Project: Climate change and impacts on rice production in Vietnam: Pilot testing of potential adaptation and mitigation measures

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Title of the report: Climate change scenarios for the study regions and their impacts on rice production with respect to droughts and salinity identified

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ABBREVIATIONS

CBA	Cost and Benefit Analysis
CMI	Climate moisture index
DEFRA	Department for Environment Food and Rural Affair
FAR	Fisrt Assessement Report
FYM	Farm Yard Manure
GCM	Global climate models
GSO	General Statistic Office
IAE	Institute for Agricultural Environment
INC	Initial National Communication
IPCC	Intergovernmental panel on Climate change
MARD	Ministry of Agriculture and Rural Development
MONRE	Ministry of Natural Resources and Environment
NCAR	National Center for Atmospheric Research
PRECIS	Providing Regional Climates for Impacts Studies
TAR	Third Assessement Report
UNFCCC	United Nations Framework Convention on Climate Change
VND	Vietnam Dong

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I. REVIEW OF CLIMATE MODELING WORK DONE IN VIETNAM

In Vietnam, there a number of climate change studies that were carried out and scenarios developed and applied for different purposes of climate change related activities during the last two decades. However, in order to have a more comprehensive scientific and practical based scenarios for the implementation of National Target Program to Respond to Climate Change (NTP), the Government assigned the Ministry of Natural Resources and Environment (MONRE) to be the coordinating agency for collecting and managing the climate related data and developing climate change scenarios, especially to address the impacts from sea level rise for Vietnam.

In this report, a brief review of the studies in Vietnam on climate change scenarios are analyzed and discussed . This review helped to find the gaps in climate scenarios development and further work to fill in the gaps. The impacts of climate change on agriculture and farming communities in general and rice production in particular were assessed for the three provinces (Nam Dinh, Soc Trang and Tra Vinh). The following were some of the most climate change relevant studies carried out in Vietnam so far:

- A climate change scenarios report developed in 1994 on climate change in Asia, a project funded by the Asian Development Bank (ADB);
- Climate change scenarios developed for GHG inventory for the purpose of Vietnam National Initial Communication to the United Nations Framework Convention on Climate Change (IMHEN, 2003);
- Climate change scenarios constructed by using the coupled method (MAGICC/SCENGEN 4.1 software) and the statistical dowscanling method for Vietnam domain and other smaller regions (IMHEN, 2006);
- Climate changes scenarios developed for the draft of the Vietnam National Sencond Communication to the United Nations Farmework Convention on Climate Change (IMHEN, 2007);
- Climate change scenarios developed by using the MAGICC/SCENGEN 5.3 software and statistical downscaling method (IMHEN, 2008);
- Climate change scenarios for Vietnam domain developed by using dynamical method (IMHEN, SEA START and Hadley Centers, 2008);
- The other studies include the tidal gauges data at Vietnam coatstal station; Vietnam studies on sea level rise such as East Sea Tides and Water Level Rise along Vietnam Coasts; and the Assesmanet of sea level rise-induced damages all carried out by the Marine Center in Vietnam (General Department of Sea and Island, MONRE).

Since 2012, Vietnam began to use several models to study climate change and impacts, particularly the sea level rise, with a priority in the coastal provinces, especially the Mekong Delta provinces. According to Dr. Tran Thuc, Director of Vietnam Institute of Meteorology, Hydrology and Environment (IMHEN), Intergovernmental Panel on Climate Change – IPCC will release scenarios of climate change in global and regional scope in the fifth assessment reports towards the end of 2014. The development of scenarios of climate change and sea level rise for Vietnam will be updated in 2015 (after the MONRE completes and publishes the results). World Bank assessed five countries to be the most affected by sea level rise including Egypt, Vietnam, Bangladesh, Surinam, and the Bahamas in which Vietnam is the second country in the world that will be strongly influenced by the impacts of climate change.

The impact and potential exposure and vulnerability to climate change should be reviewed and updated as new scenarios are published (The current report will be revised in 2015).

According to the Center for Data & Media on Disaster Preventation, Department of Meteorology, Hydrology & Climate Change, Vietnam is located in tropical monsoon of South East Asia, the coast stretches in low Delta areas, the economy depends heavily on natural resources are being seriously affected by climate change. The frequency and intensity of natural disasters is increasing, causing enormous losses of human lives, property, infrastructure, economic, cultural, social and environmental impacts (MONRE, 2009).

In 2009, on the basis of general studies within the country and outside, the MONRE developed and published climate change and sea level rise scenarios in Vietnam. But the level of details of the new scenario was limited to seven climatic zones and the coastal areas of Vietnam. MONRE assigned the responsibility to the Institute of Hydrometeorology and Environment to coordinate with other research organizations and management units in building scenarios of climate change and sea level rise for Vietnam (MONRE, 2009).

Compared with the scenarios published in 2009 (MONRE, 2009), the updated scenarios of climate change and sea level rise to Vietnam were developed on the basis of maximum exploitation of data sources and time series data upto 2010 (MONRE, 2012). During the process, climate models and statistical tools were selected, specifically for Vietnam.

The results of the updated climate change and sea level rise scenarios for Vietnam will be an important basis to guide the ministries, organizations and localities inorder to assess the potential impacts of climate change, thereby helping to develop and implement the plans to respond more effectively to minimize the environmental and socio-economic damage caused by the phenomenon.

Climate models and downscaling

At the global scale, climate scenarios have been developed using the general climate models (GCMs). The GCMs for different countries and territories often have very low resolutions. Hence, they need to be downscaled and regional climate models (RCMs) have to be developed with a more detailed resolution. There are two methods of downscaling: statistical downscaling and dynamical downscaling.

Statistical downscaling methods establish statistical relationships (nowadays mainly it is recurrent relationship or more complex regression - artificial neural network (ANN) between the observed data (on station network) and simulated data of GCM for the standard period (baseline). And the assumption is that this relationship holds true for the future. The independent variable here is the projected output of the GCM based on a set of future values of climatic factors for different stations. Primary advantage of this method is that it is simple, and easy to use. It does not require much computing resources . Most important drawbacks of the statistical downscaling methods are: (1) they do not guarantee the physical relationship between climate variables (because each variable is determined by one or a number of different contact equations); (2) the statistical relationship from the past may no longer be true for the future because climate conditions can be be modified; (3) can only capture the "rules" but difficult to capture sudden changes (extreme events); and (4) only estimates for places where statistical relationships can be established (where having monitoring data).

Dynamical downscaling uses the product of GCM as input for regional climate models. This method requires more computing and mainframe resources.

Many methods have been used to construct climate change scenarios for Vietnam such as SSM, SIMCLIM and MAGICC/SCENGEN software applications. The detailed of some of the statistical downscaling methods, using outputs from the dynamical global and regional model are shown below :

1. **MAGICC Modelling**

MAGICC was developed by the Climate Research Unit (CRU) of Britain and the National Center for Atmospheric Research (NCAR) of America (S. T.Wigley and Raper of CRU and NCAR respectively). These are the two main units that provided the main results of the study for the IPCC (MONRE, 2012).

Structure of MAGICC / SCENGEN

MAGICC provides outputs or results for average global sea level and temperature that serve as input factors to run SCENGEN. This is the model developing the climate scenarios for a simulated site.

The result of SCENGEN is the change of object forecasted on a 2.50 x 2.50 longitude – latitude grid at the period of time which needs forecasting, corresponding to selected emission scenarios. Results are shown as the change and error. The average value in each grid of SCENGEN may be monthly, meteorological seasonally: XII - II, III - V, VI - VIII, IX - XI or may be an average for a year. The forecasted objects in SCENGEN are: temperature, precipitation, sea level rise, medium sea level pressure - MSLP. Figure 1 describes the structure of MAGICC / SCENGEN.

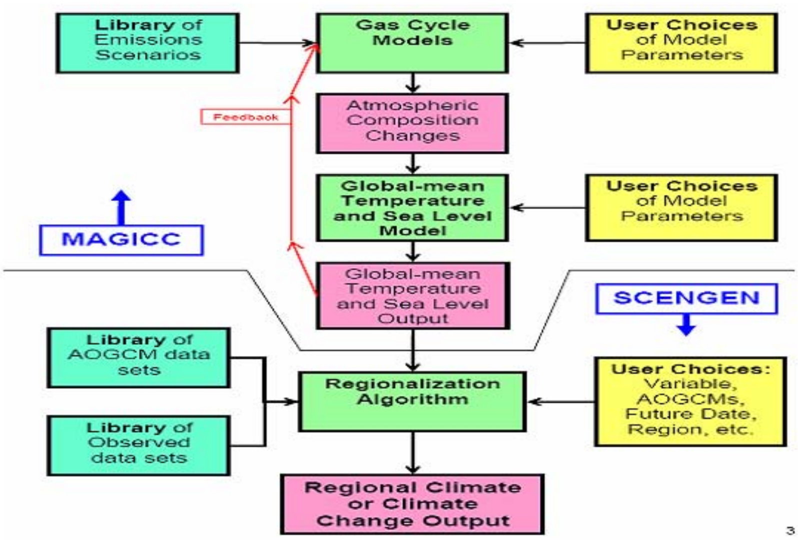


Figure 1. The structure of MAGICC/ SCENGEN (IMHEN, 2006; Wigley, 2008).

MAGICC / SCENGEN runs with the selected scenarios , and the results show the estimation of the rate of temperature change and precipitation worldwide. The results of the software are illustrated in Figure 2.

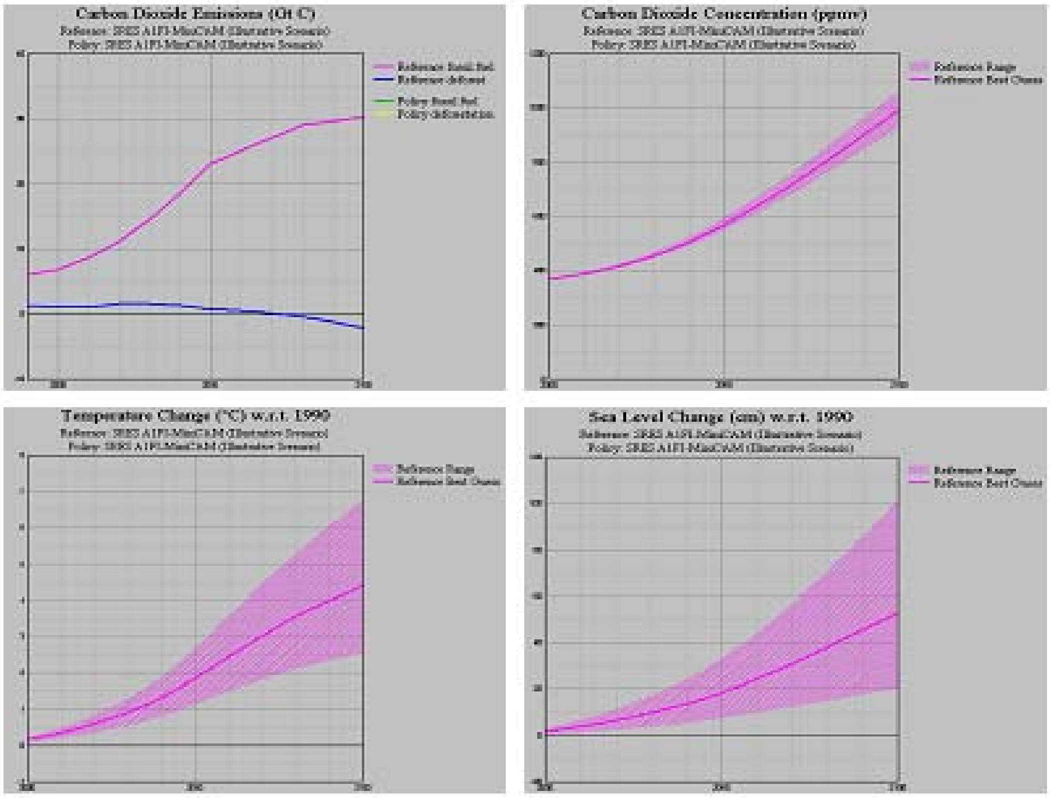


Figure 2. CO2 emission, CO2 concentration, global temperature change (°C) and sea level (cm), compared with 1990 for the high emission scenario A2.

The results of temperature, rainfall scenario for the Vietnam areas

The standard period used in MAGICC/ SCENGEN was 1961-1990. However, in the fourth-time report of the IPCC, 1980-1999 was chosen as the standard period. When calculating the results, it showed that the average values of temperature and precipitation in the period 1980-1999 was insignificantly different from one in the period 1961-1990. Hence, the standard period replacement of the period 1980-1999 in place of the period 1961-1990 is in accordance with the report of IPCC. It also does not affect the results of the scenarios which had been set up.

Climate change scenarios for temperature shows that temperature in the northern region generally will increase faster than one in the southern region. The lowest increase in temperature will be in Southwest region, followed by Southeast region, Central Highlands, North Central region, South Central region, Northeast region, North Delta region. Climatic northwest region will experience the most rapid temperature rise (IMHEN, 2008).

By 2025, the average temperature per year in climatic Northwest region will have increased by $1,5^oC$ from the low emission scenarios to the high ones. At the end of the 21^{st} century, it will increase by $1,9^oC$ (low emission scenario); $3,1^oC$ (medium emission scenario) and about $3,9^oC$ (high emission scenario); the average temperature seasonally have relatively same increase, that is about 1,9- 3,8 ^oC from the low emission scenarios to the high ones, compared with the period 1980-1999.

Meanwhile, by the end of the 21^{st} century, the average temperature per year in climatic southwest region will have increased by 1,2- $1,3^oC$. By 2100, the temperature will have increased by 1,7; 2,3 and $3,0^0C$ in low, medium and high emission scenarios respectively. It can be seen that the average temperature in season III- V will have increased the most, compared to the other seasons it will have increase by 3.8^oC high emission scenario, 3.0^oC in season $3,0^0C$ and $3,3^0C$ in season-VI-VIII and IX XI (IMHEN, 2008).

By the end of the 21st century, the annual rainfall will have increased by about 4.8 to 9.3% in the North West and North East, from 5.2 to 10.1% in the Northern Delta, about 5.0 to 9.7% in North Central; 2.2 to 4.1% in South Central, and about 1.0-2.0% in the Highlands, the South East and South West compared with the period 1980-1999 from low to high scenario. Precipitation in rainy season will have grown up in all climatic regions

Precipitation in dry season shows downward trend in most of the climatic regions of the country. Especially, the regions from South Central to South West having two seasons in which rainfall could decrease(in season XII-II and III-V). In climatic Highlands, rainfall in season III-V would decreases by 11.4 to 22.2% by 2100 compared with the period 1980-1999 from low to high scenarios. Meanwhile, it will have decreased by 2,9-5,6% in the climatic northeast region.

The rainfall would reduce in South Central, West South Central during the the dry season and increase significantly in the rainy season. Therefore, although the annual rainfall wouldn't have significant fluctuations, rain-related disasters could appear more in these areas such as drought in the dry season and floods in the rainy season, showing a inter-seasonal fluctuations. Hence it is important to provide precise fluctuations in the rainfall patterns to planners and farmers inorder to adjust the cropping calendar, cropping systems and technologies to suit the fluctuations. This is however a big challenge as the physics of monsoons is not very well developed according to the climate scientists.

PRECIS model for Vietnam

Origin and property

PRECIS (Providing Regional Climates for Impacts Studies) was developed by Hadley Center with the help of Department for Environment Food and Rural Affair (DEFRA), United Kingdom Department for International Development (DFID) and United Nations Development Programme (UNDP). PRECIS model can be runon personal computer (PC) and has the following advantages:

- The resolution is quite good: 25kmx25km.
- It can be used ot build up detailed climate change scenarios for any area in the world.
- Simple interface, users can easily install and run.
- The users don't require to do much data processing. They can do simple changes s to the data to suit their needs.

Some limitations using PRECIS:

- The areas less than 25sq km in size, especially islands cannot be covered by the software.
- To verify the outputs of PRECIS, reliable climate observations are needed.
- In addition to the   personal computer, manpower and energy are also required to maintain both software systems and equipment.
- To run the model, compilation and dissemination of results requires time to test and people who have enough experience.
- PRECIS operation can take several months so we cannot immediately get the results of climate scenarios.

Choices when using PRECIS

A PRECIS running process (an experiment) requires the following steps:

1) Select the experimental range of the region (area): can select the area available in models or user-selected.

2) Select the estimation scenarios used in experiments: The scenarios which can be changed include 4 greenhouse gas emissions of the IPCC (A1FI, A2 , B1 and B2) .

3) Duration of experiments : Can choose time to start and finish each experiment. There are several options, depending on the data provided, including background data to simulate the past and future climate data to simulate future climate change.

4) Select the type of output data : Can select the output of the model by hour / day/ months / year .

5) Run the program : Select model- mode runs to determine the method to save the output data, such as start running or continues to run when the previous run was interrupted because of some reasons.

The output parameters of the model

The results gaven by the model is a series of meteorological variables and other complex set of variables that may use for many different purposes. The time scale of the output variables is the average values for the specified period which have the options such hour, day, month, season, year and decade. The spacial sizes of the variables are also defined on the surface or on different height levels.

Output data format can be selected in the form of PP (own formats of PRECIS), netCDF or GRIB, but only PP data format can be convered to the other two forms. The PP data format is a proprietary format of the PP model, users can display in numerical form (Figure 3) and/ or a map by GrADs and Software XCONV.

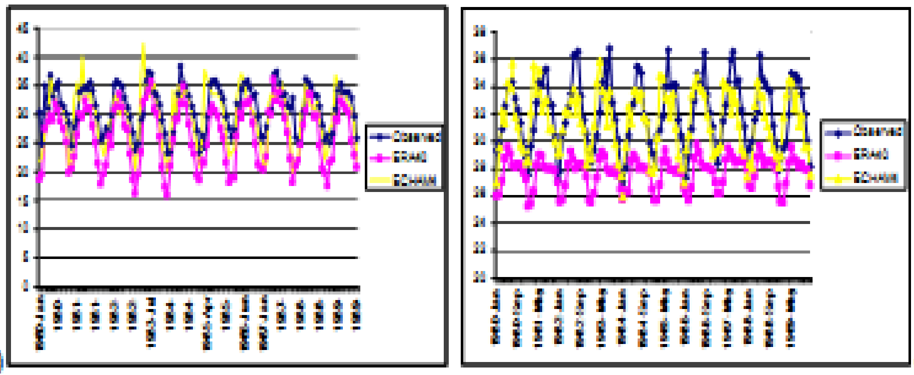
Experimental results of climate simulation in Vietnam

PRECIS model was received directly from the Hadley Centre in August, 2006. In November, 2006, the installation and operation was performed at the Center for Meteorological Research - Climate, Institute of Meteorology, Hydrology and Environment in Hanoi. .

The selected area is located between longitude: 90-120^{0}E, and latitude: 0-35^{0}N. Model was run for simulations (ERA40 and ECHAM4) using the the past 10 years climate data . The outputs are in the form of folders in which sub-folders contains the same-type data files coded (eg. 0001 includes the file containing information related to air pressure) and a folder of simulated rain map.

To evaluate and choose the input data for the model, the simulation results of a number of meteorological factors, such as air temperature, precipitation, wind speed in some typical locations are compared with the corresponding observed data.

With the average, peak and bottom air temperature, 2 sets of data are simulated, showing cycles and change trends as well.Most of the selected locations are simulated quite well when using the ECHAM4 data (Figure 3a), and it has large differences when using the ERA40 data. In the latter, the simulation results are often very low compared with observed values.



(a) (b)

Figure 3 (a) peak of temperature graph in Phu Lien monitoring and simulation station b) *Peak of temperature graph in Nha Trang monitoring and simulation station.*

The initial results of climate scenario construction for Vietnam

Until now, PRECIS model using data set ECHAM4, developed A2, B2 scenarios and completed the run for the periods 2010-2039, 2070-2100.and using the data set HadAM3P, developed A2 scenariofor 2070-2100 period. The other scenarios and periods will continue to be run in the course of time. The collected results have been processed to construct climate change scenarios for the regions of Vietnam.

The results of the model have to be re-formatted, processed, summarized and revised in accordance with the principles of unity and tolerance limitations. Here we introduce some images and data which are the initial results from PRECIS model.

PRECIS model with quite fine resolution: (25kmx25km) can be used for the construction of detailed climate change scenarios for the regions of Vietnam. The results of the PRECIS model from IMHEN (Institute of Meteorology, Hydrology and Environment) are only initial. Therefore, a lot of effort and time has to be invested so that the outputs of the model can be exploited and customized to specific areas.

SDSM model

SDSM is a tool supporting, assessing climate change at the local scale by using detailed statistic techniques.

The operation structure and various steps involved to run SDSM are as follows:

- Control quality and convert statistical data;
- Check the forecasted factors;
- Adjust the model;
- Combine existing data by factors in monitoring;
- Take the results of the model to graphical tools;
- And Combine projected future climate (climate change scenarios)

SIMCLIM model

SIMCLIM has 2 main functions which include scenario building calculation and impact assessment over scenarios.

Scenario building function: Based on the product of the global models (GCM) over each scenario and sequence of the data of climate factors, sea level rise in locals, SIMCLIM can compute scenarios of climatic factors and sea level rise in those localalites. The main method used is statistical tools combined with graphic tools. These factors include rainfall, temperature (average, extremum) and other factors such as humidity, wind etc.

Products of more than 20 general circulation atmosphere models are integrated in SIMSLIM and available in the database of PCMDI.

Impact assessment function includes:

- Assess the impacts on water resources: Demonstrated through water balance calculations. The software calculates the difference between precipitation and potential evaporation. Input of the model is the average temperature, rainfall, solar radiation. and the output is equal amount of water. Here it also possible to:

- Assess the impacts on agriculture: using heat – day calculation - Assess the impacts on shoreline erosion and water balance.

Selecting method to construct climate change scenarios for Vietnam

The method for developing climate scenarios for Vietnam is based on the appropriateness , the level of detail needed and completeness of the scenario, the method used in the published scenario for 2009 and the ability to actively update in future. The following are the methods used to build climate change scenarios for Vietnam : detailed statistics method to calculate the temperature scenario;the average rainfall seasonally and annual one for the low medium and high scenarios; AGCM model/MRI to calculate the temperature scenario, the annual average rainfall for average scenario and PRECIS model to calculate the temperature scenario, average rainfall seasonally and annual one, and the extremum for the average scenario. The SDSM, SIMCLIM software are used as the references.

II. CLIMATE CHANGE SCENARIOS IN VIETNAM

Development of climate change scenarios Climate change, sea level rise scenarios for Viet Nam are based on different emission scenarios, namely, low (B1), medium (B2) and high (A2, A1FI).

2.1. Temperature and Rain Fall Scenarios (MONRE, 2012)

- An average annual temperature rise in Viet Nam by 2100 of approximately 2.30C; if the temperature rises by 10C, the number of heat waves increases by 100 to 180 per cent, while the number of cold surges decrease by 20 to 40 per cent.
- Climate change will increase annual total rainfall everywhere in Viet Nam. In the wetter months, the probability of extreme rainfall events and flooding will also increase, especially in northern regions with increased risks of landslides in mountainous areas. With increased rainfall in June to November in Vietnam there is an increased risk of river flooding. River floods are already being exacerbated by deforestation in the upstream reaches of these rivers.
- In contrast, during the dry months, average rainfall will decrease by approximately 20 per cent, especially affecting the southern regions including the Mekong Delta. Decreasing rainfall in dry months will lead to increased drought risks, which is also because of higher temperatures that increases evapotranspiration.
- Drought and impacts: Droughts are spead over and appear in the national scale with different extent and intensity:
  - o In the moutainous areas water storage from forest is reduced and water storage from many reserviors is also reduced thereby shortening the irrigation time for crops, therefore many crops will likely face shortage of water in dry season. This may result in changes from double season to single season of crop, and decrease in yields.

- Upstream of deltas, charaterized with many middle and small reserviors will become high vulnerable with droughts, because these reserviors mostly will dry at the end of dry season impacting crops in the spring season
- Dowstream of deltas area will be facing drought in the late dry season because at this time fresh water from upstream is reduced; Sea water level will rise causing sea water to go into the mainland (about 20-30 km compared to the past 5 km in the Red River Delta and 50-70 kms compared to 10-20 kms in the past in the Mekong river delta). In all the channels and rivers the fresh water will recede and instrusion of salt water will increase. Farmers will have problems to openthe water inlets for irrigation, and this will cause drought for winter spring rice, resulting in loss of harvest.

2.2. Mean Sea Level Rise and salinity

- Rising sea levels have been observed over the past decades along the coasts of Viet Nam. Viet Nam's own planning parameter is a one meter rise in mean sea levels by 2100; without major action such as dyke reinforcements and improved drainage, a one meter rise in mean sea levels along the coast of Viet Nam would cause an estimated threat of inundation of 5.3 per cent of Vietnam's total land area.
- Data from tidal gauges along Vietnam coasts show that sea level rise was at the rate of about 3mm/year during the period of 1993-2008 which is comparable with the global tendency. In the past 50 years, sea level at Hon Dau station rose about 20cm (NTP, MONRE, 2008)

2.3. Climatic Disasters

- Vietnam is ranked 13th of the 170 countries deemed vulnerable to the impacts of climate change over the next 30 years and is one of the 16 "extreme risk" countries.
- Vietnam experiences an average of 6 to 8 typhoons annually and the possibility of gradual intensification of tropical storms and typhoons exist. Damage potential from tropical storms and typhoons appears to increase as a result of increasing population density in exposed areas and higher value economic infrastructure in these areas (MONRE, 2009).
- Much of Vietnam's 3,200km coastline is or should be protected by mangrove forest as it mitigates against the impacts of typhoons and storm surges. However, Vietnam has . 5,000km of river dykes and 3,000km of sea dykes that need expansion and reinforcemen (NTP, 2008).

2.4. Agriculture

- According to the Ministry of Agriculture and Rural Development (MARD), there are 1.6 million ha land of cultivation in the coastal areas in Viet Nam, of which paddy land is 0.9 million ha. Sea level rise will severely affect the cultivable land in coastal areas; with nearly 1.1 million ha (70 per cent) threatened by sea level rise of one meter, of which more than 930,000 ha is in the Mekong Delta, the country's "rice basket" (Nguyen Binh Thin, 2008).
- The Mekong Delta "is a densely populated region that accounts for half of the country's rice and even more of its fisheries and fruit products. By 2030, rising sea levels in the Delta-where four million people live in poverty- would expose 45 per cent of the land to extreme salinization and crop damage, with rice productivity falling by 9 per cent. Projections indicate that Viet Nam's gains over 15 years in reducing poverty, as well as solid progress towards achieving the Millennium Development Goals, would be significantly affected".

- The combination of mean sea level rise, saline water intrusion, higher temperatures, and droughts puts pressure on total agricultural production, the incomes of farmers, local and national food security and rice exports; ADB has estimated that climate change effects could hit rice and coffee production in Viet Nam .

In the IPCC's (IPCC, 2007) studies, the development of climate change scenarios for the 21st century wasthe key task conducted by Working Group 1. Scenarios are used by Working Group 2 for evaluating consequences of climate change on physical and socioeconomic condition, and later used by Working Group 3 for setting up global alternative adaptation and mitigation strategies.

III. CLIMATE CHANGE SCENARIOS AND IMPACTS ON AGRICULTURE

Assessing the impact of climate change on agriculture requires an integrated approach using three types of models: (1) agronomic or crop simulation, (2) hydrologic simulation, and (3) river basin models. For the river deltas, a hydrodynamic model is also required to evaluate the effect of sea level rise on inundation and salinity intrusion.

3.1. Impacts on rice yields and production.

Climate change and sea level rise will affects both yields and production. The impacts used in this study rely upon projections generated by a series of models, from climate models to crop-growth models. Thus, there is a large degree of uncertainty regarding these estimates. In addition, the impacts estimated in the analysis are based upon projected changes in climate variables and sea level, so they assume that all other variables for example, upstream development in the Mekong River basin remain unchanged over the period. Changes in such variables would have their own effects on yields and production. The impacts of climate change on yields are sum-marized in Table 1. Yield changes vary widely across crops and agroecological zones under climate change. There is also a crucial issue of how to deal with CO_2 fertilization. CO_2 fertilization should theoretically tend to increase yields, but its potential role is both contentious and difficult to estimate since it depends on which factors constrain plant growth. The EACC study has adopted a consistent strategy of overestimating the impacts of climate change and the costs of adaptation where such choices have to be made. Hence, in this case the study has focused on changes in yields without CO_2 fertilization. These are the figures used in the tables and the later analyses.

For rice, the key factors influencing yields are: (a) the projected reduction in runoff in the Mekong River Delta, particularly for the Dry scenario, and (b) the impact of higher temperatures (especially minimum temperatures). It is estimated that yields will decline by 0.6 tons per ha per 1°C increase in average temperature (Mai Van Trinh and Nguyen Hong Son, 2011). The worst yield reductions (for the Dry scenario) are predicted to be about 12 percent in the Mekong River Delta and about 24 percent in the Red River Delta. Across zones, the Central High-land zone tends to have the highest decline in crop yields under both the Dry and the Wet scenarios. Countrywide, rice yield show a decrease between 10 per-cent and 20 percent in 2050. If CO_2 fertilization is included, rice yields show a decrease by less than 12 per-cent for the Dry and Wet scenarios and increase marginally for the MoNRE scenario.

Table 1. Review Potential impacts of climate change on rice yield without adaptation in different agroecological zones.

Agroecological zone / River basin	Potential impacts of climate change without adaptation
North-West	Rice yields will decline by 11.1 percent to 28.2 percent; yields of other crops decline by 5.9 percent to 23.5 percent. Generally, the Dry scenario results in more yield reduction than the Wet scenario. MoNRE scenario shows the least yield reduction.
North-East	Rice yields will decline by 4.4 percent to 39.6 percent; yields of other crops decline by 2.7 percent to 38.3 percent. The largest yield reduction can be in either the Dry or Wet scenarios, depending on crops. MoNRE scenario shows the least yield reduction
Red River Delta	Rice yields will decline by 7.2 percent to 32.6 percent; yields of other crops decline by 4.1 percent to 32.9 percent. The largest yield reduction can be with either the Dry or Wet scenarios, depending on crops. MoNRE scenario shows the least yield reduction
North-Central Coast	Rice yield will decline by 7.2 percent to 32.6 percent; yields of other crops decline by 4.1 percent to 32.9 percent. The largest yield reduction can be with either the Dry or Wet scenarios, depending on crops. MoNRE scenario shows the least yield reduction.
South-Central Coas t	Rice yields willdecline by 8.4 percent to 27.0 percent; yields of other crops decline by 4.0 percent to 20.9 percent. Generally, the Dry scenario results in more yield reduction than the Wet scenario. MoNRE scenario show the least yield reduction
Central Highlands	Rice yield will decline by 11.1 percent to 42.0 percent; yields of other crops decline by 7.5 percent to 45.8 percent. The largest yield reduction can be with either the Dry or Wet scenarios, depending on crops. MoNRE scenario show the least yield reduction
South-East	Rice yield increases by 4.3 percent in the dry scenario, remains the same in the wet scenario, and declines by 8.8 in the MoNRE scenario. Yields of other crops decline by 3.0 percent to 22.7 percent. The largest yield reduction can be with any of the three scenarios, depending on crops.
Mekong River Delta	Rice yields will decline by 6.3 percent to 12.0 percent; yields of other crops decline by 3.4 percent to 26.5 percent. The largest yield reduction can take place under any of the three scenarios, depending on crops.

Source: (Mai Van Trinh and Tingju Zhu, 2011)

The Wet scenario generally results in lower reductions in yields than the Dry scenario, but there are exceptions. The Red River Delta shows a greater reduction in yields under the Wet scenario for both the 2030 and 2050 periods. This is because the Wet scenario has higher increases in minimum and average temperatures during the spring rice season in the Red River Delta, which can shorten the growing period, leading to lower yields.Table 13 shows changes in countrywide crop production as a result of the effects of climate change on yields in 2030 and 2050 relative to the baseline of no climate change for the three scenarios. By 2050, climate change may reduce rice production by 2 to 7 million tons per year. Consistently, the MoNRE scenario generates the smallest impacts on crop production.These estimates do not allow for the impact of sea level rise on harvested areas as a result of more extensive inundation of cropland in the rainy season and increased salinity intrusion in the dry season. In the Mekong River Delta, the assumption of a 30 cm rise by 2050 will result in a loss of 193,000 ha of rice area due to inundation and 294,000 ha due to salinity intrusion, both without adaptation. The loss of rice area will lead to a decline in rice production of about 2.6 million tons per year at current yields.

This is more than 13 percent of today's rice production in the Mekong River Delta. The loss of rice area to inundation in the lower Dong Nai River basin is relatively small—about 11,000 ha by 2050—and the loss of production is less than 0.1 mmt. Allowing for the changes in rice yields discussed above, the total loss of paddy rice due to sea level rise will be 2.0–2.5 mmt in 2050. Table 14 shows the combined effect of changes in yields and sea level rise on production.

3.2. Nam Dinh province

- The damage index caused by the impact of climate change on agricultural production in Nam Dinh province is as follows:

Pham Quang Ha et. al, (2013) suggests the damage index caused by the average impact of climate change in the province was 0.06 in 2000, and increased to 0.1 in 2012. Total damage index of the period 2000-2012 was 1.49, and the average of annual damage index was 0.11. However, the damage of climate change in the province is only based on the data collected from direct damage statistics to economic activities and does not include indirect damages and potential damages due to the impact of climate change.

Table 2. Average damage index in Nam Dinh province (2000 – 2012)

No	**District**	**2000**	**2003**	**2006**	**2009**	**2012**	**Total (2000-2012)**	**Average damage index (2000-2012)**
1	TP Nam Đinh	0,17	0,29	0,13	0,11	0,04	**1,84**	**0,14**
2	My Loc	0,19	0,24	0,17	0,29	0,15	**2,62**	**0,20**
3	Vu Ban	0,00	0,12	0,08	0,05	0,08	1,26	0,10
4	Y Yen	0,00	0,05	0,02	0,04	0,18	1,04	0,08
5	Nghia Hung	0,10	0,24	0,11	0,06	0,16	**1,84**	**0,14**
6	Nam Truc	0,11	0,13	0,05	0,12	0,08	**1,68**	**0,13**
7	Truc Ninh	0,00	0,16	0,01	0,01	0,03	1,23	0,09
8	Xuan Truong	0,00	0,27	0,11	0,02	0,01	1,33	0,10
9	Giao Thuy	0,00	0,00	0,00	0,22	0,22	1,08	0,08
10	Hai Hau	0,02	0,05	0,11	0,08	0,02	1,02	0,08
	Trung bình	**0,06**	**0,16**	**0,08**	**0,10**	**0,10**	**1,49**	**0,11**

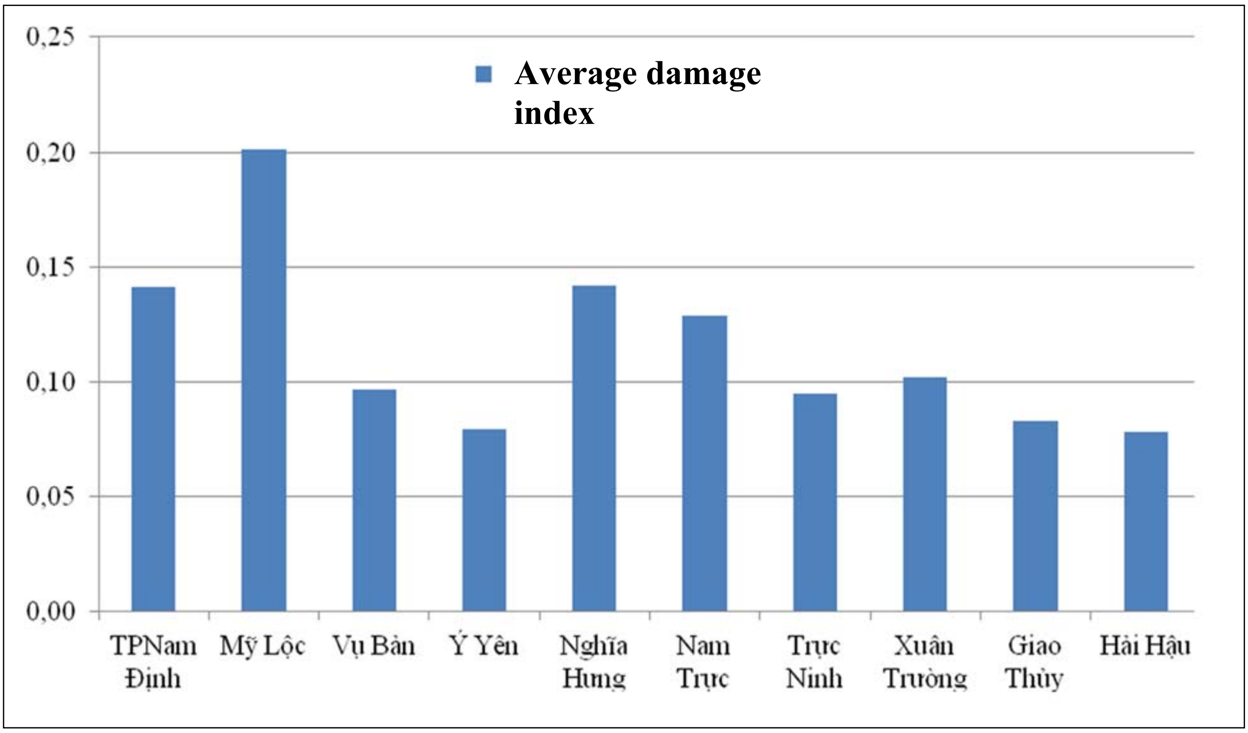


Figure 4. Average damage index for agriculture Nam Định

Thus, results showed that the extent of damage caused by the impact of climate change on agricultural production and fisheries in Nam Dinh sharply increased over the years. The impacts of storms and salt water intrusion in My Loc and Nam Truc District located in the inland are lower than in the coastal districts of Giao Thuy, Hai Hau, Nghia Hung, Xuan Truong. The reason for higher average annual damage index in Nam Truc, My Loc district and Nam Dinh City in 2000 - 2012 is the late sowing of crop in these districts compared to the provincial average (these districts are near the city and farmers are more occuped in trading and less interested in farming).The districts are located in the inland, with transportation systems and infield irrigation broken due to the urbanization process, so the districts are prone to waterlogging when it rains heavily, especially when rice is just sownand water can not drain. However during the last 3 years, especially in 2012, the district has implemented land consolidation, the fields were re-planned and reorganized, irrigation works were renovated, so the inundation is now limited and the damage index of these district in 2012 was lower compared to previous years. Thus, the province and the Central Government's solutions to cope with climate change in Nam Dinh should focus on the coastal districts of Giao Thuy, Hai Hau, Nghia Hung, Xuan Truong, inorder to sustain agricultural production and aquaculture. Calculated results of damage index also showed that districts with high level of agriculture and planting activities accountfor high damage index. This suggests we need to support farming activities while aquaculture activities can respond better and more efficiently and prone to less damage than the farming areas (Figure 4).

The damage extent caused by the impact of climate change on the agriculture in Nam Dinh province:

Pham Quang Ha et. al, (2013) also suggest the damage index in Nam Dinh is 0.64 / classified undergroup 4 according to the international classification standard. This damage extent is relatively high for an agricultural province such as Nam Dinh. However, due to lack of database at the dsitrict level more detailed damage estimates could not be done and isbased on the damage index of the province ..

The direct impact of climate change to agricultural production in Nam Dinh province:

Agricultural activities in Nam Dinh province not only suffered and had e high damage, but also directly affected by the consequences of climate change. Following is a summary of of studies relevant for Nam Dinh province showing the impacts of climate change impacts on agricultural production (DARD Nam Dinh, 2012) :

Severe damage to agricultural production due to storms and floods

According to statistics of the national flood prevention committee, from the period 1989 to 2010, Nam Dinh endured 26 hurricanes, 1 cyclone and 4 major floods, causing damages to agriculture up to a trillion VND.

- In the 2003 crop, heavy rain damaged paddy, caused flooding of nearly 50,000 hectares of rice crop alone (almost submerged 2/3s of paddy area) and yields decreased 30-45%; the value of damage was estimated over 500 billion VND;

- In the 2005 crop, storm no.7 resulted in heavy rains coincing with the harvesting stage and flooded nearly 70,000 hectares of the paddy crop: yields decreased nearly by 40%, and the value of damage was estimated to be over 1,000 billions VND. In addition, storm no.7 with surge broke and heavily eroded some critical coastal dykes;

- In the 2007, 2009, 2010, 2011 crop, heavy rain caused flooding ofof tens of thousands of hectares of new paddy; , farmers had to resow in thousands of hectares of paddy;

Thus, damage of hurricanes to agricultural production is very large and difficult to prevent. However, initiatives toprioritize activities to prevent and deal with the consequences after storms and flooding should be a top priority in the Nam Dinh province in order to quickly stabilize production after disaster. It needs to activelydevelop appropriate farming techniques to restore agricultural production after floods, including alternative cropping systems, crop conversion, land management techniques for areas impacted by sea water intrusion, improved resilience, and flood resistant varieites of rice and planting techniques in sensitive areas.

Damage caused by extreme weather events

The annual dry season (Winter-Spring season - from November 2012 to April 2013) had unusual drought. Severe drought affected 11,000 hectares of arable land seriously and over 52,000 hectares of paddy land within the 6 southern districts faced difficulties of inadequate irrigation water.

There is a need to develop farming techniques and land protection measures to address severe droughts including the anti-cold technique for rice, deacidification salt washing technique, drought resistant varieties and farming techniques to save water.

Severe damage to agricultural production due to salinity in the coastal districts:

Taking salinization boundary in Nam Dinh as 0.1% per year, the largest salinization boundary up to now (2010) was recorded in December in 2009. A 0.1% saline boundary was observed in the Red River drain-gate (next to Mom Ro): in Ninh Co river: Muc 1 drain; in Day river: Tam Toa drain. Despite breakwater systems relatively completed, saltwater intrusion continued alomst to the extent of 34.5 km into the the Red River system, about 37.5 km on Ninh Co River system and 30.5 km on Day river system.

Saltwater encroachment in Nam Dinh has affected over 38,000 hectares of arable land within the districts of Giao Thuy, Hai Hau, Nghia Hung, Xuan Truong and Truc Ninh. . In particular, there are over 12,000 hectares of arable land within the 3 coastal districts (Giao Thuy, Hai Hau, Nghia Hung) severely affected saline (salinity from 1.2 to 3 ‰, and in some years even over 4 ‰), so it is very difficult to grow rice - especially in the first crop. Each year typically have 600-1200 ha of rice are totally damaged due to salinity. Rice yields in saline coastal areas decrease by 20-30% compared to other places, while irrigation costs are higher.

Table 3.Distance saltwater intrusion in the river system in Nam Dinh

River	**Medium (km)**		**The largest (km)**	
	1‰(g/l)	**5‰(g/l)**	**1‰(g/l)**	**5‰(g/l)**
Hong River	14	12	34,5	31
Ninh Co River	13	12	37.5	33
Day River	10	6	30.5	25

Source : People's Committee of Nam Dinh province, 2012

Based on the impact of climate change on agricultural production in saline areas, it is really important to proactively prevent and adapt to saline land with suitable crop varieties, appropriate farming techniques to limit the negative impact of saline areas on the growth, development and crop yields in areas with the high risk of damage in Nam Dinh.

The soils of the RRD are generally fertile and have been utilized since ancient times for intense agriculture with predominance of rice paddy cultivation. Traditionally, the repetitive flooding events regularly added nutrient rich silt and clay to large areas of RRD. Dykes and other flood prevention measures result in the increasing use of chemical fertilizers. Typically for the RRD area, Nam Dinh is basically an agricultural dominated province. Paddy rice with 2 harvests per year represents the predominant crop with more than 58% coverage of the whole area. For centuries, flood control has been an integral part of the delta's culture and economy. An extensive system of dykes and canals has been built to irrigate the paddy fields with river water from through to contain the Red and the Dao River.

Furthermore, fish and shrimp aquaculture using fresh and brackish water is widespread with almost 5% area coverage. Other annual crops have only minor relevance with less than 2% coverage. Urban and village area represent about 16 % of the total area. In total about 74 % of the province area is temporarily flooded by paddy irrigation, aquaculture farming and other water bodies which is expected to have relevant impact for the subsurface water balance.

Cropping calendar

Table 4: Cropping calendar

	Cropping calendar	
Crop season 1 Spring	Crop season 2 Summer - Autumn	Crop season 3 Autumn-Winter
Feb- Jun	Jun- Oct	Fallow
Feb- Jun	Jun- Oct	Fallow
Jan- Jun	Jun- Oct	Fallow
Jan- May	Jun- Nov	Fallow
Feb- May	Jun- Nov	Fallow
Feb- May	Jun- Nov	Fallow

Rice is the main crop in Nam Dinh province. It is grown twice annually: once in the rainy season (January-June) and once in the dry season (July- November). Other crops such as vegetables and sweet potato are rarely grown due to the unfavorable natural conditions. The soil in most areas close to and outside the sea dike is salty due to the underground sea water.

In some areas, people can grow only one rice crop per year. Even in good weather condition, rice productivity is lower by 10-15 percent (550- 830 kg of paddy per ha per crop) than that in the other communes that are not negatively affected by the sea. In bad weather, rice productivity is greatly reduced.

The following tables provide some results from household survey of 80 farmers about their perceptions of climate change and impacts on agriculture.

Table 5 . Type of irrigation

Type of irrigation	Nam Dinh (n=80hhlds)	
	No of house holds	%
Surface water	79	99
Rain water	1	1
Total	80	100

Table 6 : Number of irrigation and water depth for spring rice season

Item	Nam Dinh (n=80hhlds)
Number of irrigation before sowing/transplanting	1
Number irrigation from sowing/transplanting to flowering	3
Number irrigation from flowering to harvesting	1
Total number irrigation per crop season	5
Average number of day interval between 2 irrigations	14
Average depth of water from soil surface for each irrigation (cm)	9

From the survey, most of the households indicated a high crop productivity loss, as follows: 39.39 percent, 35.5 percent, and 38.7 percent for households located far away, close to but inside, and outside the sea dyke, respectively. Those who indicated that the reduction was very high were 39.39 percent, 38.2 percent, and 45.2 percent, respectively. The direct impacts of sea level rise, typhoons, and storms were high but their indirect impacts are even much higher. At the end of typhoons or storms, there would be usually much heavy rains in many places of the country. These heavy rains are the main causes of floods in many communes, districts, and provinces. Floods may break down parts of the river dike system such as what happened during Storm No. 6 in October 2007, which caused the water level to rise in many rivers such Red river, Chu river, and Buoi.

Agricultural activities in Nam Dinh province not only suffered and had the high damage extent, but also directly affected by the consequences of climate change. According to the evaluation results, compiled from many sources including the results of previous studies and annual reports of Nam Dinh province on climate change impact to agricultural production, assessment result on directly impact of climate change to agricultural production in Nam Dinh province was synthesized and described as following:

Table 7: Changing in weather past 30 years

(from 1980 to now)

Changing in weather from year to year	Nam Dinh (n=80)			
	Male		Female	
	No of house	%	No of house	%

	holds		holds	
Yes	74	92	76	95
No	6	8	4	5
Total				

Table* 8 *: The changes in temperature (*)

Item	Nam Dinh (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house holds	%
Increase	24	30	31	38,75
Decrease	5	6,25	2	2,5
Hotter during hot months	5	6,25	19	23,75
Colder during cold months	12	15	15	18,75
None	3	3,75	2	2,5
Total	49	61,25	69	86,25

(*) Multiple response

Table* 9*: The trend of temperature

Item	Nam Dinh (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Increase	23	28,75	31	38,75
Decrease	4	5		
Hotter during hot months	4	5	9	11,25
Colder during cold months	2	2,5	1	1,25
None	4	5	2	2,5
Total	37	46,25	43	53,75

Table* 10*: The changes in rainfall (*)

Item	Nam Dinh (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Decrease/ Low rainfall	30	37,5	33	41,5
Increase/ High rainfall	42	52,5	40	50,0
Early rainfall	60	75,0	55	68,7
Late rainfall	35	43,7	30	37,5
Unexpected floods	10	12,5	8	10,0
Unexpected drought	6	7,5	5	6,25
Unusual rainfall	50	62,5	45	56,25
None				
Total	233		216	

(*) Multiple response

Table* 11*: The trend of rainfall

Item	Nam Dinh (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Decrease/ Low rainfall	18	23%	15	19%
Increase/ High rainfall	15	19%	17	21%
Early rainfall	10	13%	11	14%
Late rainfall	7	9%	9	11%
Unexpected floods	11	14%	7	9%
Unexpected drought	3	4%	5	6%
Unusual rainfall	16	20%	16	20%
None				
Total	80	100%	80	100%

Table 12. The objects are vulnerable due to climate change impacts

No	**Impact factor**	**Sensitive, vulnerability region**	**Sectors / field vulnerability.**
1	Temperature increase	On the whole province but coastal areas be most strongly affected .	- Agriculture (crops, livestock, fisheries) and food security) - The natural ecosystem, the biodiversity - Energy (production and consumption) - The public health
2	Rising sea levels	The coastal districts and areas with low-lying terrain in the districts Nghia Hung, Hai Hau, Giao Thuy	- Agriculture (crops, livestock, fisheries) - The marine ecosystems and coastal - Water resources (surface and groundwater) - Infrastructure and tourist resorts (Quat Lam, Thinh Long - Place of residence; community health
3	Hurricanes and tropical depressions	Coastal strip in the districts: Nghia Hung, Hai Hau, Giao Thuy	- Agriculture (crops, livestock, fisheries) - The activities on coastal and marine - Infrastructure and transport, sea dikes - Houses and means of aquatic resource exploitation - Place of residence; community health
4	Drought	Occurs locally in some districts: My Loc, Vu Ban, Truc Ninh	- Agriculture and food security. - Water resources (surface and groundwater) - Water transportation - The health and living
5	Saltwater intrusion	Mainly occurs in the districts: Nghia Hung, Hai Hau, Giao Thuy.	- Agriculture (crops, fisheries) and food security - Water resources (surface and groundwater) - Land resource - People's life - The biodiversity
6	The extremist climatic	On the whole province and	- Agriculture (crops, livestock, fisheries)- Nhà cửa

	phenomena (*)	especially the coastal areas	- The health and living

(*):Including the phenomenon: abnormal heatwaves, unusually of rainy days, storms, cyclones, tornadoes.

According to statistics of the national flood prevention committee, during the period from 1989 and 2010, Nam Dinh endured 26 hurricanes, 1 cyclone and 4 major floods, causing damages to agriculture up to a trillion.

In 2003, heavy rains at growing paddy stage caused flooding nearly over 50,000 hectares of paddy (submerged 2/3 of paddy rice) decreased yields by 30-45%, and the value of damage was estimated to be over 500 billions VND;

In the 2005 crop, storm no.7 with heavy rain at harvesting stage casued flooding nearly of 70,000 hectares of paddy, yield decreased nearly by 40%, and the value of damage was estimated to be about 1,000 billion VND. In addition, storm no.7 with surge broke and heavily eroded some critical coastal dykes;

In the 2007, 2009, 2010, 2011 crop, heavy rains flooded tens of thousand hectares of newly sown paddy; and farmers had to resow over thousands of hectares;

Thus, the affected ability of hurricanes to agricultural production is very large and difficult to prevent. However, initiatives to prevent and deal with the consequences after storms and flooding should be a top priority in order to quickly stabilize production. There is a need to actively develop appropriate farming techniques to restore agricultural production after floods, eg., alternative planting systems, crop conversion, land processing techniques for areas spilled by sea water and to improve the ability of resilience to floods and salinity.

Saltwater intrusion and droughts:

The annual dry season (Winter-Spring season - from November to April) often has unusual drought. The annual estimated results of the province showed 11,000 hectares of arable land with the high lack of severe dehydration and 52,000 hectares of paddy land of 6 Southern districts face to many difficulties on water due to unusual drought and lack of abnormal water supply for irrigation.

Due to extreme, unpredictable and unusual weather events, it is often difficult to actively cope with them. Therefore, within researching of this topic it needs to conducted to develop farming techniques and land protection based on the impact types of climate change, such as anti-cold technique for rice, deacidification salt washing technique, restructuring varieties, farming technique saving inputs, land cover farming technique, consistent crop restructuring,…

Table* 13*: The changes in salinity (*)

Item	Nam Dinh(n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Increase	60	75,0	58	72,5
Decrease	13	16,2	12	15,0
None	**7**	8,8	10	12,5
Total	80	100	80	100

Salty land caused by sea water level rise is increasing over time. Such land is unfavorable for almost all agricultural crops, resulting in reduced crop productivity, less crop diversification, and therefore increased vulnerability. Because of such experiences, recently most farmers just grow one to two rice crops; other crops like vegetable, maize, sweet potato, and potato are very difficult to grow.

Table 14: The impacts of severe weather change (as severe saline, drought, rains, typhoons) to agriculture and house (*)

Item	Nam Dinh (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Low yields	80	100	80	100
Food insecurity	30	37,5	33	41,2
Increase indebtedness	42	52,5	44	55,0
Crop loss	20	25,0	18	22,5
Damage to house and other property	10	12,5	13	16,25
Other (Organic toxic in rice field, pig and chicken died, increase salt water level leading to increase the acidity in the upper layer on soil)	34	42,5	35	43,7

If taking salinization boundary in Nam Dinh is 0.1% per year, the largest salinization boundary up to now (2010) is December in 2009: 0.1% saline boundary in the Red River is drain-gate (next to Mom Ro): in Ninh Co river: Muc 1 drain; in Day river: Tam Toa drain. Despite breakwater system relatively completes, but the phenomenon of saltwater intrusion occurred fairly quickly, 34.5 km on the Red River system, 37.5 km on Ninh Co River system and 30.5 km on Day river system.

Saltwater encroachment in Nam Dinh has affected over 38,000 hectares of arable land of the districts Giao Thuy, Hai Hau, Nghia Hung, Xuan Truong, Truc Ninh annually by drought, storm surges and saltwater intrusion. In particular, there are over 12,000 hectares of arable land of 3 coastal districts (Giao Thuy, Hai Hau, Nghia Hung) severely affected saline (salinity in popularity from 1.2 to 3 ‰, and in some years even over 4 ‰), so the rice is very difficult - especially in the first crop. Each year typically have 600-1200 ha of rice were killed by salinity. Rice yield in saline coastal areas often decreased 20-30% compared to other places, while irrigation costs are higher.

Table 15. Distance saltwater intrusion in the river system in Nam Dinh

River	**Medium (km)**		**The largest (km)**	
	1‰(g/l)	**5‰(g/l)**	**1‰(g/l)**	**5‰(g/l)**
Hong River	14	12	34,5	31
Ninh Co River	13	12	37.5	33
Day River	10	6	30.5	25

Source of : People's Committee of Nam Dinh province

Based on the impact of climate change on agricultural production in saline areas, it is important to proactively prevent and adapt with the right choice of crop varieties and appropriate farming techniques.

3.3. Soc Trang province

Soc Trang is a coastal province with 73.2% of agricultural land being salinised or acidic. However, this is also an advantage for Soc Trang in making use of its soil and ecosystems for developing areas specialized in agricultural products with high economic value. Areas specialized in aromatic rice, fruit trees, rice – shrimp systems are typical agricultural ecosystems in Soc Trang.

- ***Cropping calendar***

Table* 16*: Cropping calendar

	Cropping calendar	
Crop season 1 Winter-Spring	Crop season 2 Summer-Autumn	Crop season 3 Autumn-Winter
Dec- Mar	Jun- Sept	Oct- Jan
Jan- April	May- Aug	Sept- Dec
Jan- April	Jul- Oct	Oct- Jan
Jan- April	May- Sept	Oct- Jan
Jan- Mar	May- Aug	Aug- Dec
Feb- May	Jun- Sept	Oct- Jan

In rice-farming year of 2012, (Winter-Spring, Season and Summer-Fall crop) and as reported by the Bureau of Statistics in Soc Trang province, the total rice cultivated area in was 365,909 ha, which exceeded 7.04% of the plan, up by 4.85% over the previous year, with 16,929 ha. The province has more than 57,000 ha area under fragrant rice, that increased nearly by 3,000 ha over the same period last year.

Table* 17*: Source of water and cropping system

Item	Soc Trang (n=80hhlds)	
	No of house hold	%
Sources of water		
River	106	61
Canal	65	37
Rains	-	-
River, canal	3	2
River, rains	-	-
Canal, rains	1	1
River, canal, rains	-	-
Type of cropping systems on parcel		
Rice-rice-rice	73	88
Rice-rice	10	12
Rice-rice-corn	-	-
Rice	-	-
Total	83	100

Rice production of Soc Trang in the last two years increased continuously and more than the same period of previous year and exceeded the target of the provincial Resolution.

This is mainly due to farmers applying scientific and technical advances, using pest resistant rice varieties with high yield and good quality, in accordance with local production conditions; besides, the forecast of pest situation has been enhanced, that meant timely pest detection and treatment measures, so the productivity of rice crops increased over the same period last year. In fact, in 2010, the provincial average rice yield was only 5.619 tonnes / ha, in 2011 increased to 5.991 tonnes / ha and further in 2012 has exceeded 6.170 tonnes / ha.

Table* 18 *. Type of irrigation

Type of irrigation	Soc Trang (n=80hhlds)	
	No of house hold	%
Surface water	80	100
Rain water		0
Total	80	100

Table* 19*: Number of irrigation and water depth

Item	Soc Trang (n=80hhlds)
Number of irrigation before sowing/transplanting	1
Number irrigation from sowing/transplanting to flowering	3
Number irrigation from flowering to harvesting	1
Total number irrigation per crop season	4
Average number of day interval between 2 irrigations	11
Average depth of water from soil surface for each irrigation (cm)	8

Soc Trang is one of the coastal provinces that suffers from climate change most. Unfavorable weather tend to occur more frequently and severely than before. Droughts and saltwater intrusion are considered the two most frequent and destructive disasters by the people in Soc Trang.

According to the forecast about climate change impacts in Southern Delta, the yearly average temperature can increase up to 1.6ºC (in 2050) and 3.7ºC (in 2100). While the precipitation decreases in December to May, it is the highest in the March-to-May period (8% in 2050 and 19.6% in 2100). On the contrary, the precipitation decreases from June to November and most 10 from September to November, 10.6% in 2050 and 26.0% in 2100. The sea level rises to about 330mm in 2050 and to 621mm in 2100. With the current melting rate of ice and glacier at both Poles, the sea level in Vietnam can rise up to 1 meter or more. Unfavorable weather, especially saltwater intrusion and droughts in dry season, can happen more frequently and seriously

Table* 20*: Changing in weather from year to year in the past 30 years (from 1980 to current)

Changing in weather from year to year	Soc Trang (n=80)			
	Male		Female	
	No of house hold	%	No of house hold	%
Yes	80	100	80	100
No	-	-	-	-
Total	80	100	80	100

Table 21: The changes in temperature (*)

Item	Soc Trang (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Increase	43	54	39	49
Decrease	15	19	20	25
Hotter during hot months	68	85	68	85
Colder during cold months	60	75	62	78
None	-	-	1	1
Total	186	233	190	238

(*) Multiple response

Table 22: The trend of temperature

Item	Soc Trang (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Increase	23	29	22	28
Decrease	4	5	10	13
Hotter during hot months	36	45	36	45
Colder during cold months	17	21	11	14
None	-	-	1	1
Total	80	100	80	100

Table 23: The changes in rainfall (*)

Item	Soc Trang (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Decrease/ Low rainfall	43	54	47	59
Increase/ High rainfall	33	41	33	41
Early rainfall	27	34	23	29
Late rainfall	31	39	27	34
Unexpected floods	5	6	6	8
Unexpected drought	39	49	35	44
Unusual rainfall	13	16	6	8
None	5	6	5	6
Total	196	245	182	228

(*) Multiple response

Table 24: The trend of rainfall

Item	Soc Trang (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Decrease/ Low rainfall	34	43	35	44
Increase/ High rainfall	16	20	16	20
Early rainfall	4	5	3	4
Late rainfall	3	4	3	4

Unexpected floods	-	-	-	-
Unexpected drought	13	16	14	18
Unusual rainfall	5	6	4	5
None	5	6	5	6
Total	80	100	80	100

Saltwater intrusion and droughts :

Saltwater intrusion and droughts are big issues in the province because the increasing frequency and scale of these disasters is seriously affecting the local people's life and production.

Saltwater intrusion

When coming to the South, especially in the second half of the winter (Jan – Mar) the winter monsoon tends to blow to the east–southeast. This monsoon blows sea water back into main rivers and canals, contaminating coastal fields with salt. This monsoon, together with high tides can blow sea water back into the fields. The canal system in Soc Trang is affected by the tides twice a day with the average fluctuation of 0.4 to 1 meter. In the rainy season, parts of My Tu and Thanh Tri District are flooded, while in the dry season, runoff water in Thanh Tri, Vinh Chau, My Xuyen Districts and parts of Long Phu and My Tu Districts is salt-contaminated and therefore causes a lot of difficulty to production and life. The attack of monsoon, with the synchronous impacts of high tides, can negatively affect crops and other cereals and vegetables because sea water bubbles brought in by the wind stick to the buds and prevent their development.

Table 25: The changes in salinity (*)

Item	Soc Trang (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Increase	61	76	57	71
Decrease	20	25	19	24
None	19	24	17	21
Total	100	125	93	116

Impacts of saltwater intrusion and droughts

Grown in 2 million hectares (2 harvests each year making it 4 million hectares) accounting for 53% rice area in Vietnam, rice is the main crop in Cuu Long River Delta and is the main income for the local people. However, 0.7 million hectares of rice is affected by saltwater intrusion, especially in the dry season when saltwater intrusion seriously affects agriculture (Buu and Lang, 2004). According to a recent research by the Ministry of Agriculture and Rural development (MARD), the economic damage due to saltwater intrusion in 2005 was 45 million dollars, accounting for 1.5% of the annual crop yield of Cuu Long River Delta (MARD, 2005). In coastal districts of Soc Trang in general or Vinh Chau in particular, rice can only be grown in rainy season and the rice growth greatly depends on the precipitation. In general, there is not enough freshwater for irrigation in the beginning and in the end of the rainy season when saltwater (concentration of NaCl around 0.3%, 5dS/m) can enter the fields and either directly affect rice yields or increase the amount of salt in soil and affect the next harvests. Therefore, rice cultivation has to be carried out in the rainy season to avoid freshwater shortage and saltwater intrusion. Vegetables like red onions, turnips, chili, Japanese yams, etc are also affected although they are grown in the dry season to reduce the amount of irrigation water in the harsh conditions of droughts and saltwater intrusion in Soc Trang.

Table 26: The impacts of severe weather change (as severe saline, drought, rains, typhoons…) to agriculture and house (*)

Item	Soc Trang (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Low yields	77	96	73	91
Food insecurity	12	15	11	14
Increase indebtedness	44	55	36	45
Crop loss	35	44	32	40
Damage to house and other property	1	1	2	3
Other (Organic toxic in rice field, pig and chicken died, increase salt water level leading to increase the acidity in the upper layer on soil)	5	6	3	4

(*) Multiple response

Table 27.The vulnerable due to climate change in Soc Trang province

Impact Factor	Sensitive, vulnerable areas	Vulnerable sectors / areas
Temperature rise	On the whole province but coastal areas are affected the most strongly	- Agriculture (crops, livestock, fisheries) and food security. - Agriculture (crops, livestock, fisheries) and food security. - The natural ecosystem, biodiversity. - Energy (production and consumption). - Public Health.
Sea level rise	The coastal districts, and areas of low-lying terrain of Nga Nam, My Tu, Thanh Tri District	- Agriculture (crops, livestock, fisheries) - The marine ecosystems and coastal - Water resources (surface water and groundwater) - Infrastructure and industrial zones; - Place of residence, a public health
Hurricanes and tropical depressions	Coastal areas, such as: Vinh Chau, Cu Lao Dung, Tran De.	- Agriculture (crops, livestock, fisheries). - The activities on coastal and marine - Infrastructure and transport, sea dikes. - Buildings and capture fisheries facilities. - Place of residence, health and life

Impact Factor	Sensitive, vulnerable areas	Vulnerable sectors / areas
Drought	Occuring throughout the most of Soc Trang province, in which the largest affected districts: Tran Đe, Soc Trang City, My Xuyen, Nga Nam, and some adjacent areas with Bac Lieu.	- Agriculture and food security. - Water resources (surface water and groundwater). - Traffic waterway. - Health and life
Saltwater intrusion	Mainly occuring in districts such as Vinh Chau, Long Phu, Tran De, Cu Lao Dung, Soc Trang City, My Xuyen.	- Agriculture (crops, fisheries) and food security. - Water resources (surface water and groundwater) - Land resources. - People's life. - Biodiversity
The extreme climate events (*)	On the whole province and particularly in coastal areas.	- Agriculture (crops, livestock, fisheries - Buildings - Health and life

(*):Including the phenomenas; unusual heatwaves, the unusually rainy days, storms, hurricanes, tornadoes.

3.4. Tra Vinh province

Located in the Mekong Delta, Tra Vinh province also has common advantages, such as: rich radiation light, high and stable temperature. However, due to the distinct characteristics of the inshore climate area, Tra Vinh province has some limitations in terms of climate, such as: strong northeast wind, high evaporating level and little rain, etc.

Average temperature of the whole province is 26.6^0C, temperature amplitude between the highest: 35.8^0C and the lowest: 18.5^0C; temperature amplitude between day and night is low: 6.4^0C. The duration of sunshine in the province is 7.7 hours per day, photosynthesis radiation is abundant: 82,800 cal per year, which enables crops to grow in the whole year. However, with the current method of cultivation, this energy source is not utilized much, especially in the dry season.

Annually average moisture ratio varies from 80 - 85% and tends to change in accordance with season; 79% in dry season and 88% in rainy season. The average moisture of all months is often more than 90% that creates favourable conditions for the development and spreading of some epidemic diseases.

Total rainfall is from the medium down to low level (1,588 – 1,227 mm), distributed not fairly and strongly split in accordance with space-time. The rainfall reduces gradually from North to South, highest in Cang Long, Tra Vinh and lowest in Cau Ngang and Duyen Hai. As for the duration of rain, up to 90% of rainfall occurs in rainy season, started from May to November. The closer toward the sea, the shorter duration of rain occurs, that means the rainy season starts late but finishes early. This is a significant limit to the production of this area, because the useful rainfall for cultivated crops is little. Districts enjoy the longest time of rain are Cang Long (118 days), (Tra Vinh township 98 days); those enjoy shortest time of rain are Duyen Hai (77 days) and Cau Ngang (79 days).

Cropping calendar: Cropping calender is not synchronized a because it is dependant on the availability of water and rains

Table 28: Cropping calendar

Cropping calendar		
Crop season 1 Winter-Spring	Crop season 2 Summer-Autumn	Crop season 3 Autumn-Winter
Dec- Mar	April- Aug	Sept- Dec
Dec- Mar	April- Aug	Sept- Jan
Dec- Mar	May- Aug	Aug- Nov
Dec- Mar	Jun- Sept	Sept- Dec
Dec- April	April- Aug	Aug- Dec
Dec- April	May- Aug	Aug- Dec

Table 29: Source of water and cropping system

Item	Tra Vinh (n=80hhlds)	
	No of house hold	%
Sources of water		
River	73	48
Canal	54	36
Rains	1	1
River, canal	10	7
River, rains	7	5
Canal, rains	3	2
River, canal, rains	3	2
Total	151	100
Type of cropping systems on parcel		
Rice-rice-rice	53	58
Rice-rice	35	38
Rice-rice-corn	1	1
Rice	2	2
Total	91	100

Table 30. Type of irrigation

Type of irrigation	Tra Vinh (n=80hhlds)	
	No of house hold	%
Surface water	76	95
Rain water	4	5
Total	80	100

Table 31: Number of irrigation and water depth

Item	Soc Trang (n=80hhlds)	Tra Vinh (n=80hhlds)
Number of irrigation before sowing/transplanting	1	1
Number irrigation from sowing/transplanting to flowering	3	3
Number irrigation from flowering to harvesting	1	1
Total number irrigation per crop season	4	5
Average number of day interval between 2 irrigations	11	12

Average depth of water from soil surface for each irrigation (cm)	8	9

Statistical data analysis confirms and further explains finding from participatory assessments on the occurrence and impacts of weather abnormalities on rice production in both irrigated and coastal regions. For the dry season rice crop, in both regions local farmers perceived that the return period of the event of extremely cold temperature or of rainfall during January - February is 3 - 4 years, which causes yield loss of about 10% of the normal yield (an average of 6 tons ha-1). Drought occurs annually causing many difficulties for production, with the number of rainy days is not continuous, from 10 – 18 days. Cau Ke, Cang Long and Tra Cu are districts rarely influenced by drought. Tieu Can district is often seriously influenced by drought in the beginning of the crops (in June and July, while others, such as Chau Thanh, Cau Ngang and Duyen Hai, are more severely influenced in the mid-crop (in July and August).

Results from multiple regression analysis show rice yields are positively affected by temperature in January and rainfall in January and February. The effect of temperature on rice yield in the coastal region is not significant. The effect on yield losses of abnormal rainfall in February is more significant than that January, suggesting the effect of rainfall during ripening or harvesting stages. The variability of these weather variables explains 15% and 24% of total variability of rice yield in the irrigated and the coastal region, respectively. Statistical results reveal that the probability of the occurrence of temperature below 19 °C in January is one-fourth and that in arrange of 18 – 22 °Ctemperature dropping 1 °C would causes a yield loss of 0.12 tons ha-1 in the irrigated region. Similarly, the probability of the occurrence of abnormal rainfall above 10 mm in February is one-fourth and that each event of rainy days with 10 mm would result in yield loss of 0.3 tons in the coastal region or 0.4 tons in the irrigated region.

Table 32: Changing in weather from year to year in the past 30 years (from 1980 to current)

Changing in weather from year to year	Tra Vinh (n=80)			
	Male		Female	
	No of house hold	%	No of house hold	%
Yes	79	99	80	100
No	1	1	-	-
Total	80	100	80	100

Table 33: The changes in temperature (*)

Item	Tra Vinh (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Increase	28	35	34	43
Decrease	32	41	34	43
Hotter during hot months	51	65	51	64
Colder during cold months	56	71	56	70
None	5	6	1	1

Total	172	218	176	220

(*) Multiple response

Table 34: The trend of temperature

Item	Tra Vinh (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Increase	27	34	28	35
Decrease	17	22	16	20
Hotter during hot months	18	23	21	26
Colder during cold months	12	15	14	18
None	5	6	1	1
Total	79	100	80	100

Table 35: The changes in rainfall (*)

Item	Tra Vinh (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Decrease/ Low rainfall	44	56	53	66
Increase/ High rainfall	25	32	23	29
Early rainfall	24	30	21	26
Late rainfall	29	37	22	28
Unexpected floods	4	5	2	3
Unexpected drought	42	53	38	48
Unusual rainfall	18	23	8	10
None	7	9	7	9
Total	193	244	174	218

(*) Multiple response

Table 36: The trend of rainfall

Item	Tra Vinh (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Decrease/ Low rainfall	26	33	44	55
Increase/ High rainfall	11	14	9	11
Early rainfall	2	3		0
Late rainfall	3	4	3	4
Unexpected floods	2	3	1	1
Unexpected drought	22	28	16	20
Unusual rainfall	6	8	1	1
None	7	9	6	8
Total	79	100	80	100

Impacts of saltwater intrusion and droughts:

Mekong River Delta (MRD) is one of the three regions that will be affected most heavily in the world due to climate change (CC). In particular, Tra Vinh is influenced most heavily by saltwater intrusion and droughts.

Tra Vinh is one of the areas severely affected by the impact of climate change in the Mekong Delta, which is seen as Vietnam's red spot of climate change scenarios. Therefore, climate change will directly affect the people's life and production if we do not have respond right now with effective measures. Tra Vinh Province is strongly influenced by coastal monsoon tropical climate, especially the strongly impact of the northeast wind. The rainy season in the saline regions is often later than upper regions, about 1-2 weeks late and often ends earlier. Total rainfall from mid to low (1.598-1.227mm) distribution decreases from the north to the south. The average number of rainy days vary from 77-118. The evaporation is high, with an average of 1.293mm/year. The evaporation in Duyen Hai district is higher than the annual rainfall, causing the salt capillary and salts concentrating on the surface and making rational land bad and difficult to use. Drought often occurs, almost every year, making it difficult for production in the days with dry spells ranging from 10 -18 days, including two phases: the first crop drought (June, July) and Chang drought (July, August). The Chang drought is often more severe.

Table 37: The changes in salinity (*)

Item	Tra Vinh (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Increase	37	47	37	46
Decrease	39	49	32	40
None	14	18	18	23
Total	90	114	87	109

Table 38: The impacts of severe weather change (as severe saline, drought, rains, typhoons…) to agriculture and house (*)

Item	Tra Vinh (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Low yields	71	89	67	84
Food insecurity	10	13	8	10
Increase indebtedness	38	48	36	45
Crop loss	29	36	24	30
Damage to house and other property	1	1	2	3
Other (Organic toxic in rice field, pig and chicken died, increase salt water level leading to increase the acidity in the upper layer on soil)	2	3	1	1

Table 39: The vulnerable due to climate change in Tra Vinh province

Impact Factor	**Sensitive, vulnerable areas**	**Vulnerable sectors / areas**
The high tidal and	effects of coast erosion in the area would increase suddenly	The salinity and sea intrusion during the dry season starting from

Impact Factor	Sensitive, vulnerable areas	Vulnerable sectors / areas
salinity intrusion		December to April. In the dry season (at Co Chien station at a distance of 35 km from the sea) the highest salt level is is 10‰ (while the salt levels of sea water is 30‰).
		More than 90 percent of total agricultural land area (90,000 ha) is affected by the sea water intrusion
	In more than 90 percent of total agricultural land area, salinity usually starts in December at Hung My, Co Chien river and Tra Kha, Hau river. Salinity is at the peak in April and ends in June	A sample of 115 rice-farmers fields at Cau Ngang and Duyen Hai districts were tested for salinity A sample of 118 rice-farmer fields were tested at Cang Long and Cau Ke districts where the sea water intrusion is not a problem.

IV. CLIMATE CHANGE ADAPTATION AND MITIGATION

4.1. Nam Dinh province

Increased vulnerability

The increase in vulnerability of local residents resulting from serious negative impacts of SLR and its related events can take different forms such as loss of agricultural land due to sea water intrusion and landslide; reduction in farm productivity; damages to infrastructure, houses and buildings; loss of income due to animal/crop losses due to typhoons and storms; and death of or injured relatives. In some cases, some households became poor due to heavy losses in their aquaculture production, resulting in their inability to pay loans. The survey indicated that 36.4 percent of households living far away from the sea dyke, 35.3 percent of those living close to but inside the sea dyke, and 30.3 percent of households living outside the sea dyke viewed the increase in their vulnerability as average only. On the other hand, 48.5 percent, 55.9 percent, and 60.6 percent, respectively, indicated a high level of increase in vulnerability

Experience in defining appropriate household economic structure

To exploit the advantages of the location conditions and to minimize their disadvantages, the local government encouraged the people to improve their economic condition by guiding them in choosing salt resistant crop varieties; changing from crop production to aquaculture production where possible, and developing aquaculture. As a result, fishery accounts for 13.7 percent of the income of households far away from the sea dyke; 35.0 percent of income for households close to the sea dyke and 63.2 percent of income for households outside the sea dyke. On the other hand, agriculture gets a small share: 15.6 percent for households close but inside the sea dyke, 13.6 percent for far away households, and 8.9 percent for households outside the sea dyke. Bulk (72.7%) of the income of households living far from the sea dyke come from other sources (mainly hired labor and other works in cities such as Hanoi, Ho Chi Minh), while such income source accounts for only 27.8 percent for households living outside the sea dike.

Rice is grown in both rainy and dry seasons. The following are the three main and common adaptation strategies for maintaining agricultural production: selecting good and suitable varieties resistant to the saline and drought conditions (97.8% of households), building up the protective dyke (73.7%), and planting trees to break strong waves and winds (63.6%).

Table* 40*: Changes in farming activities in the year with extreme weather changes

Item	Nam Dinh(n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Change in rice variety/lines	50	63	47	59
Change in cropping pattern	30	38	33	41
Shift from crops to livestock	10	13	8	10
Grow more cash crops	8	10	11	14
Grow more kinds of crops	15	19	17	21
Grow input-saving crops (Planting crops that require less inputs)	4	5	5	6
Grow water-saving crops (Planting crops that require less water)	12	15	14	18
Cultivate smaller area than usual	3	4	4	5
Grow dry fodder crops	2	3	0	0
Leave as fallow	3	4	2	3
No change	10	13	12	15
Other (more pumping, sowing late, more fertilizer, selling land to repay debt, raising cow, working as hired labor in miller/ in rice harvesting using combined harvester, waiting for rains to reduce salinity and acidity to sow rice, raising cow/ milking cow to have extra income)	20	25	22	28

Table* 41*: Supporting from the government and other institutions during severe drought or salinity, rain, typhoon in Nam Dinhprovince

Item	Nam Dinh(n=80 hhlds)			
	Male		Female	
	No of house hold	%	No of house hold	%
Get support from the government and other institutions during severe drought or salinity, rain, typhoon				
Yes	33	41,25	30	37,5
No	4	5	13	16,25
Support resource (*)				
Government	33	41,25	30	37,5
Other Institutions			1	1,25
Kind of support from government (*)				
Housing				
Pension	1	1,25		
Loan from policy Bank, Saving Bank				
Health insurance				
Training on new rice technologies				
Support for farming activities				
Others (cow, land for agriculture, support seed cost, rice seeds)	32	40	31	38,75

Source of support from government (*)				
Agricultural department	1	1,25	2	2,5
Policy Bank	1	1,25	1	1,25
Cooperatives				
People Committee	3	3,75	4	5
State government	7	8,75	9	11,25
Health department				
Agricultural universities	1	1,25	3	3,75
Others (secondary and high school)				
Kind of support from other institutions (*)				
Training on new rice technologies	1	1,25	4	5
Support for farming activities				
Others (clothes, hat, pesticide)	18	22,5	10	12,5
Source of support from other institutionst (*)				
Agricultural universities				
Pesticide/fertilizer company				

(*) Multiple response

Table 42: Response (in percent) on likely adopt a technology interventions to reduce vulnerability to climate variability in Nam Dinhprovince

	Nam Dinh(n=80 hhlds)									
Impacts	Highly unlikely	%	Unlike ly	%	Neither likely nor unlikely	%	Likely	%	Highly Likely	%
Use of stress-tolerant crop varieties	1	1	1	1	1	1	19	24	57	73
ift to improved cropping systems other activities	6	7	13	17	5	6	13	17	43	54
Planting of early, medium or late varieties to avoid crop loss to variations in drought/salinity occurrence	0	0	1	1	15	19	24	30	40	50
Early sowing/production of rice to grow other additional crops	0	0	28	35	7	8	18	23	27	34
New land management techniques (i.e., zero tillage for rice or minimize tillage, resource conserving techniques, Biochar)	0	0	4	5	7	8	38	48	31	39
Changes in agricultural water-management techniques (AWD)	6	7	7	8	14	18	27	34	26	33
Pest and disease management techniques such as IPM	5	6	0	0	8	9	47	59	20	26
Development and use of crop varieties resistant to pests and diseases	1	2	3	4	10	13	49	60	17	21
New livestock breeds	21	26	5	6	14	18	29	36	11	14
Improved animal health management	16	20	7	8	10	13	27	34	20	25

4.2. Soc Trang province

Table 43: Changes in your farming activities in the year with severe weather change (as severe saline, drought, rains, typhoons…) in Soc Trang province(*)

Item	Soc Trang (n=80 hhlds)

	Male (n=80)		Female (n=80)	
	No of house hold	%	No of house hold	%
Change in rice variety/lines	60	75	56	70
Change in cropping pattern	5	6	4	5
Shift from crops to livestock	3	4	4	5
Grow more cash crops	1	1	3	4
Grow more kinds of crops	1	1	2	3
Grow input-saving crops (Planting crops that require less inputs)	3	4	-	-
Grow water-saving crops (Planting crops that require less water)	1	1	-	-
Cultivate smaller area than usual	1	1	3	4
Grow dry fodder crops	-	-	-	-
Leave as fallow	8	10	4	5
No change	15	19	19	24
Other (more pumping, sowing late, more fertilizer, selling land to repay debt, raising cow, working as hired labor in miller/ in rice harvesting using combined harvester, waiting for rains to reduce salinity and acidity to sow rice, raising cow/ milking cow to have extra income)	8	10	1	1

Table 44: Supporting from the government and other institutions during severe drought or salinity, rain, typhoon in Soc Trang province

Item	Soc Trang (n=80 hhlds)			
	Male		Female	
	No of house hold	%	No of house hold	%
Get support from the government and other institutions during severe drought or salinity, rain, typhoon				
Yes	62	78	48	60
No	18	23	32	40
Support resource (*)				
Government	61	98	48	100
Other Institutions	7	11	-	-
Kind of support from government (*)				
Housing	-	-	-	-
Pension	59	98	44	94
Loan from policy Bank, Saving Bank	1	2	-	-
Health insurance	3	5	5	11
Training on new rice technologies	1	2	-	-
Support for farming activities	2	3	-	-
Others (cow, land for agriculture, support seed cost, rice seeds)	-	-	-	-
Source of support from government (*)				
Agricultural department	7	11	3	6
Policy Bank	2	3	-	-
Cooperatives	-	-	-	-
People Committee	52	85	42	88
State government	3	5	1	2
Health department	3	5	4	8
Agricultural universities	-	-	-	-
Others (secondary and high school)	-	-	-	-
Kind of support from other institutions (*)				
Training on new rice technologies	4	57	-	-
Support for farming activities	3	43	-	-
Others (clothes, hat, pesticide)	1	14	-	-
Source of support from other institutionst (*)				
Agricultural universities	1	14	-	-

Pesticide/fertilizer company	7	100	-	-

(*) Multiple response

Table 45: Response (in percent) on likely adopt a technology interventions to reduce vulnerability to climate variability in Soc Trang province

	Soc Trang (n=80 hhlds)									
Impacts	Highly unlikely	%	Unlikely	%	Neither likely nor unlikely	%	Likely	%	Highly Likely	%
Use of stress-tolerant crop varieties	8	5	2	1	18	11	72	45	60	38
hift to improved cropping systems or other tivities	8	5	3	2	26	16	35	22	41	26
Planting of early, medium or late varieties to avoid crop loss to variations in drought/salinity occurrence	8	5	4	3	18	11	80	50	52	33
Early sowing/production of rice to grow other additional crops	8	5	5	3	26	16	49	31	44	28
New land management techniques (i.e., zero tillage for rice or minimize tillage, resource conserving techniques, Biochar)	8	5	6	4	20	13	60	38	46	29
Changes in agricultural water-management techniques (alternated wetting and drying method, …)	8	5	7	4	26	16	59	37	49	31
Pest and disease management techniques such as IPM	8	5	8	5	20	13	66	41	49	31
Development and use of crop varieties resistant to pests and diseases	8	5	9	6	13	8	74	46	54	34
New livestock breeds	8	5	10	6	29	18	49	31	51	32
Improved animal health management	8	5	11	7	20	13	59	37	53	33

4.3. Tra Vinh province

Table 46: Changes in your farming activities in the year with severe weather changes (severe salinity, drought, rains, typhoons) in Tra Vinh province (*)

Item	Tra Vinh (n=80 hhlds)			
	Male (n=80)		Female (n=80)	
	No of house holds	%	No of house holds	%
Change in rice variety/lines	58	73	51	64
Change in cropping pattern	4	5	4	5
Shift from crops to livestock	8	10	10	13
Grow more cash crops	3	4	2	3
Grow more kinds of crops	-	-	-	-
Grow input-saving crops (Planting crops that require less inputs)	-	-	1	1
Grow water-saving crops (Planting crops that require less water)	1	1	-	-
Cultivate smaller area than usual	-	-	-	-
Grow dry fodder crops	2	3	1	1
Leave as fallow	6	8	5	6
No change	14	18	17	21
Other (more pumping, sowing late, more fertilizer, selling land to repay debt, raising cow, working as hired labor in miller/ in rice harvesting using combined harvester, waiting for rains to reduce salinity and acidity to sow rice, raising cow/ milking cow to have extra income)	2	3	1	1

Table 47: Supporting from the government and other institutions during severe drought or salinity, rain, typhoon in Tra Vinh province

Item	Tra Vinh (n=80 hhlds)

	Male		Female	
	No of house hold	%	No of house hold	%
Get support from the government and other institutions during severe drought or salinity, rain, typhoon				
Yes	55	69	51	64
No	25	31	29	36
Support resource (*)				
Government	54	98	51	100
Other Institutions	4	7	-	-
Kind of support from government (*)				
Housing	5	9	4	8
Pension	39	74	39	76
Loan from policy Bank, Saving Bank	-	-	1	2
Health insurance	10	19	8	16
Training on new rice technologies	-	-	2	4
Support for farming activities	3	6	-	-
Others (cow, land for agriculture, support seed cost, rice seeds)	4	8	4	8
Source of support from government (*)				
Agricultural department	9	17	4	8
Policy Bank	-	-	1	2
Cooperatives	-	-	1	2
People Committee	38	70	37	73
State government	4	7	5	10
Health department	9	17	9	18
Agricultural universities	1	2	-	-
Others (secondary and high school)	1	2	1	2
Kind of support from other institutions (*)				
Training on new rice technologies	1	25	-	-
Support for farming activities	-	-	-	-
Others (clothes, hat, pesticide)	3	75	-	-
Source of support from other institutionst (*)				
Agricultural universities	-	-	-	-
Pesticide/fertilizer company	4	100	-	-

Table 48: Response (in percent) on likely adopt a technology interventions to reduce vulnerability to climate variability in Tra Vinh province

	Tra Vinh (n=80 hhlds)									
Impacts	Highly unlikely	%	Unlikely	%	Neither likely nor unlikely	%	Likely	%	Highly Likely	%
Use of stress-tolerant crop varieties	5	3	1	1	12	8	82	51	60	38
ift to improved cropping systems or other tivities	41	26	16	10	23	14	43	27	37	23
Planting of early, medium or late varieties to avoid crop loss to variations in drought/salinity occurrence	6	4	2	1	16	10	85	53	51	32
Early sowing/production of rice to grow other additional crops	35	22	17	11	24	15	44	28	40	25
New land management techniques (i.e., zero tillage for rice or minimize tillage, resource conserving techniques, Biochar)	20	13	4	3	23	14	69	43	44	28
Changes in agricultural water-management techniques (alternated wetting and drying method, …)	14	9	8	5	24	15	70	44	44	28
Pest and disease management techniques such as IPM	9	6	9	6	18	11	75	47	49	31
Development and use of crop varieties resistant to pests and diseases	5	3	4	3	14	9	80	50	57	36
New livestock breeds	14	9	10	6	25	16	60	38	51	32
Improved animal health management	8	5	9	6	16	10	67	42	60	38

Conclusions

- Climate change scenarios in Vietnam and in particular in the three provinces of Nam Dinh, Tra Vinh and Soc Trang shows a significant change of temperature, rainfall and extreme events, new hazards of floods, droughts, and salinity.

- The impact of climate change on agricultural production in Nam Dinh, Tra Vinh and Soc Trang is also going to be significant with losses and damages mostly due to floods, drought, and sea water intrusion.

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ANNEXURE 1

Table A. 1. The total damage caused by hurricanes, tornados, floods in Nam Dinh province of stages 1989-2010

Assessment indicators	**Damage due to Hurricane (million VND)**	**Damage due to Cyclone (million VND)**	**Damage due to flooding (million VND)**	**TOTAL (million VND)**
1. Synthesis relief needs of people and houses	**5.993**	**163**	**0**	**6.156**
People:	***43***	***54***	***0***	97
- The dead and missing (3 million VND / person)	33	9	0	42
- Wounded (1 million VND / person)	10	45	0	55
Houses	***5.953***	***109***	***0***	6.062
- Poured, drifting, collapsed (5 million VND / House)	2.060	100	0	2.160
- Flooded, roofs, damaged (0,1 million VND /House)	3.893	9	0	3.902
- The number of displaced households (0,5 million VND / household).	*0*	0	0	0
2. Synthesis damage to infrastructure	**41.070**	**0**	**13.500**	**54.570**
Damage to schools, infirmaries workplace	***22.610***	***0***	***0***	22.610
- Collapsed, drifting (50 million VND / room)	2.600	0	0	2.600
- Flooding, damaged (10 million VND / room)	20.010	0	0	20.010
- Spoiled furniture on average (1 million VND / set)	0	0	0	0
- Books lost (0,1 million VND / set)	0	0	0	0
Losses for local dikes, canals	***18.395***	***0***	***13.500***	**31.895**
- Soil erosion, drifting, sedimentation on average 50.000 NVĐ/m3)	8.361	0	13.500	21.861
- Rocks, broken concrete, drifting, sedimentation on average 200.000 VNĐ/m3)	8.085	0	0	8.085
- Small irrigation works broken, drifting on average 1000 million VND / pcs	0	0	0	0
- Small Irrigation work damaged on average 500 million VND /pcs	0	0	0	0
- the dam temporary broke, drifting on average 10 million VND /pcs	1.950	0	0	1.950
Losses traffic	***65***	***0***	***0***	**65**
- Soil erosion, drifting, sedimentation	65	0	0	65

Assessment indicators	Damage due to Hurricane (million VND)	Damage due to Cyclone (million VND)	Damage due to flooding (million VND)	TOTAL (million VND)
on average (50.000 VNĐ/m3)				
- Rocks, broken concrete, drifting, sedimentation on average 200.000 VNĐ/m3	0	0	0	0
- Bridges and culverts collapsed, drifted on average 1000 million VND /pcs	0	0	0	0
- - Bridges and culverts impaired on average 100 million VND /pcs	0	0	0	0
3. Synthesis of agricultural damage	***1.230.459***	***4.262***	***1.959.470***	**3.194.192**
Rice	*1.008.823*	*1.512*	*1.879.270*	*2.889.606*
Rice dead loss (4 Ton/ha*3,5 million VND)	341.124	1.260	1.648.850	1.991.234
Rice reduced productivity 20%	667.699	252	230.420	898.372
Food, seed loss (5,5 million VND/Ton)	0	***0***	***0***	**0**
Crops other	***14.136***	***50***	***0***	**14.186**
Dead loss (Converted to paddy 2 Ton/ha*3,5 million VND)	0	0	0	0
Reduced productivity on average 20%	14.136	50	0	14.186
Cattle dead (on average 5. million VND/ 1 Cattle)	0	0	0	**0**
Pigs dead (on average 0,5 million VND/ 1 pig)	2.521	0	0	**2.521**
Poultry dead (on average 40.000 VNĐ/1 Poultry)	1.540	0	0	**1.540**
Damage to aquatic	***207.500***	***2.700***	***80.200***	**290.400**
Area of aquaculture ruptured, flooding (on average 1 Ton/ha*20 million VND /Ton)	192.000	0	80.200	272.200
Cages were drifting, lost (on average 100 million VND /pcs)	0	0	0	0
The fish was drift, lost (on average 20 million VND /Ton)	12.000	0	0	12.000
Vessels sunk, lost (on average 500 million VND /pcs)	3.500	2.500	0	6.000
Vessels damaged (on average 100 million VND /pcs)	0	200	0	200
4. Synthesis of electricity losses	**32.085**	**75**	**0**	**32.160**
Power poles apart, fractured (on average 5 million VND / pole)	32.085	75	0	32.160

Assessment indicators	Damage due to Hurricane (million VND)	Damage due to Cyclone (million VND)	Damage due to flooding (million VND)	TOTAL (million VND)
Electrical wire broken, lost (on average 20.000 VNĐ/m)	0	0	0	0
TOTAL DAMAGE	**1.309.608**	**4.500**	**1.972.970**	**3.287.078**

(Source: Office of the Permanent Steering Committee for Flood and Storm Central)

Table A. 2 The objects are vulnerable due to climate change impacts

No	Impact factor	Sensitive, vulnerability region	Sectors / field vulnerability.
1	Temperature increase	On the whole province but coastal areas be most strongly affected .	- Agriculture (crops, livestock, fisheries) and food security) - The natural ecosystem, the biodiversity - Energy (production and consumption) - The public health
2	Rising sea levels	The coastal districts and areas with low-lying terrain in the districts Nghia Hung, Hai Hau, Giao Thuy	- Agriculture (crops, livestock, fisheries) - The marine ecosystems and coastal - Water resources (surface and groundwater) - Infrastructure and tourist resorts (Quat Lam, Thinh Long - Place of residence; community health
3	Hurricanes and tropical depressions	Coastal strip in the districts: Nghia Hung, Hai Hau, Giao Thuy	- Agriculture (crops, livestock, fisheries) - The activities on coastal and marine - Infrastructure and transport, sea dikes - Houses and means of aquatic resource exploitation - Place of residence; community health
4	Drought	Occurs locally in some districts: My Loc, Vu Ban, Truc Ninh	- Agriculture and food security. - Water resources (surface and groundwater) - Water transportation - The health and living
5	Saltwater intrusion	Mainly occurs in the districts: Nghia Hung, Hai Hau, Giao Thuy.	- Agriculture (crops, fisheries) and food security - Water resources (surface and groundwater) - Land resource - People's life - The biodiversity
6	The extremist climatic phenomena (*)	On the whole province and especially the coastal areas	- Agriculture (crops, livestock, fisheries)- Nhà cửa - The health and living

(*):Including the phenomenon: abnormal heatwaves, unusually of rainy days, storms, cyclones, tornadoes.

*Table A. 3**Sensitivity level and adaptability to climate change***

Sectors / object	Sensitivity, vulnerability level	Adaptability
Water Resource	Very sensitive	It can be adaptation a certain value
Agriculture and food security	Very sensitive	It can be adaptation a certain value
The marine and coastal ecosystems	Very sensitive	It can be adaptation a certain value
The Forestry	Sensitive	It can be adaptation a certain value
Irrigation (irrigation schemes)	Sensitive	It can be adaptation a certain value
Energy	Sensitive	It can be adaptation a certain value
Transportation	Sensitive	It can be adaptation a certain value
Industry and construction	Sensitive	It can be adaptation a certain value
Cultural, sports, tourism	Sensitive	It can be adaptation a certain value
Commercial and services	Sensitive	It can be adaptation a certain value
The residence	Sensitive	It can be adaptation a certain value
The health	Sensitive	It can be adaptation a certain value
The move	Sensitive	It can be adaptation a certain value
Natural scenery	Sensitive	Unknown

Table A. 4.The level of potential impact

Branches, domains, subjects	The impact factor						
	Temperature increases	Sea level rise	Storms and tropical depressions	Saltwater intrusion	The drought	Accreting, landslides coastal	The phenomenon of climate another extreme
Agriculture and food security	High	High	High	High	High	Medium	High
Construction	High	High	High	High	Medium	Medium	High
Fisheries	High	High	High	High	Medium	Medium	Medium
Transportation	High	High	High	High	Medium	High	Medium
The health	High	Medium	High	High	High	Medium	High
Water Resource	High	High	TB	High	High	Medium	Medium
Tourism	Medium	High	High	High	Medium	Medium	Medium
The residence	Medium	High	High	High	Medium	Medium	Medium
Energy	High	Medium	Medium	Medium	High	Medium	Medium
Industry	High	High	Medium	Medium	Medium	Medium	Medium
Natural Ecosystems and Biodiversity	High	High	Medium	Medium	Medium	High	Medium

Table A. 5 Statistics of the main soil types Soc Trang province

No	Soil types	Area (ha)	The rate (%)	Distribution
1	Arenosols	8.491	2,65	Vertical coastal of Vinh Chau, My Xuyen District.
2	Fluvisols	6.372	2,00	Concentrated in Ke Sach District, My Tu District .
3	Gley soil	1.076	0,33	The northern communes Ke Sach District

No	Soil types	Area (ha)	The rate (%)	Distribution
4	Thionic Fluvisols	158.547	49,50	To concentrate on large area in Vinh Chau, Phu and Long Xuyen District .
5	Alkaline soil	75.823	23,70	To concentrate on large area in My Tu, Nga Nam, My Xuyen District and partly in Thanh Tri and Vinh Chau District .
6	Umbrisols soil	46.146	21,82	Most concentrated in Ke Sach and Long Phu District.

Source:: Socioeconomic development planning Soc Trang Province to 2020, 2009

Table A. 6.Statistics of the main soil types Tra Vinh province

No	Soil types	Area (ha)	The rate (%)	Distribution
1.	Arenosols	17.665	7,97	Concentrated in the coastal districts as Duyen Hai, Cau Ngang, Tra Cu
2.	Salic Fluvisols	58.956	26,61	Distributed mainly in the coastal districts
3.	Thionic Fluvisols	41.267	18,63	Salinisation areas, mainly distributed in Chau Thanh and Cau Ngang districts
4.	Fluvisols	44.603	20,14	Concentrated in the same district as Cang Long, Cau Ke, Chau Thanh and Tieu Can.
5.	Other soil	38.881	17,55	

Table A. 7.Statistics of the main soil types Tra Vinh province

No	Soil types	Area (ha)	The rate (%)	Distribution
1.	Arenosols	6.563,05	4,01	Distribution of sand dunes and sandy beaches of the coastal: Giao Thuy, Hai Hau, Nghia Hung district, and distributed on riverside district of Nam Truc, Truc Ninh, Xuan Truong, Vu Ban, My Loc, Nam Dinh City
2.	Salic Fluvisols	15.615,89	9,54	Distributed in coastal areas, estuaries in Giao Thuy, Hai Hau and Nghia Hung district, and other districts, such as Xuan Truong, Nam Truc and peri So river
3.	Thionic	4.222,64	2,58	Distributed in districts: Vu Ban Y

	Fluvisols			Yen, Nam Truc, Giao Thuy, Nam Dinh city
4.	Fluvisols	101.273,63	61,85	Distributed in all districts
5.	Gleysols	1.456,29	0,89	Distribution in the low-lying topographic in the districts: Vu Ban, Y Yen, My Loc, Nam Dinh city.
6.	Acrisols	564,74	0,34	Distributed in Vu Ban, Y Yen district
7.	Leptosols	119,77	0,77	Distributed in Vu Ban, Y Yen district

Table A. 8. Data area, yield and production of paddy in 2012 in Soc Trang

No	City / District	Planted area of paddy (ha)	Yield of paddy (Quintals/ ha)	Productin of paddy (Quintals)	Planted area of spring paddy (ha)	Yield of spring paddy (Quintals/ha)	Productin of spring paddy (quintals)	Planted area of autumn paddy (ha)	Yield of autumn paddy (Quintals /ha)	Productin of autumn paddy (Quintals)
1	Soc Trang city	9.305	57,98	53.954	3.753	55,95	20.998	5.552	59,36	32.956
2	Chau Thanh	45.976	64,14	294.895	14.720	64,44	94.856	28.865	65,08	187.864
3	Ka Sach	37.574	60,49	227.288	12.484	58,28	72.762	25.090	61,59	154.526
4	My Tu	37.574	61,22	344.949	20.602	68,99	142.133	26.597	61,22	157.114
5	Cu Lao Dung	56.343	45,06	766						
6	Long Phu	170	65,69	303.871	15.484	66,44	102.876	30.776	65,31	200.995
7	My Xuyen	46.260	53,52	146.668	8.173	59,45	48.588	8.296	56,09	46.533
8	Nga Nam	27.406	62,65	231.873	18.176	73,26	133.157	8.296	52,61	95.624
9	Thanh Tri	37.009	63,06	344.540	22.799	66,50	151.613	18.176	60,59	192.927
10	Vinh Chau	54.641	42,90	14.131						
11	Tran Đe	47.931	60,26	288.811	22.651	63,03	142.613	25.280	57,77	146.044
	Total	**365.909**	**61,54**	**2.251.746**	**138.842**	**65,52**	**909.750**	**200.474**	**60,59**	**1.214.583**

Source:

Table A. 9.Data damage caused by natural disasters in Soc Trang, 2012

Soc Trang province				**Situation damage from early year to 31/12/2012**													
No	**Types of damages**	**Code**	**Item**	**District**	**Long phu**	**Vĩnh Chau**	**Ke sach**	**My Xuyen**	**My Tu**	**Thanh Tri**	**Nga Nam**	**Cu Lao Dung**	**Soc Trang city**	**Chau Thanh**	**Tran Đe**	**Tổng thiệt hại**	**Into money (million VND)**
				Unit													
1	**Person**	**NG01**	**Mortally**	Person						**2**	**1**					**3**	
		NG011	The dead	Person						2	1					3	
		NG02	The number of injuries	Person				32		43	15					90	
		NG031	Seriously injured	Person				11		43	3					57	
		NG032	Petty jury	Person				21			12					33	
		NH01	Houses were unroofed,	Piece	5	412	3	322	41	304	95	41		1	34	1.258	6.276
		NH020	Collapsed building 100%	Piece							1					1	30
		NH021	Semi-permanent houses damage 100%	pcs	5	70	3	64	14	100	22	9		1	15	303	3.030
		NH022	Temporary housing Unroofed over 50%	pcs		329		118	27	69	32	32			19	626	2.504
		NH023	Temporary housing Unroofed under 50%	pcs		13		140		133	40					326	652
		NH024	Agencies unroofed	pcs						1						1	30
		NH025	Company unroofed	pcs						1						1	30
2		**NH02**	**Houses Flooded**	**pcs**			**139**					**755**				**894**	
		NH031	Semi-permanent houses	pcs			139					755				894	
3	**Educated**	**GD01**	**Number of schools affected**				**2**	**6**								**8**	**80**
		GD011	Classrooms flooded, Unroofed	Room				5								5	50
		GD012	Classrooms flooded	Point			2									2	
		GD013	Garage collapse	pcs				1								1	30
4	**Agriculture - Forestry**	**NN01**	**Rice area damaged**				**26**		**10.120**	**2.380**	**4**			**262,6**		**12.793**	**57.058**
		NN011	Rice dead loss	Ha					4.000					206		4.206	32.216
		NN014	Reduced productivity 10%	Ha					6.120	2.130				33,2		8.283	24.645
		NN015	Reduced productivity 30%-70%	Ha						250				23,5		274	191
		NN016	Reduced productivity over 70%	Ha							4					4	5
		NN017	Rice paddy flooded	Ha			26									26	
		NN02	Area of crops damaged	Ha			15		74			1.647		5.85		1.733	13.785
		NN022	Reduced productivity of	Ha								90				90	900

Soc Trang province				Situation damage from early year to 31/12/2012													
No	**Types of damages**	**Code**	**Item**	**District**	**Long phu**	**Vĩnh Chau**	**Ke sach**	**My Xuyen**	**My Tu**	**Thanh Tri**	**Nga Nam**	**Cu Lao Dung**	**Soc Trang city**	**Chau Thanh**	**Tran Đe**	**Tổng thiệt hại**	**Into money (million VND)**
				Unit													
			sugarcane														
		NN023	Sugarcane flooded	Ha								1.548				1.548	7.700
		NN024	Watermelon damaged	Ha					74							74	4.440
		NN025	Watermelon is rain affected	Ha			15									15	225
		NN04	**The area of damaged fruit trees**													**444**	**206**
		NN041	Dead														
		NN042	Reduced productivity								400						
		NN043	Fruit trees falls													400	120
		NN044	Fruit trees damaged									1				44	86
5	**Irrigation**	**TL02**	**Dike, embankments damaged**									**10.230**				**11.389**	**737**
		TL021	Dike overflow													550	
		TL 023	Dike landslides													500	
		TL 024	The dam overflow													50	50
		TL 025	The dam is broken													37	32
		TL 026	Overflow of embankments									820				842	655
		TL 027	Overflow of embankments									9.410				9.410	
6	**Transportation**	**GT02**	**Rural Roads**													**53.495**	**1.417**
		GT020	03 bridge abutments collapsed, landslide													3	10
		GT021	Dal length collapsed													16	7,2
		GT022	Road dal overflow													53.459	1.400
7	**Fisheries**	**TS01**	**Aquaculture**									**4**		**1,4**		**5,4**	**104**
		TS011	The number of shrimp, fish is lost	Tons								4				4	100

Soc Trang province				**Situation damage from early year to 31/12/2012**													
No	**Types of damages**	**Code**	**Item**	**District**	**Long phu**	**Vĩnh Chau**	**Ke sach**	**My Xuyen**	**My Tu**	**Thanh Tri**	**Nga Nam**	**Cu Lao Dung**	**Soc Trang city**	**Chau Thanh**	**Tran Đe**	**Tổng thiệt hại**	**Into money (million VND)**
				Unit													
		TS012	The number of fish is lost	Ha										1,4		1,4	4
		NN18	Agroforestry			3.300										3.300	2.900
		NN180	Artemia damage	Ha		1.300										1.300	1.300
		NN181	The salt damage	Tấn		2.000										2.000	1.600

Source: