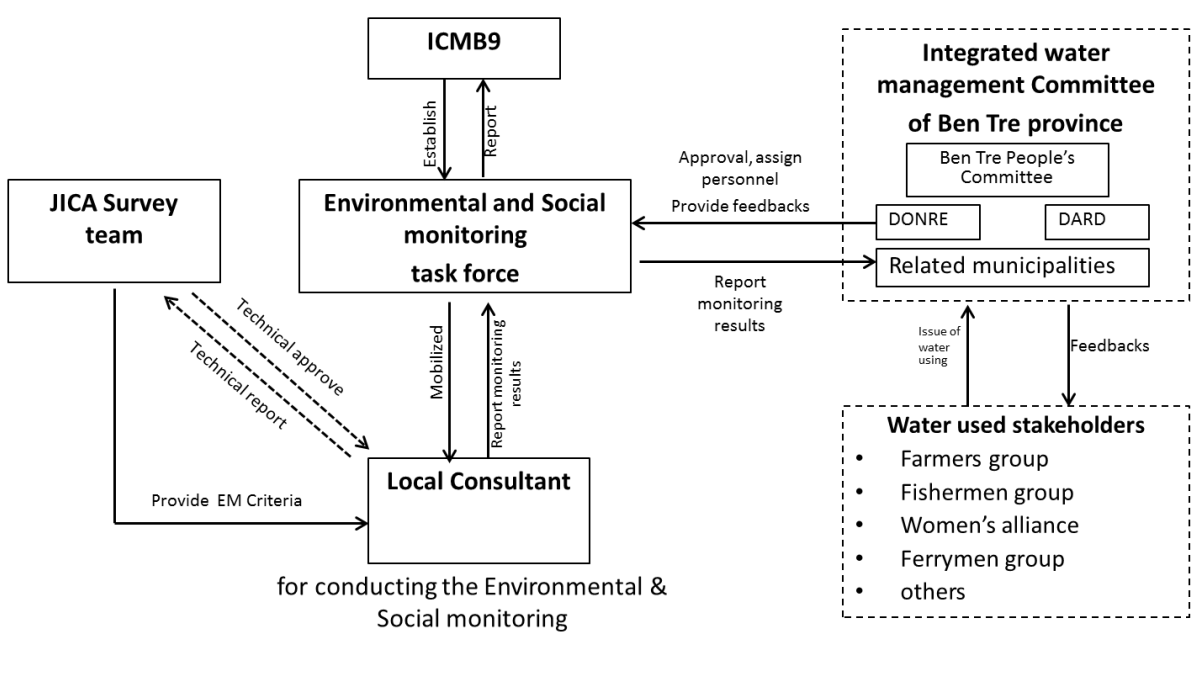


Figure 5 - 1: Environmental Safeguards Implementation Diagram of Ben Tre Water management Project

4.2.4 Internal, external monitoring, and community supervision mechanisms

ICMB9 is responsible for periodic or unscheduled internal monitoring of the implementation of environmental safeguard policies of the subprojects. ICMB9 is also responsible for ensuring effective implementation of safeguard measures and timely reporting subprojects' progress. PPMUs will establish an Environmental and Social Unit (ESU) with at least one dedicated environmental safeguard official responsible

for guiding and reminding the contractors to implement environmental safeguard measures.

Reponsibilities of the task force will include:

- To provide professional guidance for all components project owners, component project management boards of RAP, EIA, EMP required by donor JICA;
- To receive policies on resettlement, environment from JICA put into the project, compare suitability or not consistent with the national policies and make recommendations to apply;
- To implement internal monitoring (regular or irregular) under RAP, EMP; monitor, inspect, update situation and data during the process of implementing RAP, EMP;
- To recommend the necessary solutions for implementing resettlement, environmental issues at the request of the project schedule. To monitor the results of implementation and prepare evaluation report after approval;
- To examine the independent monitoring report on environmental and resettlement issues prepared by consultants, revise and submit to donors;
- To examine the RAP, EMP / IEE, EIA report established by the project component management boards and consulting firms to revise and submit to Donors;

To perform other tasks on Resettlement, Environment under the loan agreement provisions;

Safeguards Monitoring Consultant (CIMC) mobilized by ICMB9 will be responsible for periodic monitoring of the compliance with EIA, including:

- Periodic monitoring of the compliance with safeguard policies of the project and relevant documents approved for the subprojects;
- Monitoring environmental quality in the project area in accordance with approved EIA;
- Consulting with local communities regarding the implementation of safeguard policies of the project;
- Monitoring the results of grievance redress;
- Informing the CPMU, DARD, ICMB9, and contractors about the outstanding issues that need overcoming in implementing safeguard policies of the project;
- Reporting to ICMB9 the periodic monitoring results so that ICMB can adjust accordingly and timely during the project implementation process.

Local communities: Community Supervision Board at commune/village level is established in accordance with the Decision No. 80/2005/QD-TTg dated April 18 2005 by the Prime Minister promulgating the regulations on investment supervision by community.

4.2.5 Environmental grievance redress mechanism

MARD coordinating with the PPCs to verify and handle violations (if any) of ICMB9, DARDs, contractors and other relevant units in implementing environmental safeguards of the Project.

The Community Supervision Board is responsible for monitoring of day-to-day compliance with environmental safeguards during construction process and reporting to the local authorities/ ICMB9 regarding incidents occurred; or calling via the "hot line" to report to the ICMB9 for timely solution. Local authorities and communities as well as social associations and organizations will supervise the implementation of the contractors, and monitor the environmental and social impacts during the subproject phases. When complaints from people in the project area are lodged (for example, land acquisition, compensation, issues related to environment, etc.), the affected people/Community Supervision Board will report to the local authorities/contractors and ICMB9 for solution. In case the complaints cannot be solved, the final step is People's Courts at district/provincial/central level.

Contents of environmental management as well as *responsibilities of the stakeholders in managing and implementing mitigation measures* are presented in the Table below.

Table 5 - 1:Responsibility of stakeholders in management and implementation of mitigation measures

No.	Construction areas, issues / impact	Mitigation measures	Implementing agencies	Monitoring agencies	Cost	Monitoring indicators
I		Construction preparation phase				
1	Adverse effects in the design	Develop alternatives to select the best design solutions to minimize the negative impacts on environment and society Section 4. 1. 1, EIA report	Design contractor	ICMB9, EMC, local community	Included in design package	Approved document
2	Mine clearance	Conduct mine clearance before construction Section 4. 1. 2. EIA report;	ICMB9	ICMB9, EMC, local community	Included in construction package	Bidding document/EIA report Decision 96/2008/ QĐ-TTg on remaining UXO
3	Land acquisition, compensation, resettlement	- Investigate, determine land area to support and compensate; conduct consultation meeting with stakeholders on issues relating to the community; analyze public and private interests of community that the project offers. - Disseminate current policy of state and of Ben Tre province on support for land and existing buildings compensation. - Compensate, support affected people as planned	ICMB9 PPC	PPC, local community	Included in cost for support, compensation	Approve RAP
II		Construction stage				
1	Construction planning and	- Make reasonable construction plan to avoid overlapping various stages - Minimize impact that causing traffic disruption and waterway	ICMB9 Contractor	PPC, DARD,	Included in design	Approved document

No.	Construction areas, issues / impact	Mitigation measures	Implementing agencies	Monitoring agencies	Cost	Monitoring indicators
	resources			local community	package	
2	Site clearance and dredging to prepare site	- Prepare plans for disposal land, stockfile of waste sludge; location of stockpile should not be near the water sources - Topsoil should be stored separately for later use - Make the most of waste soil as filling material, such roadbed Section 4.1.2.1. EIA report	Construction contractor	ICMB9, EMC CMC, local community	Included in construction package	Bidding document/EIA report
3	Construction waste	- Solid waste is temporarily stored on site in a separate area which had been agreed and approved by local governments before being collected and destroyed by specialized collection units. - Used grease must be collected and taken off site for reuse or recycling. - Construction facility, transportation, machinery whould be repaired and maintained in maintenance centers in the province, to minimize repairs at the site (must prepare a temporary repair shop). Section 4.1.2.1, 4.1.2.2, EIA report	Construction contractor Waste collection units at commune; Specialized waste collection units such as URENCO	ICMB9, EMC CMC, local community	Included in construction package	Bidding document/EIA report
4	Domestic waste	Section 4.1.2.1, 4.1.2.5, 4.1.2.7 EIA report - Be sure to have the facilities for construction workers such as the dining room, place to take a rest, bathing room, health facilities, sanitation, etc; - Need to implement measures to reduce the risk of littering and irresponsible behavior in waste disposal. The contractor must arrange the trash, containers in all camps, construction sites;	Construction contractor Waste collection units at commune	ICMB9, EMC CMC, local community	Included in construction package	Bidding document/EIA report

No.	Construction areas, issues / impact	Mitigation measures	Implementing agencies	Monitoring agencies	Cost	Monitoring indicators
		- The garbage containers must be covered to avoid spillage, rain and sun resistant and non-corrosion - Domestic waste must be collected and dumped daily at the prescribed places - Prohibit burning and burrying solid waste at the site				
5	Traffic obstruction ans accidents	Section 4.1.2.13, 4.2.1.1, 4.2.1.2, EIA report - Strictly comply with regulations on traffic safety and the rules when participating in traffic. - Inform the community in the area on construction planning and time; determine safety zone, place signs, light in construction areas. Prohibit unauthorized persons from entering the area under construction. - Avoid transporting construction materials during peak hours	Construction contractor	ICMB9, EMC CMC, local community	Included in construction package	Bidding document/EIA report
6	Sources of dust	Section 4.1.2.2, 4.1.2.3, EIA report - The contractor is responsible for compliance with the laws of Vietnam for the quality of ambient air environment - The Contractor shall ensure to minimize sources of dust, control dust to maintain a safe working environment, minimize the negative impact on surrounding residential areas - Loading and unloading of materials must be properly covered and to cover closely during transportation to avoid spillage. - Exposed sites to gather material and land should be preventing from winds to avoid affecting on the sensitive points - Workers should have a mask when working in areas with high dust levels - Spray water 2 times periodically during the construction of	Construction contractor	ICMB9, EMC CMC, local community	Included in construction package	QCVN 05:2009 /BTNMT: technical regulation on quality of ambient air

No.	Construction areas, issues / impact	Mitigation measures	Implementing agencies	Monitoring agencies	Cost	Monitoring indicators
		management route; frequency for spraying may increase during the dry season and wind conditions				
6	Air pollution	Section 4.1.2.2, 4.1.2.3, 4.1.2.4 EIA report - All vehicles must comply with Vietnamese regulations for controlling allowable emission; - Vehicles must be checked on emission levels periodically and issued Certificate of compliance with quality control, technical safety and environmental protection in accordance with Decision 35/2005/QD-MOT - No burning waste, construction materials on site - Cement mixers must be located away from residential areas - Turn off the equipment when not in construction	Construction contractor	ICMB9, EMC CMC, local community	Included in construction package	TCVN 6438-2005 transportation vehicles, max limit for emission
8	Noise and vibration	Section 4.1.2.4 EIA report - The contractor is responsible for compliance with Vietnamese law on noise and vibration - Vehicles must be checked periodically and issued a Certificate of compliance with quality control, technical safety and environmental protection in accordance with Decision 35/2005/QD-MOT to ensure that noise under the limit; - In case of necessary, implement measures to reduce noise (mounted muffler, silencers, sound insulation panels, etc.) - Avoid or limit transport through residential areas	Construction contractor	ICMB9, EMC CMC, local community	Included in construction package	QCVN 26:2010/ BTNMT: National technical regulation on noise QCVN 27:2010/ BTNMT: National technical regulation on

No.	Construction areas, issues / impact	Mitigation measures	Implementing agencies	Monitoring agencies	Cost	Monitoring indicators
						vibration
9	Water pollution	Section 4.1.2.5, 4.1.2.6, 4.1.2.7, 4.1.2.8, 4.1.2.10 EIA report The contractor is responsible for compliance with the laws of Vietnam on wastewater - Fixed or mobile toilets with septic tank should be installed on the construction sites for workers. No discharging wastewater from toilets, kitchen, bathroom, sink directly into rivers. - Wastewater exceeding permissible standards must be collected into a tank and transported out from the sites by licensed waste collection means - Rain water, runoff water should be kept in the deposition channel and temporary pit before being discharged into watercourses. Dredge sediment periodically and at the end of construction phase	Construction contractor	ICMB9, EMC CMC, local community	Included in construction package	QCVN 09:2008/ BTNMT: National technical regulation on groundwater quality QCVN 14:2008/ BTNMT: National technical regulation on domestic waste
10	Dredge sludge	Section 4.1.2.10 - Arrange silt curtains/screens to isolate the part where the dredging activities are carried out with the other parts to prevent sludge spreading into the environment - Not transport the volume of sludge over limited barge capacity. - Use barriers to prevent overflow caused by rainfall; - Not transport in heavy weather time or in the time when large ships/vessels move.	Construction contractor	ICMB9, EMC CMC, local community	Included in construction package	Bidding document/EIA report

No.	Construction areas, issues / impact	Mitigation measures	Implementing agencies	Monitoring agencies	Cost	Monitoring indicators
		- Preventing illegal disposal of dredged materials - Prevent incidents of wrecked barges transporting sludge and other accidents by coordinating the schedule of navigation, hydrology and meteorology, - Follow strictly regulation of waterway safety during transportation time.				
11	Occupational safety, environmental safety	Section 4.1.2.9 - The contractor is responsible for compliance with law of Vietnam on labor safety - Train workers about occupational safety regulations, operating equipment properly - Prepare fire-fighting means, first aid at camps - The contractor must have safety measures such as fences, retaining walls to minimize accident risks for people and sensitive areas - Equip fully labor protection for workers	Construction contractor	ICMB9, EMC CMC, local community	Included in construction package	Decree 22/2010/ TT-BXD on construction safety Instruction 02/2008/ CT-BXD on safety issues and sanitation of construction units
12	Social impacts	Section 4.1.2.12 - Priorize use of labor resources appropriate to the job at site. - Train, disseminate awareness of people to construction workers at the project site. - Introduce to the workers of customs / habits of the local people in order to avoid misunderstandings likely occur between the workers and	Construction contractor	ICMB9, EMC CMC, local community	Included in construction package	Bidding document/EIA report

No.	Construction areas, issues / impact	Mitigation measures	Implementing agencies	Monitoring agencies	Cost	Monitoring indicators
		the local people. - Incorporate with the local authorities concerning in management of workers residing in locality.				
13	Incidents	Section 4.2.1 EIA report - In case of incident, carried out rescue activities include contacting the relevant authorities for cooperation in resolving incidents, minimizing level of damage when the incident occurres. - Equip all kinds of fire fighting equipment such as CO2 cylinder, arrange a system of water tanks near residential areas to provide timely rescue when the problem occurs. Equip knowledge on occupational safety and provide equipment and labor protection during construction. - Upon discovery of archaeological areas, monuments, graves or other objects during the construction process, the contractor needs to suspend construction activity, make zone and protect detected areas and notify the Supervision consultant and authorized agencies for dealing plans.	Construction contractor	ICMB9, EMC CMC, local community		Decree 22/2010/ TT-BXD on construction safety Instruction 02/2008/ CT-BXD on safety issues and sanitation of construction units Law on cultural heritage (2009)
III		Operation phase				

No.	Construction areas, issues / impact	Mitigation measures	Implementing agencies	Monitoring agencies	Cost	Monitoring indicators
1	Surface water pollution	Section 4.1.5 EIA report - Limit extent and duration of stagnant surface water - Strengthen environmental hygiene in salinity prevented areas. - Limit and control the abuse of plant protection products. - Regularly check environmental sanitation at the production facility, raising and processing livestock and aquaculture facilities. - Farming matching with processes for soil protection.	Construction contractor	ICMB9, local community	Cost for operation	Bidding document/EIA report
2	Sluicegates incidents	Section 4.2.1.2., 4.2.2.2 EIA report During operation phase, it needs proper maintenance mode for all of the work items. - Regularly check and monitor operation status of mechanical equipment in sluicegates, repairs or replace with new equipment should be carried out if damage or reduction of accuracy is detected. In the case that saltwater spills into the field in large scale due to dike break down or sluice gates broken, following steps should be carried out: - Timely prevent, cover with sacks of land, close reinforced concrete gate (at the sluicegates) to prevent saltwater intrusion into the field. - Promptly mobilize equipment and rescue vehicles to the scene to reinforce broken dyke embankment. - Promptly repair or replace the break down valves.	ICMB9, the work management units	ICMB9, local community	Cost for operation	Bidding document/EIA report
3	Explosive incident	Section 4.2.2.3 EIA report Fire protection should be carried out according to specific instructions about fire safety.	ICMB9, work management units	ICMB9, local community	Cost for operation	Bidding document/EIA report

4.3 ENVIRONMENTAL MONITORING PROGRAM

ICMB9, construction contractor and authorized agencies develop environmental monitoring program, collect environmental samples at locations likely generate pollution to air, water and soil environment and adverse impacts on ecosystem, social environment.

The monitoring program will be implemented during construction phase and operational phase of work with annual frequency to preliminarly assess current status of environmental quality, provide environmental information in the region for DONRE in order to contribute to environmental management of the province.

The project will establish and maintain procedures to identify natural environmental and social issues under its activities and potential impacts of such activities to determine the factors that may have serious impacts on environment. The environmental issues are factors during performance activities of the project which interact with the environment surrounding. These identified environmental issues are considered to set up environmental targets and the new information will always be updated.

Content of environmental monitoring program include:

4.3.1 Natural environment monitoring program:

a) *Air environment quality monitoring*

Air environment quality monitoring program will be carried out during construction stage, at the sites with focusing construction to assess impacts of dust, emission, vibrate generated by construction activities. Results form air monitoring at this stage will assess the impact level and enhance mitigation measures in case there is serious impacts to ambient environment and construction workers on site, as well as residents living around. The monitoring will be also applied during operation phase, the results of the monitoring will be the measure shows positive influence to improve air environment of the region, as well as the ability to increase dust due to increase of number of vehicles using the road traffic.

b) Surface water quality monitoring

Surface water quality monitoring program (including monitoring water quality in main water taking canals and on fields) will be done to asses effects of construction works, measures for rehabilitation and development of agriculture in the biochemical and physical properties of the water system. This information is also used to assess the appropriateness of water use for other interests in the region and downstream of the project, especially the data assessment on fish resources.

c) Ground water quality monitoring

Impacts on ground water wuality due to construction activities may be monitored and applied mitigation measures properly via ground water quality monitoring program during construction stage.

d) Monitoring of ecosystems

Monitoring water ecosystems is in order to determine any changes in the aquatic ecosystem and any potential negative impact on the activities of fish and aquatic organisms. Monthly monitoring will start in construction time and will continue to be stable environmental conditions

The analyzed physical, chemistry and biological indicators in the monitoring program and processes will comply with Vietnam and international rules, regulations, standards.

Table 5 - 2: Proposed environmental monitoring plan

Environmental Items	Items/Parameters	Sampling Points/ Frequency	Implementing Organization	Responsible Agency
Construction Phase				
Air	◆ TSP ◆ PM10 ◆ CO, ◆ NOx ◆ SOx	8 points/ 2 times per month	Local Contractor (Local Consultant Team)	ICMB9
Surface water	◆ pH ◆ TSS ◆ BOD_5 ◆ NO_3^- (in N) ◆ PO_4^{3-} (in P) ◆ Coliform	8 points/ 2 times per month	Local Contractor (Local Consultant Team)	ICMB9
Ground water	◆ pH ◆ TDS ◆ NH_4+	8 points/ 2 times per month	Local Contractor (Local Consultant Team)	ICMB9
Noise	◆ Noise Leve (dB(A))	8 points/ 1 times per month	Local Contractor (Local Consultant Team)	ICMB9
Ecosystem	◆ Fish catch survey	16 points/ 2 times per month	Local Contractor (Local Consultant Team)	ICMB9
Operation Phase				
Air	◆ TSP ◆ PM10 ◆ CO, ◆ NO_x	8 points/ 2 times per month	Local Consultant Team	ICMB9

	◆ SO_x			
Surface water	◆ pH ◆ TSS ◆ BOD5 ◆ NO_3^- (in N) ◆ PO_4^{3-} (in P) ◆ Coliform	8 points/ 2 times per month	Local Consultant Team	ICMB9
Ecosystem	◆ Fish catch survey	16 points/ 2 times per month	Local Consultant Team	ICMB9

4.3.2 Social environment monitoring program:

The social environmental monitoring program in the table below is proposed to ensure that necessary activities to mitigate potential social impacts will be timely implemented.

Table 5 - 3: Proposed social monitoring plan

No	Monitoring items	Construction phase	Operation phase
1	Involuntary resettlement	Monitoring plan is described in the separately-prepared RAP.	-
2	The poor	Monitoring plan is described in the separately-prepared RAP.	Monitoring plan is described in the separately-prepared RAP.
3	Local economy such as employ- ment and livelihood	Monitoring plan is described in the separately-prepared RAP.	Monitoring plan is described in the separately-prepared RAP.
4	Land use and utilization of local resources	Monitoring plan is described in the separately-prepared RAP.	-
5	Water usage	Monitoring plan for surface water quality is described in table 5-2	-
6	Existing social infra- structure and service	1) Monitoring site Around the sluice gates 2) Monitoring frequency Periodic monitoring by PMU 3) Monitoring method Check report made by contractors on the operational conditions, performance and maintenance of the safety facilities around the construction sites. Carry out field confirmation survey.	1) Monitoring site Accident prevention equipment installed around the sluice gates 2) Monitoring frequency Monthly monitoring by DOT 3) Monitoring method Check complaints raised by residents. Carry out field survey to inspect the operational conditions, performance of the acident prevention equipment.
7	Misdistribution of benefits and	Monitoring plan for noise, surface water quality is described in table 5-2	

No	Monitoring items	Construction phase	Operation phase
	damage		
8	Infectious diseases such as HIV/AIDS	1) Monitoring site Construction yards and worker camps 2) Monitoring frequency Periodic monitoring by environmental supervisors 3) Monitoring method Check reports made by contractor site-managers. Carry out field confirmation survey. Check information provided by local Women Union, Fatherland Front.	-
9	Working environ- ment (including work safety)	1) Monitoring site Construction sites and worker camps 2) Monitoring frequency Periodic monitoring by environmental supervisors 3) Monitoring method Check reports made by contractor site-managers. Carry out field confirmation survey.	-
10	Accidents	1) Monitoring site Construction sites (on land and on water) 2) Monitoring frequency Periodic monitoring by environmental supervisors 3) Monitoring method Check reports made by contractor site-managers. Carry out field confirmation survey.	1) Monitoring site Safety (accident prevention) equipment installed around the sluice gates 2) Monitoring frequency Monthly monitoring by DOT 3) Monitoring method Check monthly reports made by operators of the gates Check complaints raised by local residents. Carry out field survey to confirm performance and operational conditions of the safety equipment.

Figure 5 - 2: Environmental monitoring location map

4.4 BUDGET FOR ENVIRONMENTAL MANAGEMENT AND MONITORING PROGRAM

Cost estimates for the implementation of environmental management program are presented in the table below based on the initial calculation. ICMB9 will identify the accuracy of these costs and adjust the annual allocation according to work requirements.

Table 5 - 4: Cost estimates of environmental monitoring

No	Items	Estimated (million VND)
1	Environmental monitoring during construction phase (10-15% of the cost for construction supervision) (5 years)	1500
2	Independent environmental monitoring (including cost for water quality, ambient air, soil, ecology environment sampling) (construction and operation phase, 6 years)	2000
3	Management cost (5 năm)	500
4	Total estimated	4000

Unit price for environmental sampling:

Table 5 - 5: Unit price for air quality sampling

No	Indicators	Unit price (VNĐ)
1	TSP	91.000
2	PM10	140.000
3	CO_x	120.000
4	NO_x	120.000

5	SO_x	120.000
6	Noise	35.000
	Total	626.000

Table 5 - 6: Unit price for surface water quality sampling

No	Indicators		Unit price (VNĐ)
1	pH	mg/l	56.000
2	TSS		80.000
3	BOD_5	mg/l	200.000
4	NO_3^- in N	mg/l	140.000
5	PO_4^{3-} in P	mg/l	140.000
6	Coliform	MPN/100ml	112.000
	Total		728.000

Table 5 - 7: Unit price for shallow ground water quality sampling

No	Indicators	Unit	Unit price (VNĐ)
1	pH	mg/l	56.000
2	TSS	mg/l	80.000
3	NH_4^+	mg/l	98.000
	Total		234.000

CHAPTER 5
PUBLIC CONSULTATION

5.1 THE NECESSITY FOR PUBLIC CONSULTATION

Public or community consultation is carried out in accordance with Clause 8, Article 20 of the 2005 Law on Environmental Protection and are specified in Circular No. 26/2011/TT-BTNMT dated July 08 2011 of the Ministry of Natural Resources and Environment. In addition, for projects receiving ODA funding from JICA, the consultation is of great importance and is encouraged to conduct.

The participation of the community will be one of the basic conditions to ensure public consensus of the project as well as to limit the adverse effects and the issues that the EIA team could not foresee. Evidences show that if the community is involved early in the project preparation process, the more likely it is to build strong relationship between the community and the project, and from which the community can contribute valuable suggestions for the project; increase the coordination of the Project Owner, Design Consultant, Environmental Monitoring Consultant, local authorities and communities in the project area. Results of the consultation will be used to evaluate design alternatives and propose mitigation measures and demonstrate the support of the community in the process of project implementation.

5.2 OBJECTIVES OF PUBLIC CONSULTATION

At the stage of preparing Ben Tre water management project (JICA 3), the consultations are undertaken in order to:

- Disseminate basic information of the project: rationale for project implementation, the scale and scope of impact, the impacts of the project and the requirements and purposes of the environmental impact assessment.
- Find out about opinions and concerns of the community about the project, especially those directly affected by the construction and operation of the project. On this basis, these concerns can be appropriately addressed during project preparation and selection of solutions in the design, construction and operation processes of the project.
- Listen to the community and their concerns for the project, especially the issues related to the life/livelihoods of the community.
- Resolve conflicts in the suggestions from the community, environmental issues and issues related to the implementation of construction schedule of the local authorities.
- Confirm the validity and legality of the decisions of the local authorities to meet the legitimate requirements of the people, to consider the recommendations of the community and local authorities.

5.3 IMPLEMENTATION METHOD AND RECORDS

5.3.1 Consultation meetings held by Vietnamese agencies

a) Implementation method

As scheduled, community consultation and information disclosure of the project will be carried out in two rounds. The first round is consultation with district level and the second round is consultation with commune level and local communities.

Prior to each consultation, ICMB9-the coordinating agency of Ben Tre Water management Project (JICA 3) would send official documents to all relevant DPCs and CPCs together with the summary report of the project as well as forms to receive feedback of the CPC leaders and communal VFFs regarding the content of EIA report.

Round 1: District-level consultation: All nine project districts participated. The participants included Chairman/Vice-Chairman of each DPC; representatives of functional departments including Department of Agriculture, Department of Economics, Department of Environment, Department of Culture, etc. as well as representatives of the associations such as VFF, Women's Union and Farmers' Association, etc.

Consultation topic: determining the scope and preliminary environmental impact assessment by the activities of the project; asking for the opinions regarding the mitigation measures; determining environment factors that have not been identified earlier in the project area.

Round 2: Commune-level and community consultation: Consultation was organized at 19/19 communes. The participants included representatives of the commune leaders and people living in the project area. The details of community consultations are presented in the Table below.

Table 6 - 1: Communal and community consultation

Topic	Commune-level consultation	Community consultation
Size	All 19 project communes	45households/consultation session
Components	Chairman/Vice-Chairman of each CPC; representatives of divisions including Division of Agriculture, Division of Economics, Division of Environment, etc. Representatives of the associations such as VFF, Women's Union and Farmers' Association, etc.	Households to be directly affected by the project; households surrounding/along the canals in the construction area.
Content	Determining the scope and disclosing preliminary environmental impact assessment as well as mitigation measures of the project; Asking for the opinions regarding the communes' policies, content of the preliminary impact assessment report and mitigation measures; Collecting and recording project-related information of areas that	Disseminating key information related to the project: objectives, size, and implementation schedule; Disseminating information on the anticipated environmental impacts and impact management measures; Directly discussing with local communities regarding their opinions, concerns and queries related to the project;

	need paying due attention;	Receiving feedback and expectation of the people regarding the project.

b) Kết quả tham vấn

Qua tham vấn bằng văn bản và các buổi họp trực tiếp giữa BQLDA với chính quyền các địa phương, tham vấn các hộ dân trong vùng dự án, các ý kiến được thể hiện trong các mục dưới đây, về cơ bản các ý kiến là đồng ý với những tác động có lợi, bất lợi của việc thực hiện dự án và các biện pháp giảm thiểu được để xuất. Đã có một số góp ý về thiết kế cho dự án được chủ dự án tiếp thu, cam kết tính toán và chỉnh sửa hợp lý.

Through written consultation and face-to-face meetings between the PMU with the local authorities and households in the project area, the opinions are expressed in the following section. Basically, the local authorities and communities have agreed with the positive effects and adverse impacts caused by the project implementation as well as proposed mitigation measures. There are also some comments on the project design and the project owner has acknowledged, and committed to recalculate and adjust appropriately.

Opinions of District/City People's Committees

During the consultations, the district authorities have expressed their opinions about the project, content of the preliminary EIA report and mitigation measures as well as some issues that need to be taken into consideration. Their opinions are summarized as follows:

- Salinity intrusion in the area tends to occur faster and stronger. The impacts of salinity intrusion on production and lives of people are becoming more significant. Therefore, the construction of salinity intrusion prevention sluicegates is really necessary and urgent.
- In general, the DPCs support the project investment in the region and commit to closely cooperate to facilitate the project implementation.
- The DPCs agree with the content of the EIA report as well as preliminary mitigation measures.

There are some issues that need to be taken into consideration during the project implementation process mentioned by the commune authorities and people as follows:

- Technical conditions: taking into consideration the quality of the materials of the equipment installed under water due to high salinity, degree of corrosion, higher material damage; ensure accurate calculations and implement measures to reduce the sedimentation and erosion after the operation of the facility;
- During the construction process: to ensure good transport plans for raw materials, fuel and equipment. Optimal transportation plan is to take advantage of waterways; to ensure better safety measures during construction, avoiding incidents like fire or explosion; spread of contamination; occupational accidents, etc.

- The PMU should ensure the project quality and the implementation of the project as scheduled.

Opinions of Commune People's Committees

All of the consulted CPCs/WPCs agree with the policies and objectives of the project through written consultation and express their opinions/recommendations in the face-to-face consultation meetings.

Opinions of local communities

All of the consulted households expect that the project will be soon implemented to improve their agricultural production activities and living standards and consider that adverse impacts caused by the project are short-term and can be minimized.

Opinions of the Owner

The Owner believes that the above comments and opinions are entirely reasonable, the Owner completely agrees with the above proposals and recommendations and will strictly implement on the principle of facilitating the socio-economic development of the locality. The Owner commits to implement the activities as stated in the community consultation minutes in accordance with the applicable policies of the government.

5.3.2 Consultation meetings held by JICA survey team

a) Implementaion method

During the Preparation Survey, 5 rounds of stakeholder consultation meeting (SHCM) were organized. Records od discussion of each SHCMs are inserted in Appendix 1 of this EIA report.

Table 6 - 2: Consultation meetings held by JICA survey team

No.	Objects	Location	Date	Content
1. SHCM	- Ben Tre PPC; - DARD; - DONRE; - Representative of project affected districts, city	Ben Tre city	27/8/ 2015	Stakeholder consultation meeting (SHCM) organization plan; Selection of communes where SHCM will be organized; Methods to select the persons to be invited to the SHCMs in the communes.
2. SHCM	Local residents; Representatives of local agencies, local mass organizations	20 selected communes	3/9 – 25/9/ 2015	Project plan; Estimated significant impacts; Plan and schedule of environmental and social survey.
3. SHCM	Local residents; Representatives of local agencies, local mass organizations	20 selected communes	23/9 – 4/12/ 2015	Agricultural development vision; Draft of the land use plan; Proposed water distribution plan.
4.	- Ben Tre PPC;	Ben Tre	28/3/	- Explain the results of the Third

SHCM	- DARD; - DONRE; - Representative of project affected districts, city; Representatives of selected communes	city	2016	SHCMs; - Discuss with participants on the finalization of the draft land use plan, water distribution plan
5. SHCM	Local residents; Representatives of local agencies, local mass organizations	20 selected communes	9/5 – 25/5/ 2016	- Results of environmental and social surveys; - Content of the draft EIA report, proposed impact mitigation measures, environmental management plan (EMP); - Finalized land use plan, water distribution plan, anticipated impacts of water pollution.

b) Results from SHCMs

Table 6 - 3: Results from SHCMs held by JICA B-SWAMP survey team

No.	Results
1. SHCM	- List of 20 selected communes where the SHCMs shall be organized
2. SHCM	- There were 1.044 participants in 20 SHCMs; - Raised opinions from the SHCMs are: o Expect that the Project will be implemented soon contribute to the improvement of local residents' life and livelihood. o expect that proper measures shall be carried out to mitigate impacts such as polluted water, noise, etc. may be generated from the construction sites, and adversely affect fruit trees, and residents' life; o Want to know whether our land, and our houses will be affected by the Project or not. People who have to relocate to other places need to be informed about the resettlement plan as early as possible. o There are many boats providing services such as transportation of people, goods, agricultural products, etc. on the rivers. These boat operators should be informed as early as possible about the Project, so as they can make plan to change the route to other rivers in a timely manner. o Many residents want to cultivate citrus fruit trees in combination with aquaculture using freshwater. We want to have the instructions and supports from the relevant entities about this combined cultivation method. o Plan to construct sluice gates on other canals around the commune should also be considered in order to efficiently prevent damages caused by saline water to the locality. We want to know if such plan is being considered or not.
3. SHCM	- There were 1.044 participants in 20 SHCMs. - As a result, a large number of participants said that they want to keep their existing cultivation activities (no change) even in case of the project

	implementation. However, a small number of participants in the meetings in North Ben Tre (Thanh Tri: 28.6%, Chau Hung: 27.3%, Long Hoa: 20%, and Quoi Dien: 10%) said that they want to change their current cultivation. Regarding the reason of this change, these people said that they think surface water in the area may be polluted and their agricultural production would be decreased
4. SHCM	There were 62 participants at the meeting, of which 3 participants from ICMB9, 8 participants from BT PPC, 11 participants from 8 city/districts (i.e. Ben Tre, Binh Dai, Ba Tri, Thanh Phu, Giong Trom, Mo Cay Nam, Mo Cay Bac, and Chau Thanh), and 40 participants from 20 selected communes.
5. SHCM	Main topics explained and discussed in the meetings are: - The results of the Preparation Survey for the B-SWAMP (including the land use plan, the design of the sluice gates, the method of operation of the sluice gates, predicted saline concentration levels and pollution (BOD) levels in surface water, establishment and function of the Water Resource Management Committee); - Natural environmental impacts and mitigation measures; - Social environmental impacts and mitigation measures.

CONCLUSION, RECOMMENDATIONS, AND COMMITMENT

1. CONCLUSION

The long-term objective of the Ben Tre Water Management Project (JICA 3) is to protect the agricultural sector and the people's livelihood in the project area from being threatened by salinity intrusion caused by climate change, to control salinity and provide freshwater supply to serve domestic, agricultural production, then serve socio-economic development of Ben Tre province. In the short-term, the project mainly support the development of infrastructure, namely the construction of 8 sluicegates in area 14 communes of 6 districts of Ben Tre province in order to solve the above-mentioned risks from water and climate that can affect the development of agriculture. Thus, the project has special scale and importance for the overall development of all Ben Tre provinces. However, during the preparation, construction, and operation processes, the project will cause some impacts on the natural and socio-economic environment in the area. These effects include both positive and negative impacts.

In order to assess the project's impacts on social and environmental aspects, based on which propose the mitigation measures for adverse impacts in all phases of the project, and ensure the compliance with environmental protection regulations of Vietnam as well as the donor, the Environmental Consultant has prepared the Environmental Impact Assessment Report for Ben Tre Water Management Project (JICA 3).

The EIA Report uses updated information from the locality and other components. The Consultant Team has referred to as well as complied all of the regulations of the GoV and policy requirements of the donor. Also the Consultant has recorded the opinions and feedback of the experts, relevant agencies, authorities at different levels and local communities. The data used in this report is updated until June 2016.

The assessments and opinions given in the EIA report are based on legal and scientific documents with high accuracy and reliability. The assessment of the sources of emissions are based on calculations from the actual projects and normative documents on the effect sources (WHO). The formulas used in the calculation are used by Vietnamese as well as international experts from their empirical works. However, there is no evaluation method that is completely accurate but only for relative quantification of the impacts. During project implementation, appropriate adjustments are required so that the impacts on the environment are at the minimum level.

Adverse impacts during the project preparation process are mainly caused by dust, emission gas, noise generated from the clearance and gathering of materials and machinery, etc. These activities affect the quality of soil, water, air and ecological

environment in the area. The Project will acquire a total of 173,068 m2 of land, mainly agricultural and residential land. 30 households will be affected including 22 households who have to relocate.

The construction process will generate considerable impacts from activities such as excavation, dredging, transportation, gathering and installation, construction, concrete mixing, concentration of workers, etc. The volume of pollutants is large including sludge, excavated soil, dust, emissions, solid waste, domestic wastewater, construction waste including hazardous waste. The environmental and social components including soil, water, air, humanities will be affected. However, due to the characteristics of the project's activities, most of the construction activities are carried out at the river-bed and coastal estuaries with densely interwoven river network; therefore, the impacts on the aquatic ecosystem and hydrology of the rivers where the construction works are carried out as well as the entire region during both construction and operation processes are paid special attention.

Regarding the impacts on hydrological regime in dry season, flooding season, salinity and water quality:

+ Variation of dry season's flow: In case sluicegates are closed for preventing salinity intrusion, the water level of the main rivers such as Co Chien, Ham Luong and Cua Dai does not change with or without project as this area is mainly influenced by East Sea tide. However, at Ba Lai River in the upstream of Ba Lai sluicegate, the water level changes significantly due to the closure of An Hoa, Ben Tre, Ben Ro and Tan Phu sluicegates. Normally, without the project, the tidal amplitude in this area ranges from 1 to 2.5m. When the sluicegates are closed, the tidal amplitude is reduced to 0.5-1.5m. The water level of tide crest decreases while trough increases will cause difficulties to take water. In this case, when operating, it is suggested to open the sluicegates when salinity has not intruded into the sluicegate location to increase water exchange capacity. Especially at Ben Ro and Tan Phu sluicegates, only close the sluicegates when necessary. The water level in the project area also changes significantly when the sluicegates are closed to prevent salinity intrusion.

The flow in the project area also decreases when the sluicegates are closed, which reduces the water exchange capacity as well as water quality and increases the depositions in canal-bed.

+ Salinity control: Infield salinity distribution in Mekong Delta Region depends on the operation of the salinity control facilities. The salinity in the main rivers primarily depends on tide and upstream flow. According to the scenarios, salinity will change significantly and intrude deeper when sea level increases and upstream flow reduces.

Under the current conditions, the salinity control system in Tra Vinh is As for the salinity control system in the area between Co Chien and Ham Luong rivers, salinity has intruded Cai Quao and Mo Cay Bac entering into freshwater supply canal, causing difficulties for agricultural production. In Co Chien River, salt concentration

of 4 grams per liter has intruded near Mo Cay Nam sluicegate. As for the salinity control system in the area between Cua Dai and Ham Luong rivers, salinity has intruded into Thu Cuu River and even Ben Tre River entering into freshwater supply canal, causing difficulties for agricultural production. In Cua Dai River, salt concentration of 4 grams per liter has passed An Hoa River and entered My Tho.

After the works are completed, salinity will be controlled in most of the project area. However, in the North of Ben Tre River, the estuary canals (Song Ma, Thanh Kieu, Luong Cai canals) from Ben Tre River to Ben Ro River have not been built (small-scale works are invested by the local authorities); therefore, if these are not enclosed, salinity will intrude into the freshwater area, affecting agricultural production activities.

The effects of the construction of salinity control works will reduce the intrusion speed on the main rivers. However, the decrease level is not much.

According to the computational and analytical results, with regards to salinity control, the priority given to the sluicegates is in the following order: Cai Quao, An Hoa, Mo Cay Bac, Ben Tre, Mo Cay Nam, Ben Ro and Tan Phu. It is proposed to build three sluice-gates in the North of Ben Tre River to Ben Ro River after Ben Tre sluicegate is built. A number of other small sluicegates will be developed by the locality according to the actual production needs of people.

+ Flood control:

In case of the work completion, the water level of the main rivers in the project area does not increase much, only by 0.01m to 0.04m during flood season.

The impacts of the salinity control facilities will reduce water level in the project area, especially at the enclosed sluicegate area such as the area between Ham Luong and Cua Dai rivers. In Tra Vinh, the water level does not decrease much since flood from upstream through freshwater canals of salinity control system still enters the project area.

According to the computational results of the inundation area according to each scenario, in the current state (KB9), the area at risk of inundation is 5,410 km2, accounting for 85% of the natural area; when the works are completed as planned (KB10), the area at risk of inundation reduces by 717km2 to 4,693 km2, accounting for 74% of the natural area. In case of rising sea level until 2050 (KB11), the area to be inundated is 4,985 km2, occupying 78% of the natural area; compared to the area of KB10 scenario, the inundated area increases by 292 km2. In case of taking into consideration the rising sea level until 2100 (KB12), the area at risk of inundation is 5,237 km2, making up 82% of natural area; compared to the area in the KB11 scenario, the inundated area increases by 252 km2.

Changes in water quality:

Pre-project: The current distribution of water quality in the project area is not even; the areas which are most affected are urban and densely populated areas such as Ben Tre City, Cho Lach, Mo Cay, Ba Tri, Thanh Phu, and Chau Thanh in Ben Tre province. BOD concentration in the project area ranges from 6 to 19 milligrams per

liter. The content of total N in the project area ranges from 0.42 to 1.6 milligrams per liter. The content of total P in the project area is from 0.1 to 0.31 milligrams per liter. In general, the surface water quality meets the B1-B2 standard according to the National Technical Regulation QCVN08:2008/BTNMT.

When the works come into operation: When the construction of works is completed and put into operation, the distribution of water quality in the project area tends to increase due to less water exchange capacity. The areas that are most affected are urban and populated areas such as cities. The BOD concentration is the project area ranges from 6 to 23 milligrams per liter, increasing by 4 milligrams per liters compared to the current level. Total N content in the area is from 0.42 to 2.6 milligrams per liter, increasing by 1 milligram per liter compared to present. Total P content in the project area ranges from 0.1 to 0.46 milligrams per liter, increasing by 1.5 milligram per liter compared to the current level. In general, surface water quality still meets the B1-B2 standard according to the National Technical Regulation QCVN08:2008/BTNMT.

Impacts on ecosystem:

- The biological diversity in the project area is assessed as relatively high including freshwater and brackish water species. However, there is no endemic species listed in the Red Book of Vietnam as well as the world.

- The project implementation will cause impacts on aquatic species that have the habits to migrate to forage for food sources and spawning grounds, especially shrimps and fish. Specifically:

- As for brackish species: As the work is built with the goal to prevent salinity, when salinity level increases, sluicegates will be closed to prevent the intrusion of saltwater into infield area. Therefore, salt water species cannot migrate into the fields as before.

- As for non-halophilic species: Without the construction, their scope of migration entirely depends on salinity intrusion level of tide. However, when salinity prevention sluicegates are put into operation, the limit of tidal intrusion is at the sluicegate locations. It means that during dry season, when tide rises, the migration limit of the fishes will be extended to the sluicegate location; while during rainy season, when tide is pushed away and sluicegates are opened, they can migrate outside for foraging.

* *Altering aquatic ecosystem in the infield area:* when the sluicegates are not in place, the infield ecosystem often changed due to the salinity intrusion between the brackish water ecosystem and freshwater ecosystem. However, when the project is put into operation, a freshwater ecosystem will be maintained and stabilized with the predominance of freshwater species.

All of the adverse impacts mentioned above can be minimized through an environmental management and monitoring program. Mitigation measures and measures to prevent and respond to the environmental risks and incidents are proposed in detailed, ensuring high reliability and feasibility.

The positive effects during operation are practical and long-term such as salinity control and regulation, expansion of irrigation area, increase in water supply for domestic purposes, improvement and expansion of arable land, aquaculture, traffic improvement, and positive impacts on landscape of the area.

In short, during the process of construction and operation of the project, if the proposed mitigation measures and environmental management and monitoring program are well implemented, the positive effects brought by the project to the natural environment and socio-economic development in the project area will be significant, broad and long-term. On the other hand, in view of the socio-economic development in the area based on a harmonious combination of adaptation to nature, promotion of regional comparative advantages, and the protection of natural resources, the implementation of Ben Tre water management project is appropriate and necessary.

This report is one of the important and necessary documents for the environmental state agencies and the Donor in identifying the location and size of the project and allocating budget for the project.

Impacts on waterways in the area

The project construction area is divided by several interlacing canals, creating a river traffic network which is greatly convenient for people in the area. The construction activities will cause certain impacts impeding the operation of waterways. However, the contractors will apply flexible construction methods not to obstruct the entire river; therefore, the construction acticities only affect the waterways in a short time. The waterways, thus, are not completely closed or stagnant. In addition, the measures to ensure the flow of waterways will be taken in order to minimize the impacts during construction period.

During operation phase, apart from four sluicegates located along the tertiary waterway with the construction of locks, namely An Hoa, Ben Tre, Vam Thom, and Vam Nuoc Trong, other sluicegates are located along the canals with lower waterway demands, construction of locks is thus not required. At these sluicegates, obstruction to waterways may occur and cause significant impacts when sluicegates are closed for a long time. However, the flexible operation of the sluicegates depending on the actual conditions and experience of the locality will be calculated to avoid causing impacts to the maximum extent on the operation of the vessels in the area.

2. RECOMMENDATIONS

MONRE should carry out appraisal and approval for the EIA report of the project soon so that the next steps of the project can be carried out;

During the project implementation process, it is recommended that Ben Tre PPC should request the relevant departments and local administrative agencies to participate and cooperate in implementing the project;

During site clearance process: PMU needs assistance and cooperation from the People’s Committees and VFFs of the communes and wards in the project area as well as concerned agencies to soon prepare the site for project construction.

During construction process: PMU should cooperate with DARDs to ensure good conditions of irrigation water and crops for local people; cooperate with Department of Transportation to regulate waterway and road traffic in the project area.

The project owner should consult with the Vietnam Inland Waterway Administration and Departments of Transportation in the project area to ensure the circulation of boats, vessels on the rivers and canals where the sluicegates of the subproject are being built.

As for environmental protection activities, PMU should receive cooperation as well as support and contribution from DONREs of the project provinces to be able to perform well during project implementation.

3. COMMITMENT OF THE PROJECT OWNER

ICMB9 (Project owner) commits to implement the environmental management and monitoring programs as described in the Chapter 5 (including standards and environmental technical regulations the Project must comply with); implement the commitments with the local communities as in Section 6.4.4-Chapter 6 of the EIA Report; comply with the regulations on environmental protection including:

- Pollution treatment facilities will be designed during technical design process, built during preparation and construction phases, and completed before the project is put into operation;
- The project owner fully implement responsibilities as specified in the Decree No. 18/2015/ND-CP by the Government dated February 14, 2015 providing environmental protection planning, strategic environmental assessment, environmental impact assessment and environmental protection commitment, after the project's EIA report is approved. Specifically:
    - There are written documents sent to 6 DPCs and City PC informing the approval of EIA report with a copy of the approval decision;
    - Posting at the offices of 14 CPCs the abbreviated EIA report that was approved, specifying the types and volume of waste; waste treatment technologies and equipment; level of treatment according to the particular parameters of the waste in comparison with the prescribed standards; other measures to protect the environment;
    - Designing and installing environmental treatment facilities: based on the princples of treatment facilities proposed in the approved EIA report, proceeding with detailed design and construction of these works according to the current regulations on investment and construction.
    - After the detailed design of the treatmenr facilities of the project is approved, there must be written document reporting to Ben Tre, Vinh Long, and Tra Vinh DONREs on the installation schedule attached with the detailed design documents for monitoring and inspection;
    - Protection of the environment during the construction process: During the construction period, implementing environmental protection measures, mitigation measures for the negative impacts on the environment caused by

the project, and conducting environmental monitoring in accordance with the requirements set forth in the approved EIA report as well as other requirements specified in the decision approving the EIA report. In the process of implementing the construction activities of the project, if there is any adjustment and change in the environmental protection content and methods, there must be written documents reporting to Ben Tre DONRE and the measures can only be carried out after obtaining the written approval of the concerned agencies. During the construction and pilot operation period, if environmental pollution occurs, the activities must be stopped immediately and timely reported to the relevant Division of Natural Resources and Environment of the districts where the project is implemented as well as Ben Tre DONRE.

- The owner is responsible for cooperating and creating favorable conditions for the state management agencies to supervise and check the implementation of environmental protection measures of the project. The owner is responsible for fully providing relevant information and data upon request.
- Environmental monitoring program and training on environmental safety will be conducted during the construction and operation process. The budget for treatment facilities, environmental monitoring, and training will be guaranteed by the project owner.
- The project owner commits that during the project's operation process, if there is any violation of international conventions, Vietnamese regulations on environment or the owner lets any environmental incident occur, the project owner must be fully responsible before the law of the Socialist Republic of Vietnam.

- The Technical Regulations applied in the EIA Report including the National Technical Regulations and effective Vietnamese Standards:
  - QCVN 05:2009/BTNMT – National technical regulation on ambient air quality;
  - QCVN: 06/2009/BTNMT – National technical regulation on hazardous substances in ambient air.
  - QCVN 08:2008/BTNMT - National technical regulation on surface water quality;
  - QCVN 09:2008/BTNMT - National technical regulation on underground water quality;
  - QCVN 15:2008/BTNMT - National technical regulation on chemical residues of plant protection in the soils.
  - QCVN 26:2010/BTNMT - National Technical Regulation on Noise;
  - QCVN 27:2010/BTNMT - National Technical Regulation on Vibration;
  - QCVN 43:2012/BTNMT – National Technical Regulation on Sediment Quality

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