THE GLOBAL TECHNOLOGY NEEDS ASSESSMENT

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE ADAPTATION

VIET NAM

SYNTHESIS REPORT









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Viet Nam Technology Needs Assessment for Climate Change Adaptation

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PREFACE

Assessing, developing and applying adaptation technologies is one of the key tasks set out in the Vietnam Climate Change Strategy, as well as many countries in the world.

The Global Technology Needs Assessment project, code 1215227, is funded by the Global Environment Facility (GEF) and the United Nations Environment Program (UNEP) (via the UNEP Risoe Center in Denmark). The project was derived from the Poznan Strategy on technology transfer and was carried out in two rounds, with participation of 15 developing countries, including Vietnam, in Round 1, and 21 developing countries in Round 2, to assist these countries in technology needs assessment for adaptation to climate change in accordance with Article 4.5 of the United Nations Framework Convention on Climate Change.

In Vietnam, the implementation of the "Global Technology Needs Assessment" project was coordinated by the Department of Meteorology, Hydrology and Climate Change, the Ministry of Natural Resources and Environment, in collaboration with experts and representatives from relevant ministries, sectors and institutions.

The Report on Technology Needs Assessment for Climate Change Adaptation and Technology Action Plan for Climate Change Adaptation is one of the main parts of the Project. The Report focuses on issues related to identification, assessment and selection of priority technologies from a pool of potential adaptation technologies that are suitable to Vietnam's conditions and circumstances, as well as to the national and local plans and programs.

On the basis of identified, assessed and selected priority adaptation technologies to climate change in Vietnam, the Report provides solutions to overcome barriers to the development, application and diffusion of the selected technologies, which forms the basis for an action plan for each technology. In addition, the Report also gives a list of project ideas for the development and application of the priority technologies.

We have high expectations that this Report will contribute to promoting of adaptation technologies to climate change and serving the effective response to climate change to ensure the sustainable development in Vietnam.

Kind regards,

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ACKNOWLEDGMENTS

The Report on Technology Needs Assessment for Climate Change Adaptation and Technology Action Plan for Priority Climate Change Adaptation Technologies under the Project "Global Technology Needs Assessment" in Vietnam were developed in consultation with various national experts and representatives from relevant ministries, sectors and institutions.

Throughout the course of the Project, we also received plenty of valuable comments and contributions from experts at the Asian Institute of Technology (AIT) in Thailand and United Nations Environment Programme (UNEP) Risoe Center in Denmark in rectifying the Report and Plan.

Report on Technology Needs Assessment for Climate Change Mitigation, Technology Action Plan for Priority Climate Change Adaptation Technologies and the outcomes of the Project will contribute to the achievement of sustainable development goals, as well as efforts towards low-carbon economy and green growth in Vietnam in the future. On this occasion, the Department of Meteorology, Hydrology and Climate Change would like thank the Ministry of Natural Resources and Environment for facilitating the administrative and legal procedures of the report and project development.

We hereby would like to express the sincerest thanks to the UNEP (via the Danish UNEP Risoe Center) which managed and coordinated activities under the project and the Global Environment Facility which financed the Project.

We owe a debt to experts at AIT and UNEP Risoe Center experts for their important technical assistance to the project implementation as well as their valuable comments throughout the course of the Project.

Finally, we would like to thank the active and efficient participation of all national stakeholders who together made the Project a success.

ABBREVIATIONS

COP	Conference of the Parties under the United Nations Framework Convention on Climate Change
DNA	Designated National Authority
DMHCC	Department of Meteorology Hydrology and Climate Change
EST	Environmentally Sound Technology
GEF	Global Environment Facility
GoV	Government of Vietnam
GPS	Geographical Positioning System
HWTS	Household Water Treatment and Safe Storage
ICZM	Integrated Coastal Zone Management
IPCC	Intergovernmental Panel on Climate Change
IRBM	Integrated River Basin Management
LULUCF	Land use, Land use change and Forestry
MAR	Managed Aquifer Recharge
MARD	Ministry of Agriculture and Rural Development
MCDA	Multi Criteria Decision Assessment
MONRE	Ministry of Natural Resources and Environment
NTP	National Target Programme to Respond to Climate Change
PMU	Project Management Unit
SNC	Vietnam's Second National Communication to the United Nations Framework Convention on Climate Change
SRI	System of Rice Intensification
TAP	Technology Action Plan
TNA	Technology Needs Assessment
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change
URC	UNEP Risoe Center

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Technology Needs Assessments Report

EXECUTIVE SUMMARY

INTRODUCTION

Vietnam is considered one of the countries most badly affected by climate change in the world. With its long coastline and susceptibility to natural disasters, Vietnam's economic and social development is being threatened by climate change.

One of the major items on the agendas of the Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC) is transferring climate change adaptation and greenhouse gas (GHG) mitigation technologies to developing countries. According to Article 4.5 of the UNFCCC, Technology Needs Assessment (TNA) project is one of the items of the Poznan Strategy on Technology Transfer, proposed by Global Environment Facility (GEF) to assist developing countries in developing and updating their technology needs.

Within the framework of the TNA project, technology needs for climate change adaptation were assessed for agriculture, forestry, coastal zone management and water resources management, because they are predicted to be adversely impacted by climate change in the future. Selected technologies vary from conventional to modern technologies that are feasible in Vietnam.

The Report on technologies needs assessment on climate change adaptation consists of two parts: Part I focuses on technology needs assessment and Part II contains the technology action plans. Part I presents the technology prioritization and technology needs assessment processes and results for priority sectors. Part II analyzes barriers to the diffusion of the priority technologies of Part I and proposes solutions to overcome those barriers as well as to develop technologies action plans for each sector.

INSTITUTIONAL ARRANGEMENTS FOR THE TNA PROCESS AND STAKEHOLDER ENGAGEMENT

The Department of Meteorology, Hydrology and Climate Change (DMHCC), under the auspices of the Ministry of Natural Resources and Environment (MONRE) were assigned to coordinate the implementation of the Project. Throughout the course of the project, the Project Management Unit (PMU) under the DMHCC and the TNA national team received technical support from national consultants and experts at the UNEP Risoe Center (URC) and the AIT as well as from stakeholders.

The PMU organized consultation meetings with the core group of experts and the wide group of experts on selecting technologies for each sector. After these meetings, a set of preliminary criteria for sector prioritization were defined before a list of priority technologies with potential to adapt to climate change was produced. In the Multi-Criteria Decision Assessment (MCDA), survey forms were sent to independent experts selected from stakeholders for precise and objective results.

SECTOR PRIORITIZATION

After taking into account climate change impacts and Vietnam's natural, social and economic conditions, agriculture, forestry, water resources management and coastal zone management were prioritized as key sectors for technology needs assessment. Vietnam's climate change scenarios for seven climate zones in the 21st century on temperature, rainfall and sea-level rise. The coupled method (MAGICC/SCENGEN 5.3) and the downscaling method based on the greenhouse gas emission scenarios in IPCC Fourth Assessment Report, including high emission (A21), low emission (B12) and medium emission (B23) scenarios were used to develop these scenarios. The outcomes of these scenarios were used in calculating the impacts of climate change. Technology status of the priority sectors was also taken into consideration to categorize and reassess the current technologies for technology prioritization.

ADAPTATION TECHNOLOGY NEEDS ASSESSMENT FOR PRIORITY SECTORS

ASSESSMENT METHODOLOGY

Based on UNDP Handbook for Conducting Technology Needs Assessment for Climate Change, the MCDA was used to assess technology needs for climate change adaptation. The first step was to prioritize technologies. With the above directions, stakeholder consultations were held to prioritize sectors for climate change adaptation based on the following criteria: economic, social and environmental benefits, and application potential, potential to adapt to climate change, on a rating scheme of 0-5. In each sector, technologies were given points and weighted based on the set of criteria mentioned above and put in order of their points (higher points mean higher priority). Then, the

consultants used the MCDA to analyze the benefit-cost and the average benefit point of each technology. Finally, decisions were made to which technology was prioritized.

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE ADAPTATION IN AGRICULTURE

Climate change adaptation technologies prioritized for agriculture include: Plant genetics/Plant breeding; Shifting from rice to upland grains; and Shifting from triple cropping to double cropping and a shrimp/fish/poultry crop.

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE ADAPTATION IN FORESTRY

Climate change adaptation technologies prioritized for forestry include plant science/ plant genetics and agro-forestry.

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE ADAPTATION IN INTEGRATED COASTAL ZONE MANAGEMENT

Climate change adaptation technologies prioritized for integrated coastal zone management include: Integrated coastal zone management; Sea dykes; Coastal wetland rehabilitation; and Flood warning system.

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE ADAPTATION IN INTEGRATED WATER RESOURCES MANAGEMENT

Climate change adaptation technologies prioritized for integrated water resources management include: Harvesting rooftop rainfall for household usage; Harvesting runoff water; and Irrigated river basin management.

Chapter 1. Introduction

Climate change, most prominently demonstrated by global warming and rising sea level, is one of the biggest challenges to mankind in the 21st century. Natural disasters and extreme weather events are on the rise in many parts of the world. The global average temperature and mean sea level have been increasing at an ever-faster rate - a major threat to all nations, particularly those with a long and low-lying coastline like Vietnam. While all countries will face some social and economic consequences of climate change, the developing and least developed countries, particularly their poor population, will probably be most seriously affected.

Vietnam is considered one of the countries most vulnerable to climate change, especially to sea-level rise. In fact, it is now facing many climate change impacts on livelihoods, and natural resources, social integrity, infrastructure and economic development. Climate change consequences for Vietnam can seriously threaten the hunger eradication, poverty reduction, Millennium Development Goals accomplishment and sustainable development of the country. Today, climate change is no longer merely an environmental problem - it has become a social and economic issue. Responding to climate change is an imperative vital to Vietnam's development.

On the one hand, climate change may adversely impact Vietnam's socio-economic development. On the other hand, it represents opportunities for Vietnam to speed up the transfer, development and deployment of environment friendly technologies for climate change adaptation and mitigation and the transition towards a low-carbon economy.

Recognizing the climate change risks at its early stages, the Government of Vietnam (GoV) signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. The GoV has issued a number of directives and decisions for the implementation of the UNFCCC, the Kyoto Protocol and promulgated the National Target Program to Respond to Climate Change (NTP). Vietnam's Second National Communication (SNC) to the UNFCCC was completed and submitted to the UNFCCC Secretariat in December 2010, with support from the Global Environment Facility (GEF), the United Nations Environment Program (UNEP), and the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). SNC presents the GHG inventory for the base year 2000 and GHG emission estimates for three main sectors: energy, agriculture and land use, land use change and forestry (LULUCF) for 2010, 2020 and 2030. It also introduces a number of adaptation measures and GHG mitigation options and deployment of eco-friendly technologies in Vietnam.

Laws and legislation regarding climate change adaptation:

National laws:

- Law on Environmental Protection No. 52/2005/QH11 dated 29 November 2005 (replacing the 1993 Environmental Protection Law).
- Law on Forest Protection and Development No. 29/2004/QH11 dated 3rd December 2004 (replacing the 1991 Law on Forest Protection and Development).
- Law on Water Resources Management No. 08/1998/QH10 dated 20 May 1998.

Government policies

2003: the *National Environment Protection Strategy by 2010 - vision towards 2020* was adopted by the Government. The strategy emphasizes on promoting clean technologies, cleaner production processes and less polluting, environmentally-friendly fuels and materials.

2004: The Government passed the *Vietnam Sustainable Development Vision* (Vietnam's Agenda 21) for the national sustainable development on the basis of the close coordination of society, economy and environmental protection for a balanced development. Agenda 21 includes 5 main parts and identifies priorities in social and economic development, natural resource utilization, environmental protection and pollution control for the sustainable development.

2008: The NTP was established. The goal of the Program is to develop feasible action plans to, in short and long terms, effectively respond to climate change in order to help the country on the track of sustainable development and secure opportunities to build a low-carbon economy. The Program sets out nine tasks and corresponding solutions, including development and implementation of a national scientific research program to develop technologies for adaptation to climate change and GHG emission mitigation. In this regards, the Ministry of

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Science and Technology, in cooperation with the MONRE, has introduced the *National Science and Technology Framework on Climate Change*, which highlighting several milestones by 2015: i) establishing and updating the climate change database, ii) implementing the national science and technology program for climate change at Ministries, sectors and localities, iii) studying the sciences, nature and updating scenarios and potential impacts to cope with climate change. The activities of this Framework include the following:

1. To improve understanding about climate change nature, sciences, uncertainties, and determining its social and economic impacts; to analyze the socio-economic benefits (cost benefit analysis) of climate change response activities;
2. To integrate climate change issues into environmental protection, natural resources utilization, disaster management, and marine research programs;
3. To intensify scientific studies so as to strengthen the climate change monitoring system.
4. To establish a database to assist in climate change impact assessment;
5. To promote research and development of GHG emission mitigation and climate change adaptation technologies;
6. To develop a cooperative mechanism between research institutions, academies and technology development institutions from relevant sectors; and
7. To strengthen international cooperation in science and technology activities, particularly effective implementation and transfer of eco-friendly and climate-friendly technologies.

Climate change adaptation and GHG mitigation technology transfer to developing countries is one of the most prominent items on agendas at the Conferences of Parties (COPs) to the UNFCCC. Through technology transfer, developing countries can cut their GHG emissions, which in turn will enable them to achieve their sustainable development goals and fulfill their obligations to the UNFCCC's common goal of "*stabilizing the GHG concentration in the atmosphere and preventing dangerous anthropogenic interference with Earth's climate system."*

Despite the impressive economic growth rate over the past decade, Viet Nam's industry is still underdeveloped due to outdated technologies. Therefore, assessing technology needs is an important step in transferring climate change technologies to ensure sustainable development. One of the main tasks of the NTP is "*Development of a science and technology program on climate change*", which focuses on technology research and development in support of climate change mitigation and adaptation.

The Project *Global Technology Needs Assessment*, coded 1215227, is funded by GEF and implemented by UNEP and the UNEP Risoe Centre (URC) in 36 developing countries in two rounds. Vietnam was chosen as one of the 15 first-round participant countries and the duration of the TNA project activity in Vietnam was 18 months, commencing in mid-2010.

The Technology Needs Assessment (TNA) project is an item of the Poznan Strategic Program on Technology Transfer, proposed by GEF, to help developing countries to develop and update their technology needs according to Article 4.5 of the UNFCCC.

The purpose this TNA project is to assist the participant developing country in identifying and analyzing their priority technology needs, which can form the basis for a portfolio of climate change mitigation and adaptation technology projects and programs to facilitate the transfer of, and access to, the selected mitigation and adaptation technologies.

The project's specific goals include: (1) identifying and prioritizing adaptation and mitigation technologies, and contributing to the national sustainable development goals; (2) identifying barriers to the acquisition, deployment, and diffusion of prioritized technologies; (3) developing technology action plans (TAPs) to overcome the barriers and facilitate the transfer, adoption, and diffusion of selected technologies in the participant countries.

Chapter 2. Institutional arrangement for the TNA and the stakeholders' involvement

2.1 Overview

The Ministry of Natural Resources and Environment (MONRE) is the national Focal Point to implement the UNFCCC and the Kyoto Protocol.

The Department of Meteorology, Hydrology and Climate Change (DMHCC), under MONRE, is responsible for: i) leading and coordinating the implementation of the UNFCCC and the Kyoto Protocol, ii) hosting the Standing Office of the Steering Committee of the UNFCCC and Kyoto Protocol, and the UNFCCC Secretariat contact point, iii) coordinating with other agencies to monitor and evaluate climate change impacts and propose climate change response plans; and iv) working as Designated National Agency (DNA) of the Clean Development Mechanism (CDM). The DMHCC were also the leading agency in the development of *Vietnam Second National Communication to the UNFCCC*.

The National Steering Committee for the UNFCCC and Kyoto Protocol constitutes 18 members from 13 ministries, including: Ministry of Natural Resources and Environment (MONRE); Ministry of Foreign Affairs; Ministry of Industry and Trade; Ministry of Culture, Sports and Tourism; Ministry of Planning and Investment; Ministry of Finance; Ministry of Transportation; Ministry of Science and Technology; Ministry of Labor, War Invalids and Social Affairs; Ministry of Construction; Ministry of Agriculture and Rural Development; Ministry of Education and Training, Justice and Viet Nam Union of Science and Technology Associations. It is an inter-ministerial committee responsible for assisting the Minister of MONRE in instructing, managing and coordinating the UNFCCC and Kyoto Protocol implementation activities, and CDM projects in Viet Nam.

2.2 Institutional arrangement of Vietnam TNA project

The implementation of the TNA project in Vietnam involved the participation of multiple government agencies, research institutions, and non-governmental organisations.

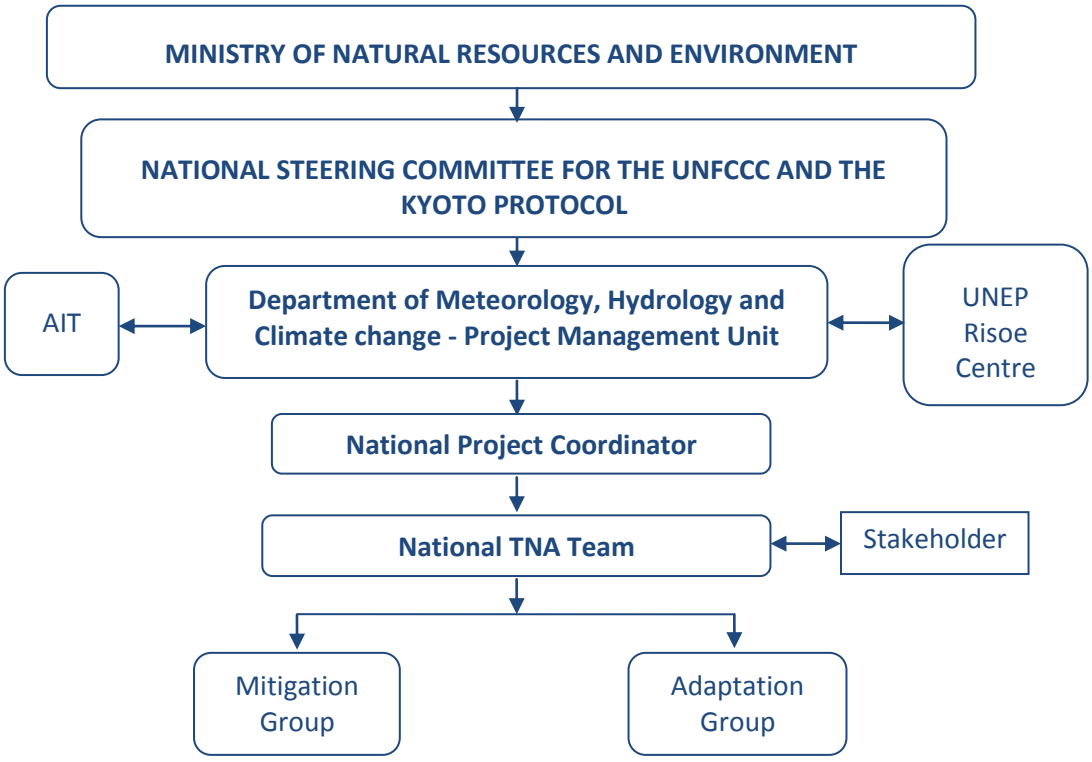

Figure 1 - Institutional arrangement for the TNA Project

As indicated in

Figure 1, the roles of different institutions are as follows:

Table 1 - The roles of institutions involved in the TNA project

Figure	*Hierarchy level*	*Job description/task/function*
MONRE	1	Line Agency
National Steering Committee for the UNFCCC and the Kyoto Protocol	2	Leads the TNA process
DMHCC	3	Coordinates the implementation of the Project
PMU	4	The PMU Director is a leader of the DMHCC. Directly coordinates and leads the project implementation
Project National Coordinator	5	An official from the DMHCC with outstanding project management skills and substantial technical knowledge
National TNA Team	6	Divided into 02 groups: adaptation and mitigation. Includes representatives from relevant institutions in the public and private sector (see Table 2.2).

The National Supervising Agency: Ministry of Natural Resources and Environment.

National Coordination Institution/Executing Agency: Department of Meteorology, Hydrology and Climate Change, Ministry of Natural Resources and Environment.

National Steering Committee for the UNFCCC and Kyoto Protocol: The TNA process was led by the National Steering Committee for UNFCCC and Kyoto Protocol.

Project Management Unit: The Project Management Unit (PMU) was formed via MONRE's Decision 259/QD-BTNMT dated 16 February 2011. The PMU composed one Project Director who is the Deputy Director-General of the DMHCC and one Project Accountant.

The PMU's mandate was to coordinate and implement the Project based on the Project Document and the TNA Handbook, and responsible for reporting to MONRE leaders and the National Steering Committee for UNFCCC and Kyoto Protocol for all activities of the Project.

2.2.1 National Project Coordinator, National TNA team and consultants

The Project Coordinator was the Head of Climate Change Division of DMHCC who has a background in engineering and was able to demonstrate his facilitation and project management skills throughout the project. He functioned as a focal point for the work and management of the overall TNA process. He was capable of providing vision and leadership for the overall effort, facilitating the tasks of communication with the National TNA Team members, and managing outreach to stakeholders, formation of networks, information acquisition, and coordination and communication of all work products.

The National TNA Team was divided into two groups of experts: mitigation and adaptation. The team included members familiar with national development objectives and sector policies, overall insights in climate change science, and potential climate change impacts for the country, adaptation needs and mitigation options of climate change. The experts came from policy-making institutes and organizations (both governmental and non-governmental) with responsibility to undertake TNA activities such as research, analyses, and synthesis in support of the TNA exercise.

Specifically, the tasks of TNA team included:

- Identifying national development priorities through reviewing national plans, national communications, energy plans, previous TNAs; identifying and categorizing sectors and potential technologies for mitigation and adaptation.
- Leading the process of technology needs assessment, identifying assessment criteria, and identifying and addressing the barriers.
- Preparing the TAP - a roadmap of policies that will be required for removing barriers; and
- Preparing the mid-term reports and final report (TNA and TAP).

During the course of the project, the TNA experts worked with various state agencies and referred to the climate tech-wiki website (http://climatetechwiki.org/) and the TNA project website (www.tech-action.org) for information and data.

For the list of organization which experts work in, see Table 2 below.

Table 2 - List of organization

P.o	Organization
1	Department of Meteorology, Hydrology and Climate Change, Ministry of Natural Resources and Environment
2	Department of Science and Technology, Ministry of Natural Resources and Environment
3	Institute of Strategy and Policy for Natural Resources and Environment, Ministry of Natural Resources and Environment
4	Department of Science and Technology, Ministry of Agriculture and Rural Development
5	Vietnam Administration of Forestry, Ministry of Agriculture and Rural Development
6	Institute of Agricultural Environment, Ministry of Agriculture and Rural Development
7	Water issues Research Institute, Institute of Geological Sciences, Vietnam Academy of Science and Technology
8	Institute of Environmental Technology, Vietnam Academy of Science and Technology
9	Institute of Industrial and Chemical Safety Technology, Vietnam Union of Science and Technology Association

2.2.2 The cooperation of UNEP Risoe Center and AIT

During the project, the PMU and TNA team received technical assistance from UNEP Risoe Center and Asian Institute of Technology (AIT).

The Vietnam's side also worked directly with UNEP Risoe Center experts to discuss solutions to difficulties and barriers arising in the technology needs assessment, and requesting assistance for the assessment and development of TAP for selected technologies.

The draft TNA reports were sent to UNEP Risoe Center and AIT for comments and later amended accordingly.

2.3 Stakeholder engagement process followed in TNA

Stakeholder consultation was an integral part of the implementation of the TNA. The list of the stakeholders included policy-making governmental agencies, research institutions, academies, and public and private organizations, whose opinions and ideas were considered to be important inputs to the technology needs assessment for climate change adaptation and GHG emission mitigation. The list of stakeholders is in Annex IV of this report.

The stakeholders were organized in two groups: a core group of direct participants and a wider group of affected and interested parties. The core group dealt with the most substantive issues of the TNA process such as management, resource assessment, technology costing and preparation of reports and other materials. The wider group of affected and interested parties participated in consultation and engagement activities, such as workshops, public hearings and consultation papers. Both groups covered the mitigation and adaptation areas.

During the assessment, the National Steering Committee and the core group, together with other stakeholders, collaborated in the following activities:

- The Steering Committee created the sector prioritization survey forms and sent them to the stakeholders. When the stakeholders gave their feedback, the Committee held meetings with the core group and the stakeholders to analyze the results and vote to determine prioritized sectors.

- The sector prioritization survey/consultation received many comments from stakeholders on the screening and elimination of old, inefficient technologies and selection of short- and long-term modern and highly potential adaptation technologies. As a result, the categorization and status and trends of the technologies became clearer and more precise, making it easier for experts in the MCDA process.

- The Committee held meetings with the core group for prioritization of technologies for the selected sectors. The outcomes of these meetings were lists of prioritized sectors which have high needs for climate change adaptation. Another important outcome is a set of assessment criteria for each sector.

- In a workshop participated by a wide range of stakeholders, comments and ideas were exchanged and collected for the identification and selection of priority sectors and finalization of the set of criteria for each the sectors.

- In the MCDA process, survey forms were sent to 10 independent experts of the sector selected from the stakeholders for objective and precise results.

- Working with stakeholders from the important, priority sectors was a good opportunity for the core group to carry out the survey in a precise and objective way when there was a plethora of expert opinions. In this process, the core group also had the assistance of stakeholders in gathering and screening data.

Chapter 3. Sector prioritization

3.1 Overview of sectors: predictions of climate change and climate change impacts on several main sectors

3.1.1 Overview of sectors

3.1.1.1 Agriculture

Agriculture has always been a pillar of Vietnam's economy. Twenty years since the Reform, Vietnam's rural areas have seen significant changes. The structure of economy has been moving towards service sector, while new, lucrative industries are emerging, creating more jobs in rural areas and increasing production. Total agricultural area in 2000 was approximately 9.3 million hectares, equivalent to 28.2% of the national land area, including 7.6 million hectares of rice fields.

Crop and livestock (including aquaculture) production are the backbones of agriculture. However, the techniques and technologies used in these sub-sectors are outdated, although agricultural production still manages to meet domestic and export demand. Vietnam is now the world's second largest rice exporter, after Thailand. Crop production has been undergoing transformation to a market-oriented system to enhance product quality and value. Livestock production (or animal husbandry) is changing towards industrial farming, with aquaculture being the subsector developing most quickly.

Agriculture has created jobs for thousands of people, and remains the major source of income for poor households. The number of households in agriculture are estimated at 8,850,083. Based on preliminary results of the total survey in rural areas, agriculture and aquaculture by 1 July 2011, the number of households who live on agriculture, forest and aquaculture in rural areas were 9.52 million household - 0.27 million (2.7%) less than in 2006. The number of households in industry, construction and services were 5.09 million, 1.63 million (47.2%) more than in 2006. Compared to 2006, the share of agricultural, aquacultural and forest households decreased from 71.1% to 62.0%, while industry and construction increased from 10.18% to 14.73%, services from 14.9% to 18.4%. The share of industry, construction and service households combined increased by 8.1% (from 25.1% to 33.2%) [*].

In 2011, output value of agriculture totaled VND 168.39 thousand billion (US$ 8.16 billion) and accounted for 13.85% of the GDP [*].

With the ongoing global climate change, food security is one of the major concerns to countries with large proportions of population relying on agriculture like Vietnam.

Based on current assessments of climate change impacts on agriculture (see 3.1.3), this sector is considered one of the most vulnerable sectors to climate change.

3.1.1.2 Forestry

According to the 2006-2020 forestry development strategy, its strategic targets are to establish, manage, protect, develop and sustainable use 16.24 million hectares of forest land, including 5.6 million hectares of protection forest, 2.2 million hectares of special forest, and 8.4 million hectares of production forest by the year 2020 [**].

Forest coverage. Total forest areas in 2000 and 2009 were 11.516 million hectares and 13.258 million hectares, respectively. The increased forest coverage benefits the environmental protection by reducing the impacts of storm, flood, drought and climate change. The number of scattered trees planted was 200 million a year, contributing to the amount of timber and burning wood available in rural areas. Quality of plantation forest is improving gradually; in many areas, plantations produce up to 15-20 m^3/ ha/year [***][****].

Better forest conservation. The Project 661 (*Transferring forest to civil communities for protection and management*) has resulted in 2.6 million hectares of 8 million hectares of protection forest and special forest planted in the period of 2006-2010, accounted for 172% of planned area of the Project 661 [**].

Logged timber production was 3.8 million m^3 in 2009 and 4.95 million m^3 in 2010, of which 90% was grown in plantations, helping to reduce pressure on natural forest [**].

Forest product output value increases every year. Production of timber and non-timber products increased by 194% from VND 60,059 billion (US$ 2.91 billion) in 2005 to VND 116,685 billion (US$ 5.65 billion) in 2009 (inflation-

adjusted). Export value increased from US$ 335 million in 2001 to US$ 2.8 billion in 2008 and reached US$ 3.45 billion in 2010 (an average growth rate of 20% a year). Vietnam's wood products have been exported to 100 countries and regions in the world, including the United States, the European Union and Japan [**].

Assessments of climate change impacts on forestry (see 3.1.3) identify this sector as vulnerable to climate change.

3.1.1.3 Water resources

Viet Nam has a network of about 2,360 rivers and streams over 10 km in length, with an average river density of 0.6 km/km^2. The nine large river systems in Viet Nam are Mekong River, Red River, Ma River, Ca River, Thai Binh River, Dong Nai River, Ba River, Bang Giang – Ky Cung River and Thu Bon River.

The Mekong River, the largest system, rises in Tibet, China, passes through Myanmar, Laos, Thailand, Cambodia and enters Viet Nam through 2 major branches, Tien River and Hau River, before draining into the East Sea. The river has a total basin area of 68,820 km^2 in Viet Nam.

The Red River is the second largest system in Viet Nam. It rises in Yunnan, China, and has a total national basin area of 72,800 km^2.

The mean multi-year annual flow of all rivers in Viet Nam reaches 835 billion m^3. Water originates from external sources contributes to 61.4%, or 512 billion m^3, while domestic sources account for the remaining 322 billion m^3.

Water is one of the key components in people's life and livelihoods; therefore using water efficiently is vitally important.

Assessments of climate change impacts on water resources (see 3.1.3) identify this sector as vulnerable to climate change.

3.1.1.4 Coastal zone management

Vietnam has a 3,200-km long shoreline, with coastal population of about 18 million, equivalent to 22% of the total population. About half of the municipalities are located in coastal areas. Coastal population relies on agriculture, fisheries and aquaculture for their living. Vietnam's coastal zones house a variety of crucial diverse ecosystems such as: forest, lagoons, tidal zones, beaches, islands, wetlands, mangrove swamps, coral reefs, or seaweed. With a long coastline and many closed, deep bays, and lying on the junction of world's maritime routes, Vietnam's maritime transportation has high potential to grow into a prosperous industry.

The natural conditions and resources in Vietnam's coastal zones also facilitate tourism and aquaculture. These areas have large oil, gas and coal reserves. Therefore, coastal socio-economic development has a very important role in the national development and defense.

Assessments of climate change impacts on coastal zone management (see 3.1.3) identify this sector as vulnerable to climate change.

3.1.2 Climate change impacts and climate change scenarios for Vietnam

3.1.2.1 Climate change impacts in Vietnam

Temperature: In the last 50 years, (1958-2007), annual average temperatures increased by about 0.5 to 0.7^{o}C. Temperatures for winters and northern climate zones increased at faster rates compared to summer and southern climate zones, respectively.

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[*] Draft report of Central Steering Committee on surveying rural areas, agriculture and fishery in 2011.

[**] Prime Minister (2007), Decision No.18/2007/QD-TTg dated 05 Feb, 2007 on approving development strategy on Vietnam's forestry period 2008-2010

[***] Verification report No.74/BC-UBKHCNMT13 dated 24 Oct, 2011 of Committee of science and technology on planting 5 million hectares of forest project

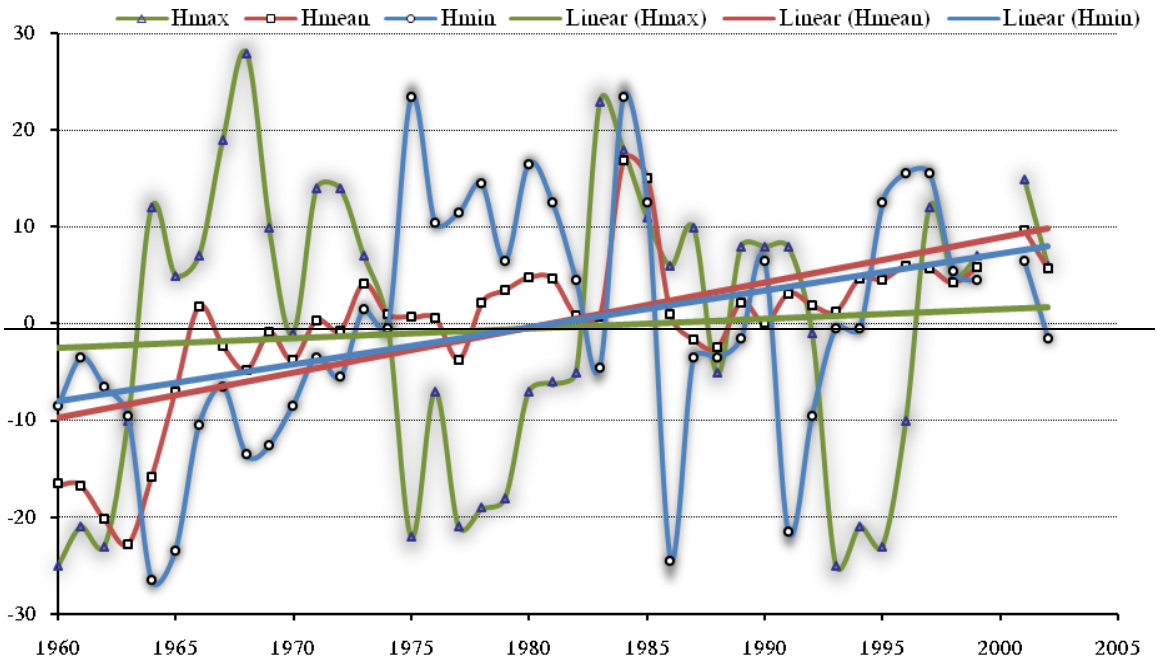
[****] Decision No.2140/QD-BNN-TCLN dated 09 Aug, 2010 of Ministry of Agriculture and Rural Development on publishing national forest status in 2009.

Rainfall: Annual average precipitation over the last nine decades (1911-2000) does not show a clear trend across regions and time periods. Instead, both upward and downward trends can be seen. Northern climate zones have seen a decrease in annual rainfall, in contrast to southern zones. Nationwide, average precipitation fell by 2% during the last fifty years (1958-2007).

Cold fronts: The number of cold fronts affecting Viet Nam has decreased significantly over the last two decades. However, anomalous events have occurred more frequently recently; most notably the damaging cold surge which lasted for 38 days in the Red River Delta during January and February 2008.

Typhoons: In recent years, typhoons with higher intensity tend to occur more frequently. Typhoon tracks show signs of moving southwards, with abnormal movements while storm seasons tend to end later.

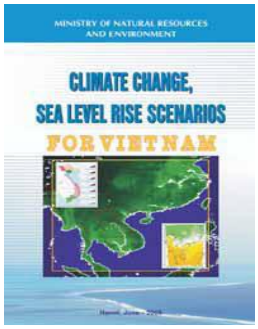
Sea level: Observations by tidal gauges in marine hydro-meteorological stations along the coastline of Viet Nam show that the mean sea level rose at a rate of 3 mm per year (during 1993-2008). Over the past fifty years, sea level observed at Hon Dau oceanographic station has risen by about 20 cm (Figure 2).



(Source: MONRE, 2009)

Figure 2 - Sea level changes at Hon Dau oceanographic station

3.1.2.2 Climate change scenarios



Vietnam climate change scenarios were developed for seven climate zones in the 21st century, featuring elements such as temperature, rainfall and sea-level rise. The coupled method (MAGICC/SCENGEN 5.3) and down-scaling method were used, based on greenhouse gas emission scenarios in Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report: Climate Change 2007 (AR4). They are high emission scenario (A2[1]), low emission scenario (B1[2]), and medium emission scenario (B2[3]).

[1] Scenario A2: A very heterogeneous world, self-reliance and preservation of nations; continuously increasing population in the 21st century, regionally-oriented economic development, technological change and more fragmented and slow per capita economic growth (high emission scenario).

[2] Scenario B1: Rapid economic growth but with rapid changes towards a service and information economy, global population reaches peak in 2050 and declines thereafter, reduction in material intensity and the introduction of clean and resources efficient technologies; emphasis on global solutions to economic, social and environmental sustainability (low emission scenario).

Projected increases in temperature, rainfall and sea level in the three climate change scenarios compared to the 1980-1999 levels are presented in Table 3.

Table 3 - Projected increases in temperature, rainfall and sea level in the three climate change scenarios relative to 1980-1999

Element/ Climate zone	Year	2020			2050			2100		
Temperature increase (^oC)	**Scenario**	B1	B2	A2	B1	B2	A2	B1	B2	A2
	Northwest	0.5	0.5	0.5	1.2	1.3	1.3	1.7	2.6	3.3
	Northeast	0.5	0.5	0.5	1.2	1.2	1.3	1.7	2.5	3.2
	Red River Delta	0.5	0.5	0.5	1.2	1.2	1.3	1.6	2.4	3.1
	North Central Region	0.5	0.5	0.6	1.4	1.5	1.5	1.9	2.8	3.6
	South Central Region	0.4	0.4	0.4	0.9	0.9	1.0	1.2	1.9	2.4
	Central Highlands	0.3	0.3	0.3	0.8	0.8	0.8	1.1	1.6	2.1
	South	0.4	0.4	0.4	1.0	1.0	1.0	1.4	2.0	2.6
Rainfall increase (%)	Northwest	1.4	1.4	1.6	3.6	3.8	3.7	4.8	7.4	9.3
	Northeast	1.4	1.4	1.7	3.6	3.8	3.8	4.8	7.3	9.3
	Red River Delta	1.6	1.6	1.6	3.9	4.1	3.8	5.2	7.9	10.1
	North Central Region	1.5	1.5	1.8	3.8	4.0	3.7	5.0	7.7	9.7
	South Central Region	0.7	0.7	0.7	1.6	1.7	1.7	2.2	3.2	4.1
	Central Highlands	0.3	0.3	0.3	0.7	0.7	0.7	1.0	1.4	1.8
	South	0.3	0.3	0.3	0.7	0.8	0.7	1.0	1.5	1.9
	Scenario	**B1**	**B2**	**A1F1**	**B1**	**B2**	**A1F1**	**B1**	**B2**	**A1F1**
Sea-level rise (cm)	Nationwide	11	12	12	28	30	33	65	75	100

(Source: MONRE, 2009)

3.1.3 Impacts of climate change

As priority sectors for adaptation technologies to climate change, climate change impacts on agriculture, forestry, coastal zone management and water resources were assessed in Vietnam Second National Communication (SNC) to the UNFCCC.

[3] Scenario B2: Continuously increasing population, but at a rate lower than A2, emphasis on local rather than global solutions to economic, social and environmental sustainability, intermediate levels of economic development, less rapid and more diverse technological change than in B1 family (medium emission scenario).

3.1.3.1 Agriculture

a) Impacts on agrometeorology

Climate change is set to raise average daily temperatures in Vietnam, with a declining number of days below 20°C, and an increasing number of days above 25°C.

Annual aggregated temperature of all regions is projected to increase by 1%-2% by 2020, 4%-5% by 2050 and 8%-11% by 2100 (MONRE, 2009). The geographical area with aggregated temperature above 10,000°C per year will extend northwards by 2020, 2050 and 2100. In 2000, the northernmost point of this area was at latitude 14°, but may move to latitude 18.5° by 2100.

The numbers of days when average daily temperature falls below 20°C in the Red River Delta could drop to 90 by 2050 and to 40 by 2100. In the Northeast, these numbers are expected to be 86 and 46 days, and 74 and 30 days in the Northwest, in the respective years.

By 2050 and 2100, the number of days with average daily temperature over 25°C will have markedly increased in the Red River Delta. In the Northwest, this number may rise from 124 days (2000) to 176 days (2050) and 207 days (2100). For the South Central Region, this number would increase from 275 days (2000) to 337 days (2050) and 365 days (2100).

With the number of days below 20°C decreasing, growing seasons and types of winter crops in northern regions may change. In contrast, the increase of days warmer than 25°C will benefit tropical crops. To take advantage of this condition, it is necessary to adjust cropping patterns and develop a suitable crop-rotation system for heat-tolerant crops.

b) Impacts on crop growth rate

Rising temperatures would increase the crop growth rate, and thus shorten growth time. A 1°C increase in temperature would shorten growth time by 5 to 8 days for rice, or up to 3 to 5 days for potato and soybean.

c) Impacts on crop water demand

Water demand for agriculture may double or even triple by 2100 compared to 2000, while risks of severe droughts and water shortage for irrigation may increase.

d) Impacts on growth and spread of detrimental pests

It is likely that increase and spread of harmful pests (such as the rice ear-cutting caterpillars, black cutworms, bark-boring beetles, fungi, etc.) may happen due to higher temperatures and changed rainfall patterns.

e) Impacts on growing seasons

According to the medium climate change scenario, in the Red River Delta, seeds may need to be sown earlier on average by 5 to 20 days for spring crops. For summer rice crops, however, the sowing time may be 20 to 25 days later.

f) Impacts on crop geographic distribution

Tropical crop areas will likely shift to higher elevations in the mountains and northwards. By 2100, tropical crops may be found at altitudes of 100 to 550 m and move 100 to 200 km northward. At the same time, subtropical crop area may decline.

Distribution of hygrophytes may be altered by changes in rainfall time and intensity and more frequent floods and droughts.

The potential increase of water shortage and evapotranspiration would decrease the cover area of hygrophytes.

g) Impacts of sea-level rise

Due to rising sea levels, arable land across the country will be significantly reduced. Annual rice output may drop by several million tonnes. Millions of people living in low-lying areas would be forced to either abandon or rebuild their homes, which may affect local and national economy.

h) Impacts on rice and maize output

Outputs of both spring and summer crops are likely to fall, most remarkably in the Red River Delta, with spring crop output decreasing by 12.5% by 2050 and 16.5% by 2070. In the Central and Southern regions, crop production may fall by 10 and 8% by the respective years. Across the country, winter rice output will decrease, albeit at a lower rate than summer rice, of around 2-4% by 2050, and 3-6% by 2070.

Climate change impacts on winter maize production will vary in the North, Central Region and South of Vietnam. In the Red River Delta, winter maize output may increase by 7% by 2050 and 2070, while declining by 3-6% by 2050 and 4-8% by 2070 in the Central Region and the Mekong River Delta.

i) Impacts on livestock and poultry production

Reductions in cattle feeds will affect livestock growth and reproduction. Livestock will have a hard time adapting to new, warmer conditions. In addition, global warming and the associated increase in extreme weather events such as typhoons, floods, storm-induced high waters, violent winds and downpours will greatly threaten the life cycle of animal. Climate change also raises the risk of epidemic break-outs.

3.1.3.2 Forestry

Climate change has varying implications for vegetation and forest ecologies.

a) Changes in distribution pattern of forest ecosystems

Natural forest ecosystems, such as those found in rainforests, broadleaf evergreen and broadleaf deciduous biomes, all tend to shrink - a trend clearly visible in 2100 (Table 4 and Table 5).

Table 4 - Changes in natural forest areas, climate change scenario B2

Forest type	2000		2020		2050		2100	
	1000 ha	%	1000 ha	%	1000 ha	%	1000 ha	%
Rainforests	375	1.2	1,544	4.6	504	1.5	302	0.9
Broadleaf evergreen rainforests	1,211	3.6	1,492	4.4	1,492	4.4	651	1.9
Broadleaf deciduous rainforests	3,827	11.4	2,251	6.7	1,307	3.9	1,179	3.5

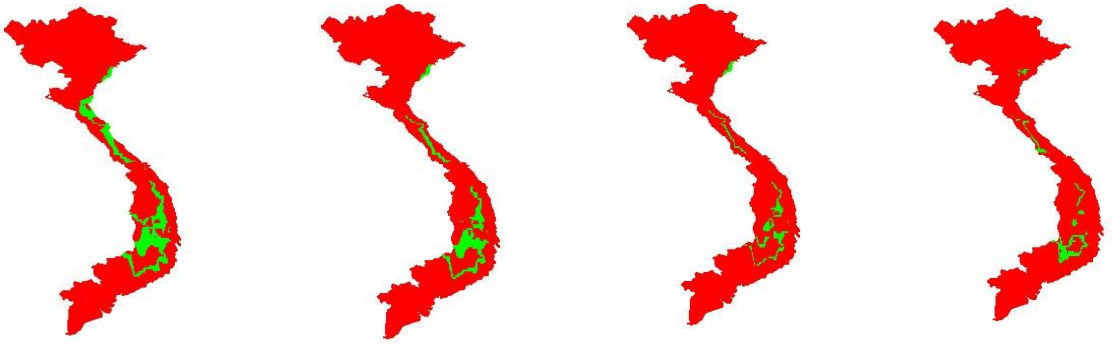
Source: Research Centre for Forest Ecology and Environment, Forest Science Institute of Viet Nam, 2008

Table 5 - Changes in planted forest areas, climate change scenario B2

Forest	2000		2020		2050		2100	
	1000 ha	%	1000 ha	%	1000 ha	%	1000 ha	%
Churkasia talbularis	1,000	3.1	1,214	3.6	686	1.1	245	0.7
Pinus merkusii	5,360	15.9	5,757	17.1	4,237	12.6	2,338	7.0

Source: Research Centre for Forest Ecology and Environment, Forest Science Institute of Viet Nam, 2008

The broadleaf deciduous rainforest ecosystem may be the most vulnerable ecosystem to climate change. In 2000, broadleaf deciduous covered approximately 3.8 million hectares, comprising about 11.4% of the total forest area, and spread from the North Central Region to the Southeast. By 2020, 2050 and 2100, under the impact of climate change, the respective areas of this forest type are predicted to be 2.3 million, 1.3 million and 1.2 million ha, equivalent to 6.7%, 3.9% and 3.5% of the total area. This type of forest will still concentrate in the Central Highlands and South Central Region (Figure 3).



Note: Green areas indicate broadleaf deciduous rainforests

(Source: Vietnam's SNC)

Figure 3 - Broadleaf deciduous rainforests distribution changes, climate change

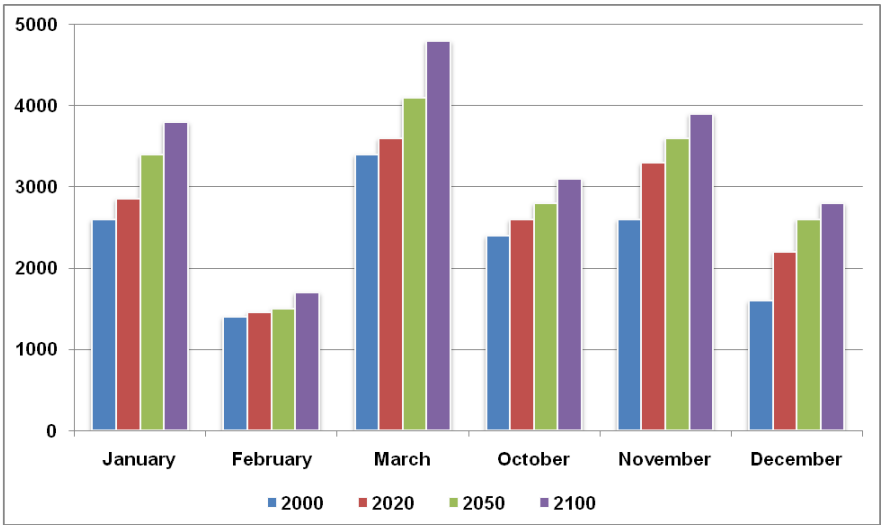
The geographical distribution of *Churkasia talbularis* or *Pinus merkusii* biomes are also affected by climate change with their coverage reduced most markedly in 2100 (Table 3.13).

Churkasia talbularis forests, which currently cover about 1.0 million hectares of northern mountains, may decrease to 0.7 million hectares by 2050 and 0.3 million hectares by 2100.

Pinus merkusii forests, with about 5.4 million hectares in the low coastal hills of the North Central Region, may be reduced to only 4.2 million hectares in 2050 and 2.3 million hectares in 2100.

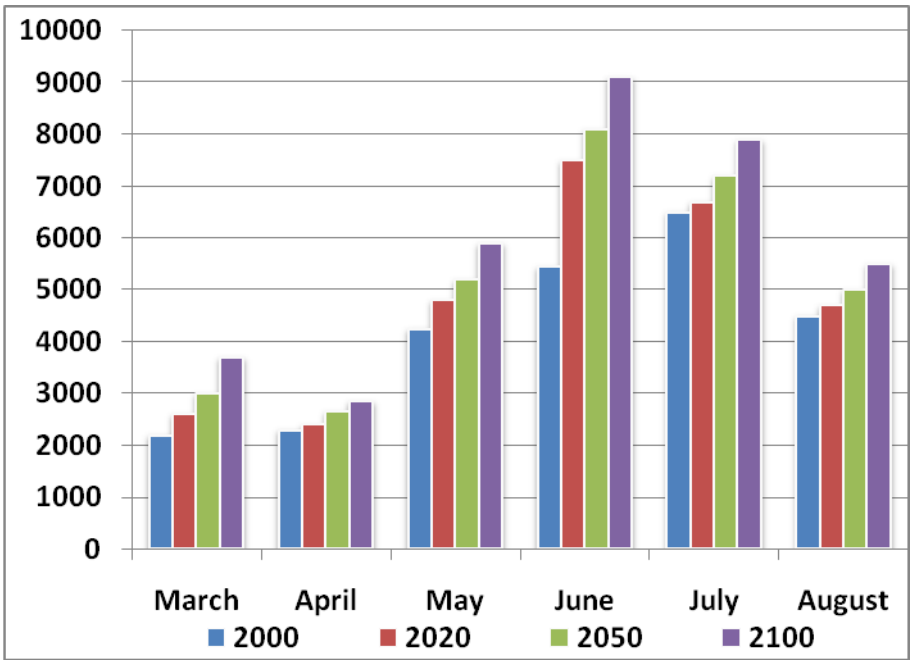
b) Impacts on forest fire risk

Based on the B2 scenario, forest fire risk calculations are shown in Figure 4 and Figure 5.



(Source: Vietnam's SNC)

Figure 4 - January, February, March, October, November, December values of P for 2000, 2020, 2050 and 2100 for the Northwest, medium climate change scenario B2



(Source: Vietnam's SNC)

Figure 5 - March, April, May, June, July, August values of P for 2000, 2020, 2050 and 2100 for the North Central Coast, medium climate change scenario B2

c) Impacts on growth and dispersion of harmful forest pests

With rising temperatures and increasing rainfall, damaging pests such as the pine processionary caterpillar, beet armyworm, inchworm, or grasshopper, and diseases such as eucalyptus leaf blight, and pine needle brown-spot blight, may spread, affecting the development of forest ecosystems.

d) Impacts on forest land

The loss of agricultural land caused by climate change-induced flooding, drought and salinization may lead to the loss of forest land by accelerating conversion of the latter to agricultural ends.

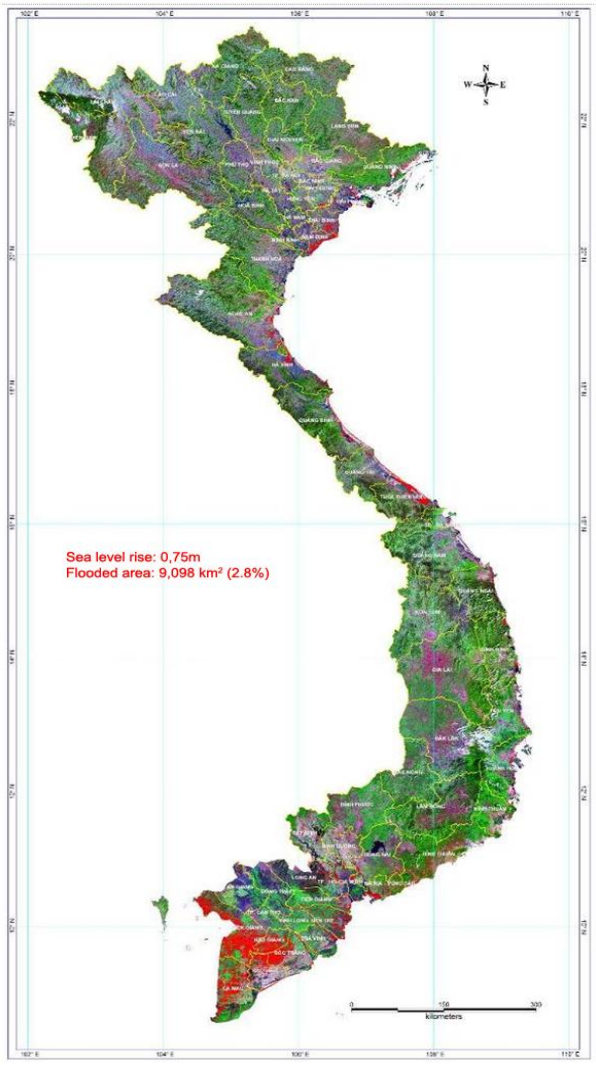
3.1.3.3. Coastal zone management

a) Sea-level rise will increase flood area, intensity and duration

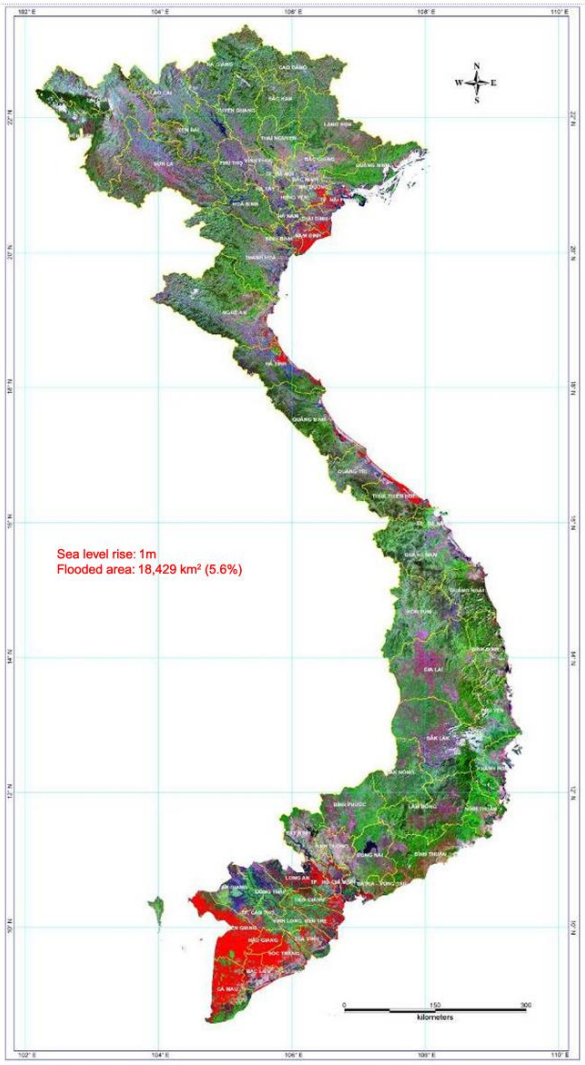
Recent research has shown that a 45-cm rise in sea level would increase the annual flooded area to 18,346 km^2, affecting another 44,210 km^2. A 100-cm rise in sea level would increase the respective areas to 40,000 km^2 and 56,000 km^2, with the most seriously affected area being the Mekong River Delta, which would account for 90% of the national flood area.

Rising sea levels may also lead to higher risks of salinization for freshwater rivers and aquifers, causing serious socio-economic damage. Coupled with increased storm intensity, this would additionally exacerbate coastal erosion.

Flood area corresponding to 75 cm sea-level rise



Flood area corresponding to 100 cm sea-level rise



(Source: Vietnam's SNC)

Figure 6 - Flood area corresponding to 75 cm and 100 cm sea-level rise

b) Coastal ecosystems may be destroyed

Coral reef ecosystems are in danger of being destroyed, with reefs in shallow waters most susceptible to destruction by rising sea-levels and strong storm waves.

Seaweed: Disturbances to the habitat, caused by storms and sea-level rise, threaten the reproduction and development of seaweed ecosystems. For example, the 1999 typhoon Linda swept away 20 to 30% of the Con Dao seaweed bed.

Lagoons: Lagoon environments are very vulnerable to severe floods and rising sea level. Increased salinity of lagoon water causes damage to aquaculture infrastructure, and the ongoing disappearance of rivulets in lagoons could have adverse impacts on local aquaculture and fishing activities.

Conservation areas: Viet Nam has 68 major wetlands and 15 marine conservation areas; of which 36 are set to be frequently inundated, 13 may be severely flooded when sea level rise reaches 100 cm. Conservation areas such as U Minh Thuong National Park and Bac Lieu Natural Reserve may be completely submerged, undermining Vietnam's biodiversity conservation efforts.

c) Impacts on mangrove forests

Sea-level rise will increase erosion rate in mangrove-fringed coasts and estuaries and wash away mangrove swamps. Such was the case with mangrove forests east of Ca Mau, where many species lost their natural habitat.

Table 6 - Forest flood areas for 100 cm sea-level rise

Unit: km^2

Region	Mangrove forest	Others forests
Mekong River Delta	207.5	25.7
Southeast	114.2	3.0
Total	321.7	28.7
Percentage of national mangrove forest cover	15.8	15.0

(Source: Institute of Environmental Technology, Viet Nam Academy of Science and technology, 2009)

Table 6 shows the flooded area of mangrove forest in case of a 100 cm rise in sea level in southern regions. A total of 300 km^2 would be inundated, corresponding to 15.8% of the total mangrove forest area.

Intertidal zones (or foreshores) will be submerged deeper at high tide as a result of sea-level rise. This will consequently prevent the growth of mangrove trees, notably white mangrove (*Avicenna*) or mangrove apple (*Sonneratia alba*) which are capable of trapping sediment and increasing sediment retention along the shorelines.

3.1.3.4. Impacts on water resources

a) Impacts of climate change on river flow regimes

Climate change may impact river water volume and its temporal and spatial distribution. The impacts of climate change on annual flows, flood flows and low flows in the future were assessed using the rainfall-flow model and the climate change scenarios.

b) Impacts on evapotranspiration

According to the medium climate change scenario B2, annual potential evapotranspiration is projected to increase by 7-10% for 2040-2059 and 12-16% for 2080-2099 above the current level. The South Central Coast and Mekong Delta will see the highest potential evapotranspiration increase of 10 to 13% and 18 to 22% respectively, in the same periods.

c) Impacts on groundwater table

After 2020, groundwater table may decrease significantly due to overexploitation and decrease in groundwater recharge during the dry season. In the Southern Delta, if the river flow decreases by 15 to 20% in the dry season, the groundwater table may drop by 11 meters below the current level. Groundwater table may tend to drop even lower in areas not subjected to tidal activities.

3.2. Process and criteria of prioritization

Process and criteria to prioritize sectors for adaptation were in accordance with the *Handbook on conducting technology needs assessment for climate change* by the UNFCCC and the United Nations Development Programme (November 2010). Several results in this report come from the NTP's official assessment reports (appraised by the GoV in December 2008) and Vietnam's Second National Communication to the UNFCCC (December 2010).

Sectors identified for adaptation are those to which effective adaptation measures can be applied, according to the national communications, the National Target Program to Respond to Climate Change, climate change action plans and the National Climate Change Strategy.

Based on the recent climate change impact assessments, the sectors most vulnerable to climate change impacts are presented in **Error! Reference source not found.**

Table 7 - Summary of potential climate change impacts and sector vulnerability

Climate change impacts	Vulnerable areas	Vulnerable sectors
Temperature rise	• Northeast, Northwest and North Central Region (mountains) • The Red River Delta	• Agriculture (cultivation, animal husbandry, aquaculture and fisheries) • Forestry • Ecology and biodiversity • Water resources • Water works • Energy (production and consumption) • Public health
Sea-level rise and saltwater intrusion	• Coastal strips (including deltaic plains and wetlands: Northern coastal plains and flatland; the Mekong River Delta, and Central coastal plains) • Islands	• Agriculture (cultivation, animal husbandry, aquaculture, fisheries and salt production) • Mangrove forest • Ecology and biodiversity • Water resources • Water works • Natural habitats • Energy • Infrastructure; industrial facilities • Public health
Flood, water loss and erosion	• Coastal strips (including deltaic plains and wetlands: Northern coastal plains and flatland; the Mekong River Delta, and Central coastal plains) • Mountainous areas: Northeast, Northwest and Northern Central Coast	• Agriculture (cultivation, animal husbandry, aquaculture, fisheries and salt production) • Water resources (for residential and industrial activities) • Water resources • Infrastructure • Natural habitats • Transportation • Health and livelihood
Typhoons and tropical cyclones	• Coastal strips (including deltaic plains and wetlands: Northern coastal plains and flatland; the Mekong River Delta, and Central coastal plains) • Islands	• Agriculture (cultivation, animal husbandry, aquaculture and fisheries) • Coastal and marine activities • Infrastructure • Natural habitats • Water works • Energy (oil and gas)

Climate change impacts	Vulnerable areas	Vulnerable sectors
		• Transportation • Health and livelihood
Drought	• Central Coast, especially South Central Coast • Northern plains and highlands • Mekong River Delta • Central Highlands	• Agriculture (cultivation and animal husbandry) • Forestry • Energy (hydropower) • Water transportation • Water resources • Water works

Source: Vietnam's SNC

Assessment of sensitivity and adaptive capacity to climate change of each sector are presented in Table 8 below.

Table 8 - Sensitivity and adaptive capacity of the sectors

Sector	Sensitivity/Vulnerability	Adaptive capacity
Agriculture	***Very sensitive***	***Can adapt at a certain cost***
Managed forest	Sensitive	Can adapt at a certain cost
Natural landscape	Sensitive	Unknown
Coastal and marine cosystems	***Very sensitive***	***Unknown or low***
Forestry	***Very sensitive***	***Can adapt at a certain cost***
Water resources	***Very sensitive***	***Can adapt at a certain cost***
Energy and industries	Sensitive	Can adapt at a certain cost
Tourism and recreation	Sensitive	Can adapt at a certain cost
Habitats	Sensitive	Can adapt at a certain cost
Health	Sensitive	Can adapt at a certain cost
Migration	Sensitive	Can adapt at a certain cost

Source: Vietnam's SNC

The sector prioritization involved consultation meetings held between the TNA adaptation team and the stakeholders involved in the technology needs assessment process for discussion and agreement on the prioritized sectors.

Sectors/sub-sectors put forward for assessment include: water resources, agriculture, coastal zone, forestry, aquaculture, energy, transportation and healthcare.

Four criteria for assessment and identification of the priority sector were agreed, including the following:

+ Economic contribution: contribution of the sector to the national economic development, expressed by the GDP share of the sector;

- Social contribution: contribution of the sector to the job market, poverty alleviation, improving cultural life and human health, etc.;
- Environmental development contribution: highlighting the implications of the sector for the development of soil, water resources, air, landscape and biodiversity, etc.;
- Reduction of vulnerability to climate change: opportunities to reduce economic loss and environmental damage through application of adaptation technologies.

Experienced experts in respective fields scored the assessed sectors. Sectors are scored using the following rating scheme:

0: no benefit

1: faintly desirable

2: fairly desirable

3: moderately desirable

4: very desirable

5: extremely desirable

Expert scores given to the sectors across the criteria were gathered to produce the total final score for the sector (see Table 9). The scores in the Table 9 were already rounded.

Table 9 - Performance matrix of prioritizing sectors for adaptation

Sectors	Economic priority	Social priority	Environmental priority	Potential for vulnerability reduction	Total benefit
Water resources	**3**	**3**	**5**	**4**	**15**
Agriculture	**4**	**3**	**3**	**4**	**14**
Forestry	**3**	**4**	**3**	**3**	**13**
Coastal zone	**4**	**4**	**3**	**5**	**16**
Energy	4	2	3	3	12
Transportation	3	2	3	2	10
Healthcare	2	4	2	0	8

Based on the results from **Error! Reference source not found.**, Table 8 and Table 9 above, the experts and stakeholders agreed that agriculture, coastal zones, water resources and forestry sectors were sectors highly vulnerable to climate change and thus identified as priority sectors for adaptation in this report.

3.3. Current status of technologies in priority sectors/sub-sectors in Vietnam

3.3.1. Agriculture

Agriculture has grown rapidly in recent years. From a country suffering from food shortage, Vietnam has risen to become the world's second rice exporter. Agricultural production (meat, fish, fruit and vegetables, etc.) also increase very fast and have moved towards industrial farming, producing products on a large scale.

These results were achieved by the development and effective

Figure 7 - Biogas digester installation in Son La

use of new agricultural practices, such as the following:

1. Plant genetics/plant breeding
2. Water-saving irrigation
3. System of Rice Intensification (SRI)
4. Organic fertilizer from agricultural residues/by-products
5. Minimum tillage (conservation agriculture)
6. Biochar
7. Agricultural by-product, foliage and plastic mulching
8. Shifting from rice to upland grains
9. Shifting from triple cropping to double cropping and a shrimp/fish/poultry crop

3.3.2. Forestry

Technologies have been an important and effective factor in the development of forestry. Major forest management practices include the following:

- Insect and pest control
- Plant genetics to select and create new drought-, flood-, and pest-resistant species for adaptation to climate change
- Organic
- Agro-forestry
- Forest fire control by the geographical positioning system (GPS) and remote sensing
- Super water-absorbent products AMS-1 (Acrylic acid modified super-absorbent from starch)

3.3.3. Coastal zone management

Technologies to protect coastal economic activities and ecosystems from seawater intrusion and flooding have been developed and applied in Vietnam, such as tide locks and seawater barriers, particularly the coastal and estuarine dyke systems with a total length of 3000 km. These structures serve as protection against salinity increase and flooding for millions of hectares of agricultural land, hundred thousands of hectares of fish farms and human settlements along the coastline.

+ New tidal locks and seawater barriers are being built, mainly in Ho Chi Minh City, the Mekong River Delta and part of Central Coast.

+ Seawater intrusion prevention structures are also being constructed in provinces like Ben Tre or Ca Mau. Thao Long seawater barrier, the biggest structure of its type in South East Asia, was built in Thua Thien Hue.

+ Various parts of those structures have already degraded or already broken due to storm surges or wave crashing. The GoV has launched two programs to upgrade sea dykes in coastal provinces, including one to repair the levees from Quang Ninh to Quang Nam starting in 2006, and the other from Quang Ngai to Kien Giang during 2009-2020, with a total investment cost of VND 19,481 billion (nearly 1 million USD).

+ Vietnam's coastal zones have diverse mangrove ecosystems. However, efforts to conserve these ecosystems are not well exerted. Due to overpopulation and export pressures, mangrove forests have been replaced by sedges and shrimp hatches in many parts of northern Vietnam. In the south, mangroves are being exploited to the point of exhaustion for round timber production, coal extraction and shrimp farming, etc., driving mangrove destruction rate faster. Efforts to restore mangrove ecosystems have been carried out by the GoV by issuing new incentives for establishment of plantations along the coastline to increase mangrove area.

+ Technologies for coastal defense and wetland biodiversity conservation have been studied and piloted in Vietnam. They have high adaptation capacity due to their ability to adjust to increases in sea level. As sea-level rise is a gradual process, wetland ecosystems can adjust to the change without much interference.

+ Integrated coastal zone management (ICZM) is now a management approach which appeals to both national and local natural resources and environmental managers. Several ICZM projects are underway in some areas of Vietnam. On 9 October 2007, the Prime Minister passed Decision 158/2007/QĐ-TTg to establish the *Program on Integrated Management of North Central Coastal Zone and Central Coast by 2010, with vision towards 2020*, which forms a legal framework for 14 provinces and central municipalities along the Northern Central coastal strip and Central Coast to manage their coasts in an integrated manner.

+ Other adaptation technologies, such as beach nourishment, sand dune building and restoration, or tidal flood warning system development, etc., are still under research and yet to be applied on large scale.

3.3.4. Water resources

As mentioned above, water resources are heavily exploited to serve social and economic needs such as: agriculture, industries, household usage, transportation and electricity generation. Efficient development and management of inland water is hindered by several barriers, including: (1) the fact that two thirds of the water resource originates from other countries; (2) inequitable spatial and temporal distribution of water; (3) water-related disasters; (4) degraded water quality in many areas; and (5) growing water demand. Water management is under pressure of (1) rapid population increase and low awareness on protecting water resources; (2) pollution caused by economic activities; (3) inadequate institution and policy; (4) climate change, global warming, droughts, flooding, sea-level rise and salinity intrusion.

Understanding how to apply appropriate technologies in extracting, using, managing and protecting water resources to adapt to climate change is crucial. Water resources technologies can be categorized into 6 groups: (1) Diversifying water supplies; (2) Groundwater replenishment; (3) Disaster warning; (4) Restoring water quality; (5) Rainfall water harvesting and management; and (6) Water source protection. In addition, some technologies can help to save energy and reduce GHG emissions and support decision making in water management, such as integrated water resource management, reservoir design and operation, market development for water, raising awareness on water value. Based on the status of the technologies, 3 groups can be classified, including: traditional and local technologies; modern technologies; and high technologies:

1) Traditional and domestic technology group

-Rooftop rainfall harvesting for household usage

-Runoff water harvesting

-Deep well extraction in the dry season

-Household Water Treatment and Safe Storage (HWTS),

2) Modern technology group

-Recovery and reuse of water

-Controlling water leakage and preventing loss in water supply

3) High technology group

-Managed aquifer recharge (MAR)

-Desalinization of sea water for fresh water

-Safe water supply plans

-Integrated river basin management (IRBM)

Chapter 4. Technology prioritization for the agriculture sector

4.1 Overview of technologies for adaptation to climate change

4.1.1 Plant genetics/plant breeding

Technology description

High-productivity crop varieties. Genetic modification and species selection are usually carried out in parallel with the production process. Scientists have been searching for years for new varieties that produce higher yields than the existing ones.

Halotolerant crop varieties. By selecting local salt-tolerant species that thrive in year-round saline habitats, scientists can select the genes that define salt resistance in mangrove plants for breeding or revigorating existing mangrove species to create salinity-resistant species.

Flood-tolerant varieties. Partial inundation due to rainfall or sea-level rise occurs very often in northern mountainous valleys, northern and central coastal zones, Southeast and the Mekong River Delta because of the low-lying terrain or inadequate drainage systems. Therefore, it is very important for developing flood-tolerant plants which can adapt to this condition.

Contribution to adaptation: Creating high yielding crops, increasing carbon assimilation or sequestration; creating salt-, drought-, and pest-resistant species to adapt to higher salinity, drought and flooding conditions or when pest and diseases increase.

4.1.2. Water-saving irrigation

Technology description

- Water-saving irrigation techniques are fundamentally different from the traditional irrigation method. They keep a thin layer of water on the field and draining at several stages to make rice fields moist enough for normal development.

- Water-saving irrigation actively controls field irrigation water to water demand during the growth stages of the rice variety. Combining flood irrigation with field draining at certain stages, this method helps increase rice productivity and reducing methane emissions in rice fields.

Contribution to adaptation: This technology helps reduce water consumption, particularly during climate change-induced water shortages; reduce energy consumption for irrigation and mitigating methane emissions from flood irrigation.

Figure 8 - Farmers in Ninh Phuoc, Ninh Thuan Province applying water-saving irrigation which produces higher economic benefits

4.1.3. System of Rice Intensification (SRI)

Technology description:

- SRI is the method based on the scientific basis from actual current rice production.
- The system of rice cultivation is done by integration of general measures: integrated pest management (IPM), integrated nutrient management (INM) and integrated water management (IWM).
- The basic principle of SRI is young seedlings; cultivation single ditch; water management; weeding and sludge aeration; and organic fertilizing.

Figure 9 - SRI in Ha Tinh province

- SRI was introduced into Vietnam in 2003. So far, there have been 21 provinces in Vietnam practicing this method on an aggregated area of 85,000 hectares (PPD and MARD, 2008). This method eliminates the disadvantages of conventional practices currently applied in wet rice cultivation. On 15 October 2007, Ministry of Agriculture and Rural Development (MARD), via Decision 3062/2007/QĐ-BNN-KHCN, announced that SRI is an advanced technology that can be practiced in rice production in northern provinces.

Contribution to adaptation: This is a comprehensive technology that optimizes tillage, soil nutrition, reduces fertilizer and water consumption and makes use of less fertile land in areas where there is little or almost no practice of intense cropping

4.1.4. Organic fertilizer from agricultural residues/by-products

Technology description: This technology produces organic fertilizers from agricultural crop residues by using certain enzymes to accelerate the decomposition of cellulose.

Contribution to adaptation: This technology utilizes agricultural residues, incorporates organic matters into soil, improves soil fertility, and reduces the fossil fuel (fertilizer) costs, which is suitable in degraded soils where organic materials are scarce.

4.1.5. Minimum tillage

Technology description:

This is a technology-based minimum cultivation technique for growing plants with little or no tillage.

On steep slopes: Minimum tillage is widely applied in mountainous areas to save labor costs, usually coupled with advanced weed control techniques.

On flat terrain: Minimum tillage is applied only for winter crops, such as soybean, potato and winter maize. This practice was first used for growing a maize crop between two main crops. It is later employed in soybean no-till production.

Contribution to adaptation: Reducing tillage costs, minimizing soil erosion and degradation, reducing drought risks.

4.1.6. Biochar

Technology description

Biochar is created by burning agricultural residues at high temperatures and in the airless condition. By-products used in producing biochar vary from one region to another; for example: peanut shells, rice husk, coconut shells, cane bagasse and maize stubble.

Biorchar has a porous structure and highly stable carbon form, which prevents it from releasing GHGs (carbon dioxide or methane). In addition, it can retain soil moisture, nutritious matters and useful bacteria, raise soil fertility and agricultural productivity while functioning as a natural carbon sink.

Contribution to adaptation: This technology transforms biomass carbon into very slowly mineralized carbon, creates underground long-term carbon sinks, increases water and nutrition retention and strengthens tolerance to drought in degraded land.

4.1.7. Agricultural by-product, foliage and plastic mulching

Technology description: This technology is popular in areas that are water-intensive, arid, or have heavy evaporation or sandy soils with poor moisture retaining capacity. Inputs for this technology include: i) post-harvest straw or hay; ii) foliage from agro-forestry systems; and iii) plastic mulch.

Contribution to adaptation: Reducing surface evaporation, soil erosion and ensuring sustainable production.

4.1.8. Shifting from rice to upland grains

Technology description: This technology is common in some areas in Vietnam. This type of farming that combines the garden-pond-barn (VAC) production model with the rice paddy field systems has been established in flood-prone low-lying lands, where rice productivity is low due to constant inundation and low productivity potential.

Contribution to adaptation: Adaptive to water stress due to climate change in the dry season, which renders rice cropping very difficult and forces farmers to alter their crops to ensure income.

4.1.9. Shifting from triple cropping to double cropping and a shrimp/fish/poultry crop

Technology description: This is a transformation from the system of triple cropping to the system of double cropping plus a shrimp/fish/poultry crop.

Contribution to adaptation: This technology facilitates adaptation in flooded areas, where rice crops are unstable or even fail at the end of the wet season. A crop of shrimp/fish/poultry will make adaptation to the new condition easier and increase productivity than a normal rice crop.

Table 10 - Possible prioritized adaptation technologies in agriculture

P.o	Technology	Description	Application potential
1	Plant genetics/Plant breeding	- Creating new varieties that can increase productivity, carbon uptake or biomass - Increasing drought, salt and flood resistance of crop varieties	High
2	Water-efficient irrigation technology	- Reducing water consumption - Increasing fertilizer efficiency - Reducing methane emissions	High
3	SRI	- Decreasing demand for rice seed, fertilizer, pesticide and water - Reducing methane emissions	High
4	Organic fertilizer from agricultural residues/by-products	- Providing alternative sources for mineral fertilizer - Reducing nitrous oxide emissions in the dry condition and methane emissions in the flood condition - Preventing environmental pollution due to waste and waste burning	Medium
5	Minimum tillage	- Stopping soil erosion and soil carbon loss - Reducing costs for tillage and pouching	Medium
6	Biochar	- Capturing 50% of plant biomass carbon - Slowing carbon decomposition, storing carbon for a long time in soils, and reducing emission - Significantly improving soil fertility - Increase fertilizer efficiency, reducing emissions of nitrous oxide - Used as an alternative fuel. - Used as a potting soil	Medium
7	Mulching technology	- Preventing soil erosion and carbon loss - Preventing nitrogen volatilization and nitrous	Low

		emissions - Saving water, reducing fertilizer and weed management costs - Reducing the use of pesticides	
8	Rice to upland grains	- Reducing methane emissions	Medium
9	Triple cropping to double cropping plus a shrimp/fish/poultry crop	- Utilizing low-lying lands	Medium

4.2 Criteria and process of technology prioritization

4.2.1 Criteria of technology prioritization

The set of criteria for prioritization of adaptation technologies in agriculture includes:

- Cost: capital, operation and maintenance costs (O&M), and cost-benefit of the climate change adaptation.
- Benefit:
  - Potential for vulnerability reduction;
  - Environmental: increasing carbon assimilation in photosynthesis; increasing tolerance (to salinity, flooding and drought); reducing environmental pollution.
  - Social: food security.
  - Economic: increasing income and utilizing land resources.

Based on the above criteria, an expert consultation table was sent to the agriculture experts to carry out the prioritization process.

4.2.2. Process of technology prioritization

In each sector, technologies were scored and weighted for each criterion and arranged in priority order. The more the point was, the higher rank was.

Weight: Weight reflects importance of each criterion in making decision. It considers differences between the upper and lower of the elevation of point and the level of group interest (namely 'changeable weighted method'). Once the weights for all criteria are decided, scoring is then done on each criterion. This is necessary to ensure independence when giving point to one criterion. For example, 100 points for environment is different from 100 point for society. The elevation of weighted point has the scale of 100. The effect of one criterion on decision is maximum at 100. Consequently, criteria affected in different decision making will be weighted on the scale.

The weighted point was converted as below:

$$w_{n,}(\%) = \frac{W_n * 100}{\sum W}$$

Where:

w_n : Convert weight of criterion n (%)

W_n : Query weight of criterion n

$\sum W$: Sum of overall query weight of all criteria

Giving point (scoring): This was to evaluate expected productivity of technology based on its contribution to the criteria. The productivity of technology was considered by categorized information in selecting technology, knowledge and reviews of experts.

The experts were asked to give point from 0-100 in TNA Table (0 means least preferable option). The best and least options were identified first and issued in order from 100-0, then come other points of other options.

The process of giving point repeats for each group, each sector.

Given the counsels and information, points for each expert are calculated by the following formula:

$$S_i = w_1 s_{i1} + w_2 s_{i2} + \cdots + w_n s_{in} = \sum_{j=1}^{n} w_j s_{ij}$$

Where:

S_i: overall points of experts on the technology "i"

w_n: converted weighted point for criterion "n"

s_{in}: weighted point of technology "i" according to criterion "n"

The benefits when used MCDA: The main option for MCDA was benefit-cost analysis and for each technology. Cost analysis was depended on each related elements such as NPV, IRR, operation, maintenance & adaptation costs, etc. However, benefit-cost analysis was complicated because it required all benefits in cash while some of them cannot be estimated. Therefore, based on overall point from formula of each experts, benefit-cost analysis of each experts was calculated as $S_b = S_i - S_c$

Where:

S_b: benefit point of technology "i"

S_i: overall point of expert for technology "i"

S_c: overall point of cost for technology "i"

The average benefit point: The points were given by experts as explained above by survey forms. The average benefit point was quotient of overall benefit point of all experts and numbers of experts. Therefore, the average benefit point (S_a) would serve as a basis for arrange technologies in priority order. S_a was calculated as:

$$S_a = \frac{\sum(S_i - S_c)}{\text{Number of experts}}$$

Number of experts involved in scoring and weighting were 10 persons per sectors.

4.3 Result of technology prioritization

According to the technology prioritization results in 4.2, survey forms were sent to agriculture experts to assess the technologies.

Results of adaptation technology prioritization in the agriculture sector are presented in the Table 11 below.

Table 11 - Result of adaptation technology prioritization in the agriculture sector

P.o	Technology Option	Average MCDA score	Average benefit (S_a)
1	Water-efficient irrigation technology	49.08	33.10
2	Biochar	74.77	53.17
3	Plant genetics/Plant breeding	79.86	58.11
4	SRI	56.70	36.18
5	Organic fertilizer production technology from	39.15	25.00

	agricultural residues/by-products		
6	Rice to upland grains	78.18	55.63
7	Triple cropping to double cropping plus a shrimp/fish/poultry crop	72.25	51.53
8	Minimum tillage	31.59	24.36
9	Mulching technology	40.16	24.73

Results of the adaptation technology prioritization in agriculture are shown in the priority order in Table 12

Table 12 - List and assessment of prioritized adaptation technologies in agriculture

Availability/Scale	Technology	Adaptation potential in 20 years	Benefits out put from MCDA assessment	Estimated investment cost* (1000 USD)
Long-term/large-scale	Plant genetics/Plant breeding	High	58.11	400,000
Long-term/medium-scale	Rice to upland grains	High	55.63	200,000
Long-term/small-scale	Triple cropping to double cropping plus a shrimp/fish/ poultry crop	Low to medium	51.53	400,000

* Estimation of cost for developing and deploying technologies overall country

Chapter 5. Technology prioritization for the forestry sector

5.1 Overview of possible adaptation technology options for forestry

5.1.1 Insect and pest control

Technology description: Insect and pest control has been efficient in agricultural production. However, in forestry, integrated pest and insect management has just started to be piloted in several material plantations.

Contribution to adaptation: Benefits of these methods do not materialize in the short term but rather in the long term in terms of economic gains, ecosystem stability, biological balance and environmental integrity.

5.1.2 Plant genetics to select and create new drought-, flood-, and pest-resistant species for climate change adaptation

Technology description: Biotechnology is widely used in forestry, such as plant cutting, tissue culture, cross-breeding, genetic engineering or the recent genetic modification technology. Techniques to develop new genes that define resistance to pest and diseases have been applied successfully in Vietnam and achieved some results. Crossbred or genetically modified plants that can tolerate drought and resist diseases have been created. Pulp materials are extracted from plantations with tissue cultured, high-productivity plants.

Contribution to adaptation: Protecting the rare and valuable gene pool; conserving biodiversity; increasing the rate of afforestation and reforestation in degraded lands.

5.1.3 Agro-forestry

Technology description: Agro-forestry is a land use system in which the growing and management of perennial trees (forest trees, industrial long-range trees, fruit trees) exist in harmony, in terms of time and space, with short-term industrial trees and livestock to create a sustainable system in terms resources, ecosystem and social and economic development. Selection of species is very important in an agro-forestry system.

Contribution to adaptation: Preventing burning forest for cultivation; promoting sustainable land use and management to prevent land degradation and drought; minimizing adverse impacts of climate change.

Figure 10 - Agro-forestry in lychee and pineapple

5.1.4 Forest fire control by the geographical positioning system (GPS) and remote sensing

Technology description: The geographical positioning system (GPS) consists of three parts: signal receivers, handy self-recording device, and computer with data processing software. The self-recording devices will collect data at specific positions and send signals to the receivers; the signals will be coded and sent to computer, where they will be processed and synthesized by software.

Contribution to adaptation: This large-scale technology has contributed greatly to forest fire control. Besides, it is also important in mapping water resources, crops, forest coverage, particularly vegetation of an entire area to formulate a drought algorithm which is very meaningful to climate change response.

5.1.5 Super water-absorbent products AMS-1

Technology description: Super water absorption product was named AMS-1 by Assoc. Prof. Nguyen Van Khoi et al. (Polymer Lab of Institute of Chemistry - Vietnam Academy of Science and Technology) researched and manufactured from the graft polymerization acrylic acid combined with denaturant starch and had two registered products were AMS - 1 and AMS – 2 (trademarks copyright). A small amount of AMS-1 applied to the soil can retain water in the soil 400 times more than normal soil and provide water for root of plants. When the stored water was

consumed by plants and evaporation, the AMS-1 material shrinks to the original volume and then continues to save water from rains or irrigation.

Contribution to adaptation: Efficient in saving water, not toxic, safe to the environment which helps protecting the environment, protecting land from erosion, increasing vegetation cover and underground water.

Table 13 - Possible prioritized adaptation technologies in forestry

P.o	Technology	Description	Potential to application
1	Insect and pest control	Controlling pest and insects in forest production	Short-term
3	Plant science/Plant genetics	Plant cutting, tissue culture and genetic engineering has been studied and applied successfully in forestry and in material plantation in Vietnam; tissue culture is applied in a large scale	Short-term
3	Agro-forestry	Using good cultivation and management techniques to create sustainable environmental, social and economic systems to adapt to climate change and reducing GHG emissions from land use change	Short-term
4	Forest fire control by the GPS and remote sensing	Control forest fire through satellite images, remote sensing, and increasing management efficiency	Short-term
5	Super water-absorbent product AMS 1	Using super water-absorbent products in water-stressed areas. Helping plants to grow in arid lands is significantly important to change landscape of arid lands	Short-term

5.2 Criteria and process of technology prioritization

5.2.1 Criteria technology prioritization

The forestry and land use change expert group agreed on a set of criteria for assessing priority adaptation technologies, including:

- Cost: capital, operation and maintenance costs (O&M), and cost-benefit of adaptation to climate change.
- Benefit:
  - Potential for vulnerability reduction.
  - Environmental: improving soil and preventing soil degradation; protecting water resources and reducing runoff degradation; improving air quality; securing biodiversity.
  - Social: job opportunities; and rural development.
  - Economic: improving livelihoods; protecting infrastructure; and encouraging other industries.

5.2.2 Process of technology prioritization

The technology prioritization process in forestry is similar to the process mentioned in 4.2.3.

5.3 Result of technology prioritization

Based on the criteria, an expert consultation table was sent to the forestry experts to carry out the prioritization process. The results are shown in Table 14 below:

Table 14 - Result of prioritized technology in the forestry sector

P.o	Technology Option	Average MCDA score	Average benefit (S_a)
1	Forest fire control by the GPS and remote sensing	22.97	11.03
2	Super water-absorbent products AMS1	53.22	29.65
3	Agro-forestry	72.17	**50.31**
4	Insect and pest control	57.29	34.59
5	Plant genetics	75.61	**56.40**

Table 15 - List and assessment of prioritized technology in the forestry sector

Availability/Scale	Technology	Adaptation potential in 20 years	MCDA score	Estimated investment cost
Short-term/large-scale	Plant science/Plant genetics	High	56.40	143,000 USD/ species (including research and transfer fees)
Short-term/small -scale	Agro-forestry	High	50.31	2,380-3,333 USD/ha (applied to about 1000 ha in a specific region)

Chapter 6. Technology prioritization for the coastal zone management sector

6.1 Overview of possible adaptation technology for coastal zone management

6.1.1 Closing bank-protection bank and intercepting sewer

Technology description

- Large-scale storm surge barriers with movable bulkheads have been used efficiently in several projects in developed countries in Europe , for e.g. The Netherlands, but still have not in use in developing countries;
- Medium-scale closure dams: have been already in use in developing countries due to lower investment capital and operation costs. In Vietnam, there are several riparian small-scale tidal lock structures built on rivers.

Contribution for adaptation: Reducing floods due to sea level rise and salinity intrusion.

6.1.2 Beach nourishment

Technology description

- Widely used in The Netherlands, Belgium, Germany, Denmark, the USA and Australia, etc.; under research in developing countries such as Nigeria, Ghana or Malaysia, etc...
- Feasibility studies in provinces namely Hai Hau, Ca Mau, and Kien Giang and some islands in Vietnam.

Contribution for adaptation: Limiting coastal erosion due to sea level rise and maintaining ecological marine landscape.

6.1.3 Artificial Sand Dunes and Dune Rehabilitation

Technology description

- Artificial sand dunes simulate the function of natural dune ecosystems. Dune rehabilitation is considered as a mitigation technology to stop soil erosion, wind effects, storm surges and flood in coastal zones and an adaptation technology to climate change,
- Applied in a large scale in several countries such as the UK, or the USA, etc. In Vietnam, there have been some case studies on this technology on its ability to protect and rehabilitate Central Coast's sand dunes.

Contribution for adaptation: Protecting coastal economic zone and ecosystem as well as reducing sea level rise effects.

6.1.4 Sea dykes

Technology description

- Applied in a large scale in countries such as The Netherlands, the USA, Bangladesh or Thailand, etc.
- Introduced in Vietnam in 1960s, but have been degraded in many parts ever since. Currently, Vietnam has more than 2000 km of dykes that need strengthening.

Contribution for adaptation: Protecting coastal economic zone and ecosystem as well as reducing sea level rise effects.

Figure 11 - Dyke reinforcement in Thuy Hai, Thai Binh

6.1.5 Seawalls

Technology description

- Seawalls are used to avoid erosion in coastline; generally are the type to retain soils and prevent wave impacts and floods.
- In the South, several seawalls have been being built as constructions as well as temporary solutions. There are such types of seawalls as rock dike, mole, concrete dike etc…

Contribution for adaptation: Protecting coastline from sea level rise impacts due to climate change.

Figure 12 - construction in Phu Quy Island

6.1.6 Technologies for Coastal wetland rehabilitation

Technology description

- Mangrove swamps can be restored by growing types of saline grass. Grass roots can stabilize and protect mangrove swamps. Mangrove trees like *Melaleuca leucadenra Myrtaecae*, plants of *Rhizophoraceae (Bruguiera), Avicenniaceae, Myrsinaceae (Aegiceras), Rubiaceae (Ixora)* are adapted to saline habitats and popularly used in Vietnam. Choosing the right mangrove plants for a particular ecological environment to serve protection purpose is important.

Contribution for adaptation: Protecting coastal ecosystems, reducing erosion and negative impacts of storms.

6.1.7 Flood warning systems

Technology description

- Have been developed to predict the situations of storms and floods in order to plan in time to minimize negative impacts;
- Have an important role in developing countries with poor infrastructure and prone to flood;
- Coastal flood warning systems in Vietnam are not efficient and advanced due to out of date technologies.

Contribution for adaptation: Minimizing loss and damage of lives and properties due to extreme weather.

6.1.8 Integrated coastal zone management (ICZM)

Technology description

- ICZM have been developed over the last four decades in many countries. Many successful ICZM programs and projects took place in Europe, America, Latin America, Australia, Asia and The Caribbean.

- It is the multi-sector field that requires both management and civil technologies.

Contribution for adaptation: The technology itself requires integrated technologies designed to meet the changes of natural conditions towards sustainable development. Therefore, this technology is the most comprehensive adaptation to climate change.

Table 16 - Possible prioritized adaptation technologies in coastal zone management

P.o	Technology	Description	Potential to application
I. Protective group			
1.1	Beach nourishment	Ecologically beneficial, maintaining landscapes, increasing tourism potential Long-term investment: periodic observation and assessment Soft measure	Piloted in areas with tourism potential
1.2	Storm surge barriers and closure dams	Hard structure, preventing flood and seawater intrusion. High capital and maintenance costs.	Not applicable in short-term
1.3	Artificial Sand Dunes and Dune Rehabilitation	Sand dune natural sediment deposition, relocating or building new artificial sand dunes, reshaping sand dunes. Conflicts in land use. Participation of community.	Piloted in sand dune environment
1.4	Sea dykes	Hard structure. Widely used. Adaptive to sea-level rise. Expensive.	Repairing and upgrading sea dykes is highly urgent
1.5	Seawalls	Low hard structures. Preventing soil erosion. Not favorable to ecology.	Temporary measure to protect densely populated areas, eroding coastal zones
II. Retreatment group			
	Coastal wetland rehabilitation	Meaningful to the environment, reducing maintenance costs for coastal structures. Not expensive. Conflict in land use; requiring competent experts	Feasibility studies showed good results
III. Adjustment group			
3.1	Flood warnings	Supporting community. Requiring interdisciplinary knowledge and good cooperation between stakeholders.	Applicable in Vietnam.
3.2	ICZM	Beneficial to the environment. A combination of various technologies. Large-scale, cross-section.	Piloted in important economic zones.

6.2 Criteria and process of technology prioritization

6.2.1 Criteria for technology prioritization

The coastal zone management expert group agreed on a set of criteria for assessing priority adaptation technologies, including:

- Cost: investment capital, operation and maintenance costs (O&M), and cost-benefit of the climate change adaptation.
- Benefit:
  - Potential for vulnerability reduction.
  - Environmental: geographical environment (coastal erosion); water environment (preventing salinity intrusion, water utilization); air environment (reducing air pollution, e.g. CO_2, SO_2, dust etc…); biodiversity (protecting biodiversity and habitat).
  - Social: creating job opportunities for local people; preventing epidemic by sanitation; reducing costs for food preservation; enhancing public awareness; protecting life line structures; and reducing disasters risks; strengthening security in the region.
  - Economic: creating a dynamic, attractive investment area; stabilizing and improving international accounting capacity; saving import expenditure for equipment and fuels as well as energy.

6.2.2 Process of technology prioritization

The technology prioritization process in coastal zone management is similar to the process in agriculture in 4.2.3.

6.3 Result of technology prioritization

Based on the above criteria, the survey forms were sent to the coastal zone management experts to carry out the prioritization process. The results are shown in **Table 17** below:

Table 17 - Result of prioritized technology in the coastal zone management sector

P.o	Technology Option	Average MCDA score	Average benefit (S_a)
1	Beach nourishment	35.97	19.77
2	Coastal wetland rehabilitation	80.52	54.90
3	Storm surge barriers and closure dams	45.94	25.49
4	Artificial Sand Dunes and Dune Rehabilitation	46.40	25.64
5	Sea dykes	81.72	55.20
6	Seawalls	39.56	27.06
7	ICZM	79.39	51.16
8	Flood warnings	78.30	50.63

Results of the adaptation technology prioritization in the coastal zone management are shown in the priority order in Table 18.

Table 18 - List and assessment of prioritized technology in the coastal zone management sector

Availability/Scale	Technology	Adaptation potential in 20 years	Benefit from MCDA assessment	Estimated investment cost
Short and medium term/ large scales	Sea dyke	High	55.20	Reinforcement: 1.5 million USD/km New: 5 million USD/km
Short and medium term/ large scales	Coastal wetland rehabilitation	High	54.90	Maintenance: 41 USD/ha/ year

Chapter 7. Technology prioritization for water resources

7.1 Overview of possible adaptation technology options in water resources

7.1.1 Harvesting rain water from rooftop for household usage

Technology description

Figure 13 - Rainfall water barrel of a family in Ha Tinh

- A local traditional technology in developing countries to supply water for domestic activities of local communities when there is no central water supply system. In developed countries, people store harvested rain water in tanks for gardening, toilet flushing, or washing. This technology is being developed in Germany, the Netherlands and the US.
- In Vietnam, people have been storing rain water from rooftop in cement tanks or barrels for domestic usage. These kinds of storage are designed to ensure safety and sanitation for users, and that they do not contain water-borne or insect-borne diseases.

Contribution for adaptation: It diversifies sources of water supply for households and reduced floods by collecting runoff from the rooftop during storms.

7.1.2 Harvesting runoff rain water for public storage

Technology description

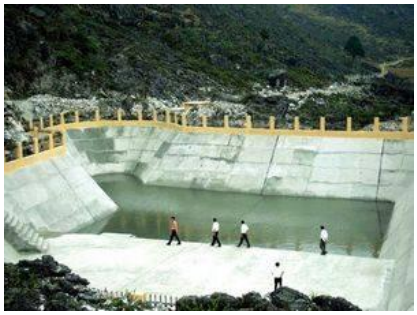


Figure 14 - A water-collecting reservoir in Ha Giang

- It is used to harvest rain water from mountain cracks, rivers, streams etc., to store in small reservoirs or public tanks, or household barrels for household uses or production in dry periods.
- Commonly used by villagers in mountainous areas in the north such as Cao Bang, Ha Giang and the Central Highlands. Small reservoirs are under construction for agricultural and domestic uses in northern highlands or the central region.

Contribution for adaptation: Harvested surface rain water can be a convenient and reliable source of water during dry seasons and drought periods. On the other hand, large-scale rainfall harvesting helps reducing erosion and floods and stabilizing ground water level.

7.1.3 Deep well extraction in the dry season

Technology description

- New technical skills of drilling for deeper intrusion into the ground in order to extract water more efficiency; fixing the damaged wells; drilling provision wells for dry season.
- Widely used in place of surface water in rural households.

Contribution for adaptation: The deeper the wells, the less negative impacts by climate change.

7.1.4 Household Water Treatment and safe Storage (HWTS)

Technology description

- Widely used with traditional methods like boiling water to modern technologies such as disinfecting drinking water by ultraviolet, RO filtration, or chemical disinfection, etc. and safely storage (sanitized bottlers or tanks).

- Marketed with a wide range of treatment equipment, filters or safe storage equipment for households. Purified water, bottled sterilized mineral water are highly commercialized.

Contribution for adaptation: The technology allows the ability against degradation of water quality for users.

7.1.5 Recovery and reuse of water

Technology description

- There are central wastewater treatment facilities in urban residential areas and in industrial areas. Treated wastewater will be reused in industries and agriculture later.
- Laws and regulations on industrial and urban wastewater treatment have been issued before discharging wastewater.

Contribution for adaptation: The recovered and reused water helps to diversify and conserve water resources. By using retreated water for multi purposes (except to drinking) can reduce degradation of water sources and prolong their longevity. Moreover, retreated water can be pumped directly to the ground for recharging and preventing salinity intrusion in estuaries.

7.1.6 Controlling water leakage and preventing loss in water supply

Technology description

- Water loss control: decentralization; water level meters are installed at the sub-regional level.
- Leakage detection: technologies such as acoustic detectors, infrared, chemical marking or hydraulic principles are being used.
- Fixing leaks: study applications and use of new materials (for pipes, solder mount) and handling leaks.

The concept of preventing water loss has appeared in Vietnam for 15 years. There have been researches and programs to prevent water loss, with limited success as the rate of water loss remains high (30%). The Ministry of Construction has submitted the proposal for a national program to prevent water loss until 2025 to the Government for approval.

Contribution for adaptation: Discovering leakage of water systems is one of the important tasks in the comprehensive strategy to lower the stress on current water resources. Cutting down water demand in urban areas means cut down the GHG emissions and therefore helps in adaptation to climate change. It also saves a quite huge energy that is used to transport and distribute water.

7.1.7 Managed aquifer recharge (MAR)

Technology description

- Types of MAR such as absorption through the walls, absorption through the dunes, the lake, seepage tank, rainwater collection tank, sand dams, underground dams; replenishment, aquifer storage recovery (ASR) , aquifer storage transfer and recovery (ASTR) have been studied in Vietnam.
- Has been effectively deployed in many countries around, the world especially developed countries like USA, Japan, Germany and some developing countries like Mexico.

Contribution for adaptation: Providing water during dry season and droughts as well as being helpful against salinity intrusion.

7.1.8 Desalinization of sea water for fresh water

Technology description

A promising technology which has been applied to large water filtration plants in Israel, Singapore, Australia and Korea, and the United States.

There are water purification plants in Hon Tam, Nha Trang with a capacity of 1,000 m^3/day.

Water purification technology is mostly under research. Small-scale studies on applications of water supply services to offshore islands, rigs and vessels at sea have been conducted.

Figure 15 - Desalinization system in Vinpearl Land tourism and recreation area on Hon Tre Island

Contribution for adaptation: Diversifying water supply sources in order to support clean water in case of contamination or shortage.

7.1.9 Safe water supply plans

Technology description

- Technical procedures of this technology have been completed, including: systematic assessment, observation and management of water sources;
- In 2006, Vietnam carried out pilot projects of safe water supply and capacity building activities such as staffing, guiding, monitoring and implementing the plan and roadmap to safe supply; studying how to incorporate the plan into existing programs and projects; raising public awareness on safe water supply.

Contribution for adaptation: WSP approach allows water suppliers to be flexible in meeting the demand by changing input parameters. A successful WSP can help to respond to serious impacts of climate change by taking into account risk assessments and identifying suitable control measures.

7.1.10 Integrated river basin management (IRBM)

Technology description

- It is an interdisciplinary technology which integrates all other management and technical methods for sustainable development in a river basin.
- Currently, there are legal frameworks and research on IRBM. IRBM committees have been established. Some river basin environment protection committees have been active.

Contribution for adaptation: Facilitating the conservation and efficient use of the available water resources to cope with climate change.

Table 19 - Possible prioritized adaptation technologies in water resources

P.o	Technology	Description	Potential to application
I. Traditional and domestic group			
1.1	Rooftop rainfall harvesting for household usage	Easy. Reducing capital costs and water transportation costs.	Large-scale technology
1.2	Harvesting runoff water	Solving water shortage problems in mountainous areas. Reasonable costs.	Carefully choose areas to apply

1.3	Deep well extraction in the dry season	Solving water shortage problems in dry periods. Reasonable costs.	Under research for zoning and application
1.4	Household Water Treatment and Safe Storage	Widely used. A wide range of methods from traditional to modern.	Has been used in Vietnam and has potential to develop,
II. Modern group			
2.1	Recovery and reuse of water	Using water treatment techniques. Diversifying water supplies.	High demand in industrial areas.
2.2	Controlling water leakage and preventing loss in water supply	Reducing water supply costs and pressure on water. Saving energy.	High demand in urban areas in Vietnam.
III. Hi-tech group			
3.1	Managed aquifer recharge (MAR)	Potential for large-scale application in areas with available water sources. Must pay attention to pollution of aquifer.	Can be piloted in big urban areas.
3.2	Desalinization of sea water for fresh water	Expensive.	Can be applied in islands.
3.3	Safe water supply plans	Integrated water development plans into social-economic development plans.	Under research in Vietnam.
3.4	Integrated river basin management (IRBM)	A combination of multi-disciplinary technologies for water management to ensure sustainable development.	Experimented in several basins. Can be expanded.

7.2 Criteria and process of technology prioritization

7.2.1 Criteria technology prioritization

The expert group agreed on a set of criteria for assessing priority adaptation technologies, including:

- Cost: capital, operation and maintenance costs (O&M), and cost-benefit of the climate change adaptation.
- Benefit:
  - Potential for vulnerability reduction;
  - Environmental: reducing pollution and soil erosion; improving living conditions; utilizing water; minimizing air pollution; ensuring biodiversity and natural habitats.
  - Social: job opportunities; preventing epidemic and enhancing sanitation; raising public awareness; increasing life quality and reducing disaster risks.
  - Economic: creating new dynamic and attractive investment areas; reducing costs for importing equipment and fuels; saving energy.

7.2.2 Process of technology prioritization

The technology prioritization process in the water resources sector is similar to the process agriculture in 4.2.3.

7.3 Result of technology prioritization

Based on the above criteria, the survey forms were sent to the water resources experts for the prioritization process. The results are shown in Table 20 below.

Table 20 - Result of adaptation technology prioritization in the water resources sector

P.o	Technology Option	Average MCDA score	Average benefit (S_a)
1	Rooftop rainfall collection for household usage	82.13	60.40
2	Harvesting runoff water	77.11	55.56
3	Deep well water extraction in the dry season	42.31	26.80
4	Household Water Treatment and Safe Storage	59.85	39.92
5	Recycling water	36.48	24.05
6	Controlling water leakage and preventing loss in water supply	68.56	50.32
7	MAR	41.07	24.35
8	Desalinization of sea water for fresh water	11.98	5.88
9	Safe water supply plans	46.33	33.46
10	IRBM	71.90	54.82

Results of technology prioritization for adaptation in water resources management are shown in the priority order in Table 21.

Table 21 -List and assessment of prioritized technology in the water resources sector

Availability/Scale	Technology	Adaptation potential in 20 years	Benefit from MCDA assessment	Estimated investment cost
Short-term/ Small-scale	Rooftop rainfall harvesting for household usage	Medium	60.40	200 US$/family (rural area)
Short-term/ Small- and medium-scale	Harvesting runoff water	Medium	55.56	270 US$/$m^3$ (concrete reservoir)
Short- and medium-term/Large-scale	IRBM	High	54.82	N/A

Chapter 8. Summary/Conclusions

In the framework of implementation of technology needs assessments to adapt to climate change, 04 priority areas were selected to evaluate the technology priorities including agriculture, LULUCF, water resources and coastal zone management.

The list of prioritized technologies o to adapt to climate change are summarized in the table below:

Table 22 - List of prioritized technologies to reduce greenhouse gases emissions

P.o	Sector/Technology	Availability/Scale
1	***Agriculture sector***	
	- Plant Genetic/Breeding	Long term/Large
	- Rice to upland grain	Long term/Medium
	-Triple cropping to double cropping + shrimp/fish/poultry crop	Long term/Small
2	***LULUCF Sector***	
	- Plant Science/ Genetics	Short term/Large
	- Agro-forestry	Short term/Small
3	***Coastal Zone Management***	
	- Sea - dyke	Short and Medium term/Large
	- Coastal wetland Rehabilitation	Short and Medium term/Large
4	***Water resources***	
	- Rooftop rainfall harvesting for household usages	Short term/Small
	- Harvesting runoff water	Short term/Small and Medium
	- Integrated River Basin Management	Short and Medium term/Large

PART II

Technology Action Plans

EXECUTIVE SUMMARY

Based on the technology assessment needs in Part I, priority technologies were identified for each sector. However, the application of technologies needs to comply with the nation-driven development plans and policies of the sector. Moreover, current mechanisms still, to some extent, barricade the diffusion of technologies. Therefore this report on technology action plan (TAP) provides brief information on barrier analysis and solution proposals for technologies, based on which an action plan was produced to apply the priority adaptation technology.

ANALYZING BARRIERS TO APPLICATION OF CLIMATE CHANGE ADAPTATION TECHNOLOGIES

For priority adaptation and mitigation technologies, the proposed analysis process is as follows:

Step 1: Clarifying priorities and establishing key milestones. This included two major sub-steps: reaffirming development and climate priorities in the National Target Program to Respond to Climate Change, sectoral development plans and generating milestones for the sectors/sub-sectors and the selected technologies.

Step 2: Identifying measures to develop capacities and enabling framework. In this step, the current systems were characterized, such as policies, driving forces, market conditions, policy frameworks and stakeholder networks. Then, an analysis was conducted to identify bottlenecks and barriers in terms of economic, institutional, technological capacities as well as market potential of the technology, and to propose measures. These measures were grouped to create an enabling framework for the development and diffusion of the technologies.

Step 3: a national strategy and action plan were built upon the enabling framework by the following activities: aggregating and rationalizing measures to develop national capacities for acceleration the development and transfer of the technologies; prioritizing and characterizing technology acceleration measures for the national strategy/action plan; incorporating technology investment costs and benefits; and finalizing the national strategy/action plan.

A TAP for each sector was built upon the following preliminary targets and the barrier analysis.

PRELIMINARY TARGETS AND BARRIERS

AGRICULTURE

There are four preliminary targets in agriculture: developing a healthy, diverse and sustainable commodity agriculture; transfer and application of advanced technology to production; developing a market for science and technology in rural areas; linking and coordinating with the National Target Programs, and other socio-economic programs in selecting and diffusing suitable technologies; enhancing technical capacity for local people and staff.

Based on the above general targets, specific targets for plant genetics/plant breeding, shifting from rice to upland grains, biochar and shifting from triple cropping to double cropping and a shrimp/fish/poultry crop were identified.

Barriers to application of these technologies were categorized into socio-economic, technical and environmental groups. In terms of socio-economy, the major problem is investment, or lack thereof, and restructuring the distribution market for products. In technical terms, infrastructure and national technical capacity are not sufficient. In terms of environment, the technologies may have some side effects such as causing pollution or changes in the natural gene pool.

FORESTRY

Sustainable forest management is considered the basis for forestry development with the target of increasing the national forest coverage to 45% in 2020. Therefore, the following tasks need to be considered: completing bordering and planning for the three types of national forest; sustainable management, planning and use of protection forest and special use forest; planning for afforestation and reforestation.

Based on the above general targets, specific targets for plant science/plant genetics and agro-forestry were identified.

Barriers to application of these technologies were categorized into socio-economic, technical and environmental groups. In terms of socio-economy, local budgets are not sufficient for technology development, in addition to inadequate policies for handing over forestland to local people. In technical terms, infrastructure and national technical capacity are not sufficient. Areas for forest production are fragmented while forest product quality and

quantity are still low or unstable. In terms of environment, applying these technologies may accelerate land degradation due to overexploitation.

INTEGRATED WATER RESOURCES MANAGEMENT

Development of integrated water resources management (IWRM) will enhance adaptive capacities of human communities and natural ecosystems to climate change, increase living standards and ensure water security and sustainable water resources development. Prioritizing development of climate change adaptation technologies in water resources management will ensure water security, poverty alleviation, social security, public healthcare, enhance living standards and protect water sources in the context of climate change.

Barriers to application of these technologies were categorized into socio-economic, technical and environmental groups. In terms of socio-economy, there is not enough investment. Besides, conflicts over access to water sources are of major public concern. In technical terms, there is not enough space in urban areas for rainwater storage. Also, it is hard to determine the scale of large reservoirs in rural areas. Currently, authority has yet reached a consensus on the institutional arrangements of the Integrated River Basin Management Committee. In addition, there is a need for a uniform database and information sharing mechanism for stakeholders. In terms of environment, water pollution will have negative impacts on downstream lives and ecosystems, such as epidemic outbreak.

INTEGRATED COASTAL ZONE MANAGEMENT

In the future, priority technologies for integrated coastal zone management in Vietnam will be promoted to approach the international level through the following activities: capacity building and development of professional and skilled staffs; technology development and transfer; strengthening existing structures; securing socio-economic targets; protecting coastal zone ecosystems.

Barriers to application of these technologies were categorized into socio-economic, technical and environmental groups. In terms of socio-economy, construction in coastal zones and preservation areas requires high investment and long-term maintenance costs. In technical terms, there is a lack of data which causes difficulties to finding a suitable solution. In terms of environment, coastal zone structures can change coastal dynamics and impact on coastal ecosystems.

Based on the preliminary targets and identified barriers, TAP for each sectors were developed.

TECHNOLOGY ACTION PLAN

TECHNOLOGY ACTION PLAN FOR FORESTRY

Vietnam is a tropical country with diverse vegetation. Therefore, research on application of plant genetics from the existing gene pool for agricultural, forest, aquacultural production and for enhancing biological products are urgent and very meaningful Vietnam's biology. To accelerate the development of this technology, besides the above solutions, biological centers need to be established to coordinate with research centers, manufacturing utilities, application agencies and advertisement entities. In addition, nursery gardens need more investment to support researchers to put ideas into practice.

Agro-forestry is one of the most effective solutions that the Ministry of Agriculture and Rural Development (MARD) aims to develop in the future. However, barriers to this technology that need to be overcome are:

Land management: Replant land, with an emphasis on agro-forestry, to the commune level, with a long-term vision to ensure in-depth investment.

Research and development of agro-forestry techniques: Find out soil improvement methods, sustainable tillage on specific ecosystems, agro-forestry modals for poor people.

Support policies: Emphasize on remote areas, extremely poor areas; Integrate agro-forestry into projects and programs to maximize the effectiveness of agro-forestry and utilize financial sources for agro-forestry.

Support market for agro-forestry: Use the Market Analysis and Development (MA&D) method to analyze market for products; Structure the effective market chain; create a system of information for agro-forestry in mountainous areas.

TECHNOLOGY ACTION PLAN FOR AGRICULTURE, INTEGRATED WATER RESOURCES MANAGEMENT AND INTEGRATED COASTAL ZONE MANAGEMENT

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From now to 2025: Continue assessing potential for technology application as well as Vietnam's circumstances. Facilitate international cooperation in experience and knowledge sharing in management, especially between countries with the same level of development as Vietnam. Build human capacity development plans for operation of newly transfered technologies. Research how to apply water resources management tchnologies and pilot several technologies in certain areas to see how efficient it can be. Continue to develop and innovate the technology. Develop appropriate support policies and mechanisms for research of priority water resources management technologies. Develop guidelines on technical requirements and mandatory procedures for relevant projects.

Post-2025: Develop and apply the priority technologies that are feasible. Complete the application of modern, automated technologies.

Chapter 1. Technology Action Plan for Agriculture

In Part A, the technology capable of adapting to climate change in agriculture has been taken into account, scoring and evaluation to select the most preferred technology. As a result, these technologies are arranged in order of priority and summarized in the table below

Table 23 - List and assess the technology to adapt to climate change in selected priority agricultural sector

Availability/Scale	Technology	Adaptive potential for 20 years	Benefit from MCDA output	Estimated cost of technology investment ($ 1,000)
Long term / large	Genetic Technology	high	58.11	400,000
Long Term / Average	Transfer rice to upland crops	high	55.63	200,000
Long term / small	Conversion into 2 3 wheat rice / fish - shrimp	low-medium	51.53	400,000

1.1 Preliminary targets for technology transfer and diffusion

The overall goal to develop technologies in the agricultural sector is based on the sectoral strategies, plans and national program in general or sub-sectoral in particular, all of which have Prime Minister's approval.

The sectoral strategies, plans and national program mentioned above also indicate the specific objectives for each sub-field to serve as a basis for developing milestones for technology development.

1.1.1 Reaffirmation of targets for technology transfer and diffusion

a) General targets

- Encourage green, low-carbon production in agriculture, secure sustainable development and national food security, and contribute to the poverty alleviation.

b) Specific targets [*]

- By 2020, conduct research programs and implement measures for climate change adaptation in agriculture, secure the sector's 20-percent growth target, reduce poverty rate by 20%, maintain an aggregated area of double cropping at 3.8 million hectares, and ensure food security and poverty alleviation

1.1.2 Establishing milestones to accomplish technology development targets

a) National milestones in the agriculture sector [*]

- Ensure food security, maintain crop area at 3.8 million hectares with at least 3.2 million hectares for double cropping.

- Maintain the sectoral growth of 20%, reduce the poverty rate by 20% in each 10-year period.

b) Milestones for priority technologies in the agriculture sector

By 2020:

- Ensure rice production reached more than 41 million tons in cultivated area of 3.7 million ha. Forming monitoring system and regulatory policy to maintain output in proportion to the scope of domestic and foreign markets (coffee production of 1.1 million tones, rubber latex production of 1.5 million tons, pepper production reached 120,000 tons, 600,000 tons of tea leaves 1 million tons, 12 million tons of fruit ...) [**]

- Complete the planning and assessment of adaptive capacity to climate change, and forecast the crop yield decline possibility according to the climate change scenarios in seven eco-regions.

- Change the cropping patterns and growing seasons to adapt to the new climate conditions in the eco-regions.

- Select and create new crop varieties that can reduce green house gas (GHG) emissions and respond to climate change.

- Apply good agricultural practices in crop production, such as reducing application of chemical fertilizer, saving water, minimizing the use of chemical pesticides, avoiding heavy tillage and monitoring irrigation. Align cropping patterns towards climate change adaptation.

1.2 Barrier analysis

A proposed method for technology innovators to find barriers and problems is mapping market.

By this method, the group of experts discussed and exchanged information to build up a comprehensive picture of the entire existing system elements related to the development of new technologies and the linker / binding can cross between them. The relevant factors are mainly considered include:

- Environment that allows the introduction of new technologies (such as legal, institutional, organizational, cultural, geographical, economic and social conditions ...)
- The relevant object in the system (such as manufacturers, wholesalers, retail dealers, consumers, households producers ...)
- Supporting services (such as finance, quality management, performance, standards, etc ...).

Based on this picture, the Steering Committee and other stakeholders to identify existing problems in the system, from which barriers would be found out for each technology and common barriers to all technologies in the same field of sector. Next, by simple voting groups, implementation groups (they are experts who works in agencies/organizations are mention in Table 2) have pointed out the barriers that need to be addressed prior to deciding which measures short-term, medium term and long term for each field.

The market mapping is only applied for technologies which are classified by consumer and capital goods. The detail of market maps for these technologies categories of adaptation technologies are presented in the Annex 2. Following that, maps of analysing framework condition for them are shown parallel as well in this Annex 2.

1.2.1 Barrier identification and analysis for the transfer and diffusion of plant genetics/plant breeding

a) Social and economic barriers

The genetic material of Vietnam is still limited and did not meet the requirements for basic research and long-term research related to climate change adaptation

b) Technical barriers

- Existing facilities and national expertise do not allow quality products for short-term adaptation to climate change.

- Long time requirement: the creation of a new species usually takes 5 continuous years.

c) Environmental barriers

- Risks of affected human health and food chain caused by genetically modified (GM) crop varieties.

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[*] Approval decision on reducing greenhouse gas emission on agriculture, rural areas towards 2020

[**] Strategy on developing agriculture, rural from 2011 to 2020, Ministry of Agriculture and Rural development Oct, 2009

1.2.2 Barrier identification and analysis for the transfer and diffusion of shifting from rice to upland grains

a) Social and economic barriers

- High costs for field improvement and seed purchase.

- Requiring consideration of a distribution system for the product.

b) Technical barriers

- Developing a methodology tailored for each crop species, terrain or locality is a challenge.

- Lack of high-quality fruit crop varieties that are of high import value.

c) Environmental barriers

- Risks of land use change

- Changes in regional and sub-regional ecologies

1.2.3 Barrier identification and analysis for the transfer and diffusion of shifting from triple cropping to double cropping plus shrimp/fish/poultry farming

a) Social and economic barriers

- High costs for field improvement, large investment costs for fish, shrimp or poultry.

- Lower fishery and waterfowl productivity compared to intensive farming.

b) Technical barriers

- Absence of a well-defined farming methodology, mostly depending on local experience

- Lack of production techniques in varied inundation conditions

c) Environmental barriers

- Risk of water pollution.

1.2.4 Linkages of the barriers identified

During the analysis, it became clear that many of the barriers and system blockages were common across all technologies, except to some specific technologies and sectors. Therefore, the common barriers across the technologies of the sector were aggregated to minimize overlaps and ensure that the process would flow smoothly, as shown in Table 24.

Table 24 - Common barriers and inefficiencies identified for technologies

Market linkage	
	Currently no market for this technology
	Products not outstanding or maintaining long-term stability
	Lack of investment on infrastructure, leading to short-term, low efficiency
Enabling environment	
	Incentive policies for diffusion of the new technology are not strong enough
	Procedures for approval or registration are usually complicated, sometimes unsuitable or unable to meet the demand

	Poor infrastructure
	Sustainable production is not done on a voluntary basis
Support actions	
	Lack of support for research and development
	Lack of information
	Lack of project management capacity
	Limited local management capacity and expertise
	Limited financial support for development of the new technology

1.3 Enabling framework for overcoming the barriers

From the analysis and identification of general and specific barriers mentioned above, the barriers will be classified according to six general groups of the core element (core group barriers) and sorted, classified according to the same core group of factors, including the group of the following measures:

- Create a network of experts: is an important medium that allows exchange ideas and information to ensure demonstration, innovative and successful implementation of measures to promote strategies that include compulsory information campaign message and raising awareness.

- Policies and measures: promote exist technologies transfer in countries that have many obstacles need resolving by implementation and enforcement measures as well as new, rationalized policies towards new directions.
- Change organization / behavior: usually occur outside the market system but it is important in improving market and non-market functions. These obstacles caused by the actual state of the current operation or organizations may request a change in management approach.

- Market, support systems and other financial services: to ensure accountability, functions and providing these services to achieve efficiency. There are many relevant systems in one place. It is supposed to relate to many financial services, quality insurance system, consultancy and information services.

- Skills, education and training: is the key foundation to development. Planning and investment in this area will need to make in parallel with other measures to bring the required skills and ensure appropriate education and training.
- International Cooperation and IPR issues: may not be sufficient nationwide for promoting technology and required international link through international activities. Trade and international IPR system need editing and the tasks under other international agreements also have influence.

Based on expert knowledge of the stakeholders and the picture of an enabling environment for technology, experts have discussed measures to make possible to overcome barriers for each group of factors for each core technology. Through this discussion, the recommendations are proposed for the agricultural sector. Frameworks to overcome barriers to agriculture sector are described in detail below.

1.3.1 Possible solutions to address the barriers for the transfer and diffusion of plant genetics/plant breeding

1.3.1.1 Measures to support the creation of a stakeholder network for the development and transfer of the technology

- Measure 1: Strengthen and establish national focal centers

1.3.1.2 Actions to improve policies and creating measures for technology development and transfer

- Measure 1: Make support policies for fundamental and long-term research

- Measure 2: Develop pilot programs to test the applicability of research outcomes

1.3.1.3 Measures to strengthen functioning of organizations and institutions

- Measure 1: Support organizations and individual experts in their research on the technology

1.3.1.4 Measures to strengthen market, system support and financial services

- Measure 1: Localize GM products to adapt to the ecology of the locality.
- Measure 2: Carry out large-scale testing for GM crops.

1.3.1.5 Measures to support skills training and education for technology development and transfer

- Measure 1: Strengthen the capacity of agronomy universities and colleges

1.3.1.6 Measures to facilitate international cooperation and deal with intellectual property rights (IPR)

- Measure 1: International cooperation/international consultants/overseas staff training

1.3.2 Possible solutions to address the barriers for the transfer and diffusion of shifting from rice to upland grains

1.3.2.1. Measures to support the creation of a stakeholder network for the development and transfer of the technology

- Measure 1: Create a network of experts with expertise on agriculture, hydrology, industrial and fruit crops.

1.3.2.2. Actions to improve policies and creating measures for technology development and transfer

- Measure 1: Locate area that needs shifting from rice to upland grains.

1.3.2.3. Measures to strengthen functioning of organizations and institutions

- Measure 1: Increase the leading role of the central and local governments
- Measure 2: Raise awareness of agricultural extension agencies on climate change

1.3.2.4. Measures to strengthen market, system support and financial services

- Measure 1: Analyze the advantages of the technology
- Measure 2: Introduce crop varieties which bring higher value than rice crops.
- Measure 3: Multiply the proven success modal.

1.3.2.5. Measures to support skills training and education for technology development and transfer

- Measure 1: Raise public awareness

1.3.3 Possible solutions to address the barriers for the transfer and diffusion of shifting from triple cropping to double cropping plus shrimp/fish/poultry farming

1.3.3.1. Measures to support the creation of a stakeholder network for the development and transfer of the technology

Measure 1: Create a network of experts with expertise on agriculture, hydrology, plant protection and livestock veterinary.

1.3.3.2. Actions to improve policies and creating measures for technology development and transfer

Measure 1: Locate area that requires the technology.
Measure 2: Make support policies for the deployment of the technology.

1.3.3.3. Measures to strengthen functioning of organizations and institutions

Measure 1: Increase the leading role of the central and local governments.

Measure 2: Raise awareness of agricultural extension agencies on climate change.

Measure 3: Make and enforce rules and mechanisms for coordination between sectors and organizations.

1.3.3.4. Measures to strengthen market, system support and financial services

Measure 1: Create market outlets for new products.

Measure 2: Plan and build appropriate infrastructure.
Measure 3: Multiply the proven success modal.

1.3.3.5. Measures to support skills training and education for technology development and transfer

Measure 1: Raise public awareness.

Measure 2: Mainstream the issue into the official educational system.

1.3.4 Recommended solutions for Agriculture

It can be seen that in short, medium and long terms, a step-by-step plan for development, innovation or modernization of identified priority technologies for adaptation to climate change in agriculture is needed. Doing so would require restructuring or strengthening of the existing research-extension-market systems taking into account changes occurring in biophysical condition in a given locality. This is an urgent matter which needs to be done in a scientific and specific way. In addition, international cooperation also needs to be strengthened in order to increase management capacity as well as accelerate the diffusion of advanced technologies. Investment in high quality human resources must be continued for securing human capital for short, medium and long terms. Science institutions and experts should advise the Government on policy making and development of legal frameworks for deployment and diffusion of advanced science to accelerate agricultural production, ensure sustainable development, environmental protection, poverty eradication, and protect and enhance quality of life.

1.4 Technology action plan, project ideas, and other issues in agriculture

1.4.1 Plant genetics/plant breeding

1.4.1.1 Technology action plan for plant genetics/plant breeding

a) Aggregation and rationalization of measures identified for technology acceleration

The list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table 25 below.

Table 25 - Aggregation for strategy formulation

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Creation of network			
Strengthening and creating national focal centers for selected crops and commodities (e.g. rice, coffee, banana, dragon fruits etc..) including a dedicated section maintaining, collecting and studying and acquiring germs plasm of needed properties (e.g. salt tolerant rice etc..)	X	X	X
Policies and Measures			
Support policies for fundamental and long-term research	X	X	X
Pilot programs for testing of applicability of research outcomes	X	X	X
Organizational/behavioral change			

Support for organizations and individual experts in technology research	X	X	X
Market support actions			
Localization of GM products to the eco-region	X	XX	XX
Large-scale testing for GM crops	X	X	X
Skills training and education			
Strengthening capacity of agronomy educational institutions	X	XX	XX
International cooperation and IPR			
International cooperation/international consultants/overseas staff training	X	XX	XX

* Note: This table illustrates for a strategy of acceleration measures according to letters of each square, using the timescale for completion of an action, where:

- Letter "X" refers to measures which need to be started in the short term and carried out within the next five years;

- Letter "XX" refers to measures which can be completed in up to 10 years;

- Letter "XXX" refers to measures longer-term measures which can be planned for completion within 15 years from the current date and also will be used for other technologies below.

b) Prioritization and characterization of technology acceleration measures for a national plan

The list of measures identified for the acceleration of technologies and the innovation stage structured under the core elements of a national strategy are identified and aggregated in Table 26 below.

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Table 26 - Prioritization and characterization of technology acceleration measures

Sector: Agriculture							
Specific Technology and category: Plant genetics/plant breeding/ Large scale, long-term							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio -rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000USD)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Creation of networks							
Strengthening and creating national focal centers	1	Helps to rationalize and increase the role of existing organizations Helps to create national focal research centers	MARD	Review and assess the capacity of existing agencies Restructure the organizational structure towards specialization Establish focal centers	2 years	MARD MOST	96
Policies and measures							
Support policies for fundamental and long-term research	1	Current support policies do not provide enough incentive for fundamental and long-term research	MARD	Review existing relevant support policies Make and bring into force new support policies Create funds for technology R&D	5 years	MARD MOST, MOF	240
Pilot programs for testing of applicability of research	1	Many research outcomes have not	MOST, MARD,	Summarize, categorize and assess	5	MOST,MOF	480

outcomes		been implemented Lack of financial resources for piloting and duplicating the results	MOF, local People's committees	existing research outcomes Select technologies and carry out pilot projects	years	MARD	
Organizational/behavioral change							
Support for organizations and individual experts in technology research	1	There is need for strengthening the operation of organizations and for the participation of leading experts	MARD, MOST	Review and assess needs of existing organizations Develop research support plans and programs Implement research and assess research outcomes	3 years	MARD MOHA MOET	240
Market support actions							
Localization of GM products to the eco-region	1	Genetically modified products must be evaluated for their suitability to the eco-region before going into large-scale production	MARD	Assess limitations of seeds in each natural, soil and ecological condition Experiment and select the best seed for each eco-region	7 years	MARD MONRE MOST	240
Large-scale testing for GM crops	2	Helps to identify the sustainable traits of GM products	MARD, provinces	Develop a test network Determine representative eco-regions and carry out testing experiments Organize workshops for assessment	5 years	MARD	192
Skills training and education							
Strengthening capacity of agronomy educational institutions	2	Helps to prepare required human resources ready for the innovation and transfer of the new technology	MOET MARD	Standardize the quality of lecturers Build lecturers' capacity	5 years	MOET, MOF	240

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International cooperation and intellectual property rights (IPR)							
International cooperation/international consultants/overseas staff training	1	Helps to take advantage international experience, develop human resources, and accelerate technology transfer and diffusion	MARD MOET MOFA	Make agreements on international cooperation and training Develop overseas training programs	10 years	MARD MOST	480

* Note:

(1) Measures were grouped under the core elements for a technology acceleration action plan. Using a simple process, expert groups (they work in angencies and organizations which was mentioned in Table 2 and they came from national steering committee for the UNFCCC and the Kyoto Protocol) were requested to categorize each measure into level 1, 2 or 3 according to their view on the importance of the measure to the action plan. The priority levels reveal the importance of the measure, divided into 3 levels from 1 to 3 with the following specifications:

- 1: very important, should be carried out in the short term.

- 2: important, can be carried out in new future (the next 5-10 years) or when possible.

- 3: fairly important, should be carried out but in a longer term, no need to be done in the short time.

c) Finalizing national strategy

Based on priority technology action plans in the sub-sectors, a national strategy and action plan for the plant genetics/plant breeding development targets are presented in Table 27.

Table 27 - National Strategy (technology transfer and development for adaptation)

	0-5 years	5-10 years	10-15 years
Large-scale, long-term technology			
Plant genetics/plant breeding			
Strengthening and creating national focal centers	X		
Support policies for fundamental and long-term research	X		
Pilot programs for testing of applicability of research outcomes	X		
Support for organizations and individual experts in technology research	X		
Localization of GM products to the eco-region	X	X	
Large-scale testing for GM crops	X	X	
Strengthening capacity of agronomy educational institutions	X	X	
International cooperation/international consultants/overseas staff training	X	X	X

1.4.1.2 Brief summary of project ideas for international support (Annex 3)

1.4.2 Shifting from rice to upland grains

1.4.2.1 Technology action plan for shifting from rice to upland grains

a) Aggregation and rationalization of measures identified for technology acceleration

Similar to the section above, the list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table 28.

Table 28 - Aggregation for strategy formulation

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Creation of networks			
Creating a network of experts on agriculture, hydrology, industrial and fruit crops	X	XX	XX
Policies and Measures			
Locating areas that needs shifting from rice to upland grains	X	XX	XX
Organizational/behavioral change			

Increasing the leading role of the central and local governments	X	XX	XX
Raising awareness of agricultural extension agencies on climate change	X	XX	XX
Market support action			
Analyzing the advantages of the technology	X	XX	XX
Introducing crop varieties with higher market value than rice	X	X	X
Replicating the proven success models			
Skills training and education			
Public awareness raising	XX	XXX	XXX

* Note: see Note under Table 25.

b) Prioritization and characterization of technology acceleration measures

Similar to above, the measures were prioritized and characterized through a detailed process for an action plan, as seen in Table 29 below.

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Table 29 - Prioritization and characterization of technology acceleration measures

Sector: Agriculture							
Specific Technology and category: Shifting from rice to upland grains/Medium scale, long-term							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Creation of networks							
Creating a network of experts on agriculture, hydrology, industrial and fruit crops	1	There is a need for inter-sectoral coordination in assessing adaptive capacity of crop varieties.	MARD, MOST	Select experts of various principles Create a network and define the role of the stakeholders	3 years	MARD	86
Policies and measures							
Locating areas that needs shifting from rice to upland grains	1	There is a need for relocation of suitable areas for technology application	MARD	Investigate, assess the water scarcity and economic efficiency of wet rice cultivation practice Locate areas the need the new technology	5 years	MARD	144
Organizational/behavioral change							
Increasing the leading role of the central and local governments	1	Uniform instruction from the central through to local levels is the determining factor in the technology	MARD, provinces	Integrate the technology into action plan at the national and local levels Form multi-sectoral taskforces and steering	4 years	GoV	480

		development		committees			
Raising awareness of agricultural extension agencies on climate change	2	Agricultural extension agencies have limited understanding of climate change Agricultural extension agencies is the responsible organization for adaptation technology transfer	MARD	Prepare materials on climate change and adaptation measures Organize training courses for agricultural extension officials	5 years	MARD	240
Market support actions							
Analyzing the advantages of the technology	1	Helps to raise awareness of public to change their cultivation behaviors.	MARD	Carry out research experiments and observations. Assess and demonstrate the advantages of the new technology	3 years	MARD	144
Introducing crop varieties with higher value than rice crops	2	Helps farmers to choose an appropriate method that can produce high economic benefits.	MARD	Organize exhibitions-workshops to promote the new technology and capacity of service suppliers	5 years	MOST; MARD	240
Multiplying the proven success modal	2	Because they are modals that have proven to be scientifically successful and have low risks.	MARD	Integrate into annual plans Conduct study tours to learn about existing modals	5 years	MARD	240
Skills training and education							
Public awareness raising	1	Because of the long-standing traditional cultivation practices, people may not accept the new technology	MARD	Organize training courses and workshops to introduce about the technology and share experience	10 years	MARD, MOST	192

* Note:

(1) See Note under Table 26

c) Finalizing national strategy

Based on priority technology action plans in the sub-sectors, a national strategy and action plan for the technology development targets are presented in Table 30.

Table 30 - National Strategy (technology transfer and development for adaptation)

	0-5 years	5-10 years	10-15 years
Large-scale, medium and short-term technology			
Shifting from rice to upland grains			
Creating a network of experts on agriculture, hydrology, industrial and fruit crops	X		
Locating areas that needs shifting triple cropping to double cropping plus shrimp/fish/poultry farming	X		
Increasing the leading role of the central and local governments	X		
Raising awareness of agricultural extension agencies on climate change	X	X	
Analyzing the advantages of the technology	X		
Introducing crop varieties with higher value than rice crops	X	X	
Multiplying the proven success modal	X	X	
Public awareness raising	X	X	X

1.4.2.2 Brief summary of project ideas for international support (Annex 3)

1.4.3 Shifting from triple cropping to double cropping plus shrimp/fish/poultry farming

1.4.3.1 Technology action plan for shifting from triple cropping to double cropping plus shrimp/fish/poultry farming

a) Aggregation and rationalization of measures identified for technology acceleration

Similar to the above section, the list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table 31.

Table 31 - Aggregation for strategy formulation

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Creation of Network			
Creating a network of experts with expertise on agriculture, hydrology, plant protection and livestock veterinary	X	XX	XX
Policies and Measures			
Locating areas that needs shifting triple cropping to double cropping plus shrimp/fish/poultry farming	X	X	X

Support policies for the deployment of the technology	X	X	X
Organizational/behavioral change			
Increasing the leading role of the central and local governments	X	X	X
Raising awareness of agricultural extension agencies on climate change	X	XX	XX
Rules and mechanisms for coordination between sectors and organizations	X	XX	XX
Market support actions			
Creating market outlets for new products			
Planning and building appropriate infrastructure	X	XX	XX
Multiplying the proven success modal	X	X	X
Skills training and education			
Public awareness raising	XX	XXX	XXX
Mainstreaming into the official educational system	X	XX	XX

* Note: see Note under Table 25.

b) Prioritization and characterization of technology acceleration measures

Similar to above, the measures were prioritized and characterized through a detailed process for an action plan, as seen in Table 32 below.

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Table 32 - Prioritization and characterization of technology acceleration measures

Sector: Agriculture							
Specific Technology and category: Shifting from triple cropping to double cropping plus shrimp/fish/poultry farming/ Small scale, long-term							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
Creation of networks							
Creating a network of experts with expertise on agriculture, hydrology, plant protection and livestock veterinary	1	There is a need for inter-sectoral coordination in assessing adaptive capacity of rice and fish/waterfowl	MARD, MOST	Select experts of various principles Create a network and define the role of the stakeholders	3 years	MARD	86
Policies and measures							
Locating areas that needs shifting triple cropping to double cropping plus shrimp/fish/poultry farming	1	There is a need for relocation of suitable areas for technology application	MARD	Investigate, assess the water scarcity and economic efficiency of triple cropping Locate areas the need the new technology	5 years	MARD	192
Support policies for the deployment of the technology	1	There is no appropriate support policy for technology diffusion Helps to facilitate the deployment of research outcomes in production	MOST, MARD, MOF, MPI	Demonstrate the science and necessity of the technology Develop and bring into force appropriate policies and tax incentives to diffuse the technology	3 years	MOF	48

Organizational/behavioral change							
Increasing the leading role of the central and local governments	1	Uniform instruction from the central through to local levels is the determining factor in the technology development	MARD, provinces	Integrate the technology into action plan at the national and local levels Form multi-sectoral taskforces and steering committees	4 years	GoV	480
Raising awareness of agricultural extension agencies on climate change	2	Agricultural extension agencies have limited understanding of climate change Agricultural extension agencies is the responsible organization for adaptation technology transfer	MARD	Prepare materials on climate change and adaptation measures Organize training courses for agricultural extension officials	5 years	MARD	240
Rules and mechanisms for coordination between sectors and organizations	3	Coordination between relevant agencies is weak. There is a need for a coordination mechanism to strengthen the implementation	MARD, MONRE, People Committee	Review existing legal documents Consult with stakeholders to make appropriate, feasible policies Develop and bring into force new coordination mechanism	2 years	GoV, National Steering Committee for Climate Change	5
Market support actions							
Creating market outlets for new products	2	Helps to ensure the market outlets for new products	MARD, MOIT, MOF	Research the market and create linkages with business organizations Organize marketing campaign for the product Create a new market for the product	5 years	MARD, MOIT	48
Planning and building appropriate infrastructure	1	Helps to ensure sustainable development Facilitate the deployment of the	MPI, MARD, MOC,	Investigate, design and develop investment plan for each period according to the priority level.	5 years	MPI, MARD	4,798

		new technology	Provinces	Plan and implement according the planning.			
Multiplying the proven success modal	2	Because of the long-standing traditional cultivation practices, people may not accept the new technology	MARD	Integrate into annual plans Conduct study tours to learn about existing modals	5 years	MARD	240
Skills training and education							
Public awareness raising	1	Because of the long-standing traditional cultivation practices, people may not accept the new technology	MARD	Organize training courses and workshops to introduce about the technology and share experience	10 years	MARD, MOST	144
Mainstreaming into the official educational system	2	Helps to prepare required human resources ready for the innovation and transfer of the new technology	MOET, MARD	Prepare teaching materials and textbooks Increase extracurricular activities	5 years	MOET, MARD	24

* Note:

See Note under Table 26

c) Finalizing national strategy

Based on priority technology action plans in the sub-sectors, a national strategy and action plan for the development targets of shifting from triple cropping to double cropping plus shrimp/fish/poultry farming are presented in Table 33.

Table 33 - National Strategy (technology transfer and development for adaptation)

	0-5 years	5-10 years	10-15 years
Large-scale, medium- and short-term			
Shifting from triple cropping to double cropping plus shrimp/fish/poultry farming			
Creating a network of experts with expertise on agriculture, hydrology, plant protection and livestock veterinary	X		
Locating areas that needs shifting from triple cropping to double cropping plus shrimp/fish/poultry farming	X		
Support policies for the deployment of the technology	X		
Increasing the leading role of the central and local governments	X		
Raising awareness of agricultural extension agencies on climate change	X	X	
Rules and mechanisms for coordination between sectors and organizations (Multi-stakeholder platforms from local to national level) with possible links to regional and international institutions for backward and forward links for innovation and market respectively	X	X	
Creating market outlets for new products		X	X
Planning and building appropriate infrastructure	X	X	
Multiplying the proven success modal	X	X	
Public awareness raising	X	X	X
Mainstreaming into the official educational system		X	X

1.5 Summary

The national technology action plan for agriculture will be as follows:

From now to 2025: Continue assessing the potential for technology application as well as ongoing and future climate change and its impacts in Vietnam. Facilitate international cooperation in sharing experience and knowledge of management, especially between countries with the same level of development and similar climate conditions as Vietnam and other countries in the region. Develop plans to enhance human capacity through revising educational curricular and to support the improvement of local innovation and application capacity of the proper adaptation technologies for Vietnam. There are needs for researches on application of agricutural technologies and pilot several technologies in certain areas to test their efficiency. Continue the development and innovation the technology. Make appropriate support policies and mechanisms for research of priority agricultural technologies. Develop guidelines on technical requirements and mandatory procedures for relevant projects.

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Post-2025: Develop and deploy feasible priority technologies that are suitable to Vietnam's agriculture. Complete the application of modern, automated technologies in agriculture

Chapter 2. Technology Action Plan For Forestry And Land Use Change

In Part A, the technologies that are capable of adapting to climate change in the field of forestry and land use changes are taken into account before they were scored and evaluated to select as the most preferred technology. The table below shows arranged technologies in order of priority.

Table 34 - List of the technologies and their assessment to adapt to climate change in selected priority areas of forestry and land use change

Availability/Scale	Technology	Adaptation potential in 20 years	MCDA score	Estimated investment cost
Short-term/large-scale	Application of biotechnology in selecting forest tree breeding to adapt to drought, floods and have high disease resistance	High	56.40	143,000 USD/ species (including research and transfer fees)
Short-term/small -scale	Agro-forestry	High	50.31	2,380-3,333 USD/ha

2.1 Preliminary targets for technology transfer and diffusion

The identification of the targets and timelines for the forestry sector and land use changes are the same as described in Chapter Agriculture (Section 1.1)

2.1.1 Reaffirmation of targets for technology transfer and diffusion

a) General targets

- Encourage farmers to develop household-scale and farming forestry production practices by delegating forestland to them and increasing agro-forestry extension services.

- Increase climate change mitigation and adaptation capacity to reduce damage and ensure sustainable development.

b) Specific targets

- Develop a system of policies and integrate into sectoral programs and specific actions;

- Develop action plans and recommend support policies for climate change-affected areas to ensure sustainable development of the sector;

- Build capacity for research and forecast the impacts of climate change.

2.1.2 Establishing milestones to accomplish technology development targets

a) National milestones

- By 2020:

+ To ensure the sustainable forestry production activities according to the development plan and restructure the three types of forest and forestland.

+ The growth rate of forestry production (including forest product processing and environmental services) is to increase from 3.5% to 4 or 5% per year; by 2020, GDP of forestry is to constitute 2-3% of the national GDP.

+ National timber production reach 20-24 million m^3/year (including 10 million m^3 of large timber), basically meeting the demand for material of product processing, pulp industry and for import. [*]

b) Prioritized technology milestones

Plant science/Plant genetics

The goal of the Program of Biotechnology Application in Forestry is by the end of 2020, Vietnam will be among top countries in ASEAN in terms of forestry biotechnology and among top countries in the world in certain areas of biotechnology. [**]

70% of forest will be guaranteed with disease-free varieties, created by using multiplication biotechnology, with adequate amount of fertilizer and pesticide application, and drought-tolerant varieties.[***]

Agroforestry

Forestry Development Strategy by 2020 focuses on forestry production on household, farming, community and cooperative scales. For mountainous regions, agro-forestry is considered the main practice as it can minimize the tillage on steep slopes.

The Strategy also emphasizes on expanding agro-forestry practices and intesifying agro-forestry production.

2.2 Barrier analysis

The review process, identify similar barriers as described in the Agriculture sector (Section 1.2). The technological barriers in the field of forestry land use changes are described in detail below.

2.2.1 Barrier identification and analysis for the transfer and diffusion of plant science/plant genetics

a) Economic barriers

Limited investments in the technology, lack of budget for local forestry seed bank.

b) Technical barriers

Inadequate national expertise is the biggest challenge.

Lack of information of and facilities for biotechnology

c) Environmental barriers

Environment for many plants are being threatened by increase in droughts, changing climate and pests.

Biodiversity loss is a threat the precious gene pools.

2.2.2 Barrier identification and analysis for the transfer and diffusion of agro-forestry

a) Economic barriers

- Lack of uniform policies to promote agro-forestry, to delegate forestland to people, and to facilitate agricultural policies such as production credit schemes, rural agricultural policy, poverty alleviation, etc.

- Lack of an adequate market for agricultural product, especially in the mountains.

b) Technical barriers

- Production areas for agriculture are not concentrated but fragmented.

- Product is produced with low quality, in small and not stable quantity.

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[*] Prime Minister (2007), Decision No.18/2007/QD-TTg dated 05 Feb, 2007 on approving development strategy on Vietnam's forestry period 2008-2010

[**] Prime Minister, Decision No.14/2008/QD-TTg dated 22 Jan, 2008 on approving development strategy on biotechnology until 2020.

[***] Decision No.78/2008/QD-BNN of Minister of Ministry of Agriculture and Rural Development on approving strategy on researching Vietnam forestry until 2020.

c) Environmental barriers

Inadequate rural infrastructure.

Land and other resources have been overexploited, which makes it not feasible for production.

2.2.3 Linkages of the barriers identified

Similar to Chapter 1, the linking and aggregation of the common barriers across the technologies of the sector helped to minimize overlaps and ensure that the process would flow smoothly, as shown in Table 35.

Table 35 - Common barriers and inefficiencies identified for technologies

Market linkage	
	Lack of a technology transfer network
	Limited awareness and lack of measures to respond to climate change
	High investment costs for new technologies
	Lack of experienced experts with local knowledge
	Underdeveloped markets of agro-forestry and production material
Enabling environment	
	Support policies for new technologies are usually not strong or uniform
	Lack of rules and standards for implementation
	Long production cycles
	Hostile climate conditions, degraded environment
	Fragmented production, which makes it hard for large-scale concentration production
	Poor infrastructure
	Lack of incentives
Support actions	
	Lack of tools and methodologies to assist policy makers
	Lack of coordination in policy making, planning and program development to respond to climate change
	Inadequate land planning
	Forest delegation policies and other incentives are not capable of encouraging people to stay in the rural areas
	Weak management

2.3 Enabling framework for overcoming the barriers

The work of building framework to overcome the barriers in the field of forestry and land use changes are the same as described in Chapter Agriculture, Section 1.3. Below is the framework to overcome barriers for each technology.

2.3.1 Possible solutions to address the barriers for the transfer and diffusion of plant science/plant genetics

2.3.1.1. Measures to support the creation of a stakeholder network for the development and transfer of the technology.

Measure 1: Create a network for technology application

2.3.1.2. Actions to improve policies and creating measures for technology development and transfer.

Measure 1: Develop the seed selection procedure

2.3.1.3. Measures to strengthen functioning of organizations and institutions.

Measure 1: Increase research for creation of new varieties that can tolerate climate change.

2.3.1.4. Measures to strengthen market, system support and financial services through quality assurance, availability of consultancy, market information, financial services, etc..

Measure 1: Raise awareness on the outcomes of research

Measure 2: Subsidize the product price

2.3.1.5. Measures to support skills training and education for technology development and transfer.

Measure 1: Increase staff capacity building

2.3.1.6. Measures to facilitate international cooperation and deal with intellectual property rights (IPR), particularly for a more cooperative model for RD&D.

Measure 1: Increase bilateral and multilateral cooperation

2.3.2 Possible solutions to address the barriers for the transfer and diffusion of agro-forestry

2.3.2.1. Measures to support the creation of a stakeholder network for the development and transfer of the technology.

Measure 1: Establish agro-forestry extension taskforces

Measure 2: Raise public awareness on natural resources protection

2.3.2.2. Actions to improve policies and creating measures for technology development and transfer.

Measure 1: Facilitate investment on development

2.3.2.3. Measures to strengthen functioning of organizations and institutions.

Measure 1: Develop land planning for agro-forestry in mountainous regions.

Measure 2: Implement the modal for sustainable agro-forestry.

2.3.2.4. Measures to strengthen market, system support and financial services through quality assurance, availability of consultancy, market information, financial services, etc..

Measure 1: Develop a system for product distribution and consumption

2.3.2.5. Measures to support skills training and education for technology development and transfer.

Measure 1: Build capacity for agro-forestry extension officials

2.3.2.6. Measures to facilitate international cooperation and deal with intellectual property rights (IPR), particularly for a more cooperative model for RD&D.

Measure 1: Increase bilateral and multilateral cooperation

2.4 Technology action plan, project ideas, and other issues in forestry and land use change

2.4.1 Plant science/plant genetics

2.4.1.1 Technology action plan for plant science/plant genetics

a) Aggregation and rationalization of measures identified for technology acceleration

Similar to the above section, the list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table 36.

Table 36 - Aggregation for strategy formulation

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Creation of networks			
Creating network for technology application	X	X	X
Policies and measures			
Developing seed selection procedure	X	X	X
Organizational/behavioral change			
Increasing research for new climate change-tolerant varieties	X	XX	XX
Market support actions			
Raise awareness on research outcomes	X	XX	XX
Product subsidization			
Skills training and education			
Capacity building for staff members	X	XX	XX
International cooperation IPR			
Improve bilateral and multilateral cooperation			

* Note: see Note under Table 25

b) Prioritization and characterization of technology acceleration measures for a national plan

Similar to the above sections, the list of measures identified for the acceleration of technologies and the innovation stage structured under the core elements of a national strategy are identified and aggregated in Table 37 below.

Table 37 - Prioritization and characterization of technology acceleration measures

Sector: Forestry and land use change							
Specific Technology and category: Plant science/plant genetics/ Large scale, long-term							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
Creation of networks							
Creating network for technology application	1	Helps to facilitate the diffusion of new scientific achievements into economic activities	MOST, MARD, Forestry Administration	Assess existing networks Create options for strengthening capacity of the networks Create a network for technology application	3 years	MOST MARD	144
Policies and measures							
Developing seed selection procedure	1	Ensures and enhances the efficiency of application of the technology	MARD	Develop criteria and standards of the procedure Carry out pilot projects to apply the procedure, draw lessons for a complete, appropriate procedure	1 year	MARD	14
Organizational/behavioral change							
Increasing research for new climate change-	1	Helps to meet the national demand Facilitates the creation of new	MOST, MARD, research	Make research plans for creation of new varieties	7 years	MOST, MARD	240

tolerant varieties		varieties that can tolerate changing climate conditions Increases national research activities	institutes	Invest on research facilities, equipment and infrastructure Pilot and diffuse the technology on a large scale			
Market support actions							
Raise awareness on research outcomes	2	Helps to expand and promote the outcomes of research	MARD, MOST,	Introduce the research outcomes through mass media Organize workshops for introduction of the research outcomes and experience sharing	3 years	MARD	72
Product subsidization	2	Subsidization is needed to encourage the deployment of this technology	MARD, MOF	Develop product subsidization schemes Mobilize financial resources from forestry support funds	5 years	MARD, MOF, MPI	360
Skills training and education							
Capacity building for staff members	1	Helps to form a basis for technology innovation and transfer	MARD, MOET	Develop capacity building programs and materials for staff members Organize training courses and forums to exchange experience	3 years	MARD, MOET	58
International cooperation and IPR							
Bilateral and multilateral cooperation	2	Helps to take advantage of international resources and experience Gains rapid access to latest scientific achievements	MARD, MOST, MOET	Organize overseas study tours Develop cooperation with experienced international organizations	10 years	MARD, MOST	96

* Note:

(1) See note under Table 26

c) Finalizing national strategy

Based on priority technology action plans in the sub-sectors, a national strategy and action plan for the development targets of plant science/plant genetics are presented in Table 38.

Table 38 - National Strategy (technology transfer and development for adaptation)

	0-5 years	5-10 years	10-15 years
Large-scale, long-term technology			
Plant science/plant genetics			
Creating network for technology application	X		
Developing seed selection procedure	X		
Increasing research for new climate change-tolerant varieties	X	X	
Raise awareness on research outcomes		X	X
Product subsidization		X	X
Capacity building for staff members	X		
Bilateral and multilateral cooperation	X	X	X

2.4.1.2 Brief summary of project ideas for international support (Annex 3)

2.4.2 Agro-forestry

2.4.2.1 Technology action plan for agro-forestry

a) Aggregation and rationalization of measures identified for technology acceleration

Similar to the above section, the list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table 39.

Table 39 - Aggregation for strategy formulation

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Creation of networks			
Establishing agro-forestry extension taskforces	X	X	X
Raising public awareness on natural resources protection	X	X	X
Policies and measures			
Facilitating investment on development	X	X	X
Organizational/behavioral change			
Land planning for agro-forestry in mountainous regions	X	X	X
Developing Implementing sustainable agro-forestry modal	X	XX	XX

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Market support actions			
Developing system for product distribution and consumption	X	XX	XX
Skills training and education			
Capacity building for agro-forestry extension officials	X	XX	XX
International cooperation and IPR			
Bilateral and multilateral cooperation	X	XX	XX

*Note: see Note under Table 25.

b) Prioritization and characterization of technology acceleration measures for a national plan

Similar to the above sections, the list of measures identified for the acceleration of technologies and the innovation stage structured under the core elements of a national strategy are identified and aggregated in Table 40 below.

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Table 40 - Prioritization and characterization of technology acceleration measures for a national plan

Sector: Forestry and land use change							
Specific Technology and category: Agro-forestry/Small scale, short-term							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
Creation of networks							
Establishing agro-forestry extension taskforces	1	Helps to take advantage of experts involved in the taskforces	MOST	Create a network of agro-forestry extension at the local level, consisting of local official and providing allowance	5 years	MOST, MONRE	355
Raising public awareness on natural resources protection	1	Helps to raise awareness of people in order for them to make the right, sustainable decisions	Provinces	This will be done through mass media, by extension taskforces and training courses	5 years	People Committee	14
Policies and measures							
Facilitating investment on development	2	Helps to encourage people to use the technology Helps to promote the technology on a larger scale	MOF, SB, MARD	Review, develop and implement loan policies, measures with convenient, simple procedures	3 years	MOF, MARD	288
Organizational/behavioral change							
Land planning for agro-forestry in mountainous regions	1	Creates land resources for te technology application Accelerate the diffusion of technology in	MPI, MARD, MONRE	Investigate and develop uniform planning for all regions	3 years	MPI, MARD, MONRE	288

		potential localities		Implement the planning			
Implementing sustainable agro-forestry modal	1	Helps to change the traditional behaviors and accelerate the diffusion of the technology	MOST	Choose an area to apply the modal Assess the results of the modal application Multiply the application on a large-scale	3 years	MARD, MOST	96
Market support actions							
Developing system for product distribution and consumption	2	Helps to increase the product value and household income Contributes greatly to the poverty alleviation program in rural and mountainous areas	MARD, MOIT, local People's Committees	Organize a system of market outlets for the products Establish wholesale markets	2 years	MARD, MOIT	96
Skills training and education							
Capacity building for agro-forestry extension officials	1	Helps to relay the knowledge to people Ensures the efficiency of the modal	MARD, DARDs	Organize training courses for agro-forestry extension officials	3 years	MARD	14
International cooperation and IPR							
Bilateral and multilateral cooperation	2	Helps to take advantage of international resources and experience Gains rapid access to newest scientific achievements	MARD, MOST, MOET	Organize overseas study tours Develop cooperation with experienced international organizations	10 years	MARD, MOST	96

* Note:
(1): See Note under Table 26

c) Finalizing national strategy

Based on priority technology action plans in the sub-sectors, a national strategy and action plan for the development targets of agro-forestry technology are presented in Table 41.

Table 41 - National Strategy (technology transfer and development for adaptation)

	0-5 years	5-10 years	10-15 years
Small-scale, short-term technology			
Agro-forestry			
Establishing agro-forestry extension taskforces	X		
Raising public awareness on natural resources protection	X		
Facilitating investment on development	X	X	
Land-use planning for agro-forestry in mountainous regions	X		
Developing and implementing sustainable agro-forestry modal	X		X
Developing system for product distribution and consumption		X	
Capacity building for agro-forestry extension officials	X		
Bilateral and multilateral cooperation	X	X	

Note: This is a small-scale and short term technology with implementation time less than 5 years but hold position number 1 for priority, which means it need to implement immediately. Therefore strategic time for this technology is around 10 years back

2.4.2.2 Brief summary of project ideas for international support (Annex 3)

2.5 Summary

With wide diverse arrays of biological organisms, Vietnam's research on the application of biotechnology to increase plant production based on the existing gene pool for agricultural, forestry, fishery production and germ plasm conservation to enhance the quality of biological products has been the key direction of Vietnam's biological technology in recent years. However, despite the large investment, Vietnam's biotechnology still lags far behind other countries in the region and in the world. It has yet been able to meet the demand for socio-economic development or create key products for the national economy. To diffuse this technology, in addition to these above measures, there is a need for a biotechnology center functioning as a coordinator between research institutes, production facilities, marketing agencies, etc. Besides, more investment should be placed on research by business sector to support the application of research ideas into production.

Agro-forestry is one the most effective measures that MARD has been specifically interested in developing in the future. Several barriers, however, need to be addressed in order for the development of this technology as follows:

Land management: Land planning should put an emphasis on agro-forestry planning to the commune level; planning must be long-term to encourage people to invest on the technology.

Research and development of biotechniques: Search for soil improvement and sustainable cultivation methods on different eco-regions, find suitable agro-forestry modals for poor people.

Incentive policies (agro-forestry extension, etc.) must prioritize remote areas, extremely poor areas, integrate into other projects, programs to maximize the effectiveness of agro-forestry, or provide loans for production.

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Agro-forestry market: apply the market analysis and development (MA&D) method for each product; establish efficient markets, create a market information system for products in the mountains.

Chapter 3. Technology Action Plan For Water Resources

In Part A, the technologies that are capable of adapting to climate change in the field of water resources are taken into account before they were scored and evaluated for selection of the most preferred technologies. The table below shows arranged technologies in order of priority.

Table 42 - List of the technologies and their assessment to adapt to climate change in selected priority areas of water resources

Availability/Scale	Technology	Adaptive potential of about 20 years	Assessment scores (MCDA)	Estimated investment costs for technology
Short term / small scale	Collecting rainwater from roofs for their daily needs	Medium	60.40	200 US$/family (rural area)
Short / small and medium scale	Rainwater collection to reserve for the community	Medium	55.56	270 US$/m3 (concrete reservoir)
Medium and short term / large scale	Management of river basins	High	54.82	N/A

3.1 Preliminary targets for technology transfer and diffusion

The identification of objectives and milestones for the field of water resources is the same as described in Chapter Agriculture (Section 1.1)

3.1.1 Reaffirmation of targets for technology transfer and diffusion

a) General targets [*]

Strengthen human resilience and natural system adaptive capacity to climate change in order to safeguard and enhance people's life quality, ensure water availability and water sustainable development.

Accelerate national sustainable development in the light of global climate change and join forces with international community to protect and stabilize the climate balance on a global scale.

b) Specific objectives [**]

Prioritize water resources management adaptation technologies to ensure water security, social security, alleviate poverty, protect public health, enhance quality of life, and protect water sources in the context of climate change.

3.1.2 Establishing milestones to accomplish technology development targets [**]

a) National milestones in water resources management

By 2015: Review policies and mechanisms on water use management based on river basins; accelerate research on application of advanced water storage and water saving technologies.

[*] Decision No.2139/QD-TTg dated 05 Dec, 2011 of Prime Minister on acceptance of National Strategy on Climate change.

[**] Decision No.81/QD-TTg dated 14 Apr, 2006 of Prime Minister on acceptance of National Strategy on Water resources to 2020.

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By 2020: Provide guidelines on IBRM; establish and initiate river basin committees; implement water storage and water saving technologies in the framework of IBRM to serve sustainable development and climate change adaptation.

b) Milestones for priority technologies in water resources management

Rooftop rainfall harvesting for household usage

By 2015: Implement skills training and education, raise public awareness on benefits and techniques for harvesting, storing and using rainwater; monitor rainwater quality; investigate potential areas for technology application; pilot the technology in potential areas.

By 2020: Diffuse the technology on a large scale in areas with high risks of water shortage.

Harvesting runoff water

By 2015: Investigate hydrometeorological and geological conditions of potential areas for runoff water harvesting; study which technologies are feasible; pilot the technologies in potential areas.

By 2020: Diffuse this technology on a large scale in areas with high risks of water shortage.

Integrate River Basin Management (IBRM)

By 2015: Implement skills training and education, raise public awareness on benefits of IBRM; issue guidelines on management and use of water sources in a river basin that are compatible with the technology; capacity building and training.

By 2020: Apply this technology to certain basins.

3.2 Barrier analysis

The review process and identifying barriers are as similar as described in the Agriculture sector (Section 1.2). The technological barriers in the field of water resources are described in detail below.

3.2.1 Barrier identification and analysis for rooftop rainfall harvesting for household usage

a) Social and economic barriers

- Investment costs are too high for poor people or people in remote areas.

b) Technical barriers

- Rooftop materials, and house and roof designs are not suitable for harvesting rainfall water.

- Lack of space for rainfall storage in urban areas.

c) Environmental barriers

- Rainwater quality can be affected by air pollution

3.2.2 Barrier identification and analysis for runoff water harvesting

a) Social and economic barriers

- Possible conflicts between communities on water access rights.

- High capital costs for large-scale harvesting projects to build large reservoirs, public tanks, channels, which may exceed local capacity.

b) Technical barrier

- Hard to indentify the suitable site and scale of rainwater reservoirs or tanks.

c) Environmental barriers

- Possible negative environmental impacts in the downstream of reservoirs.

- Risk of disease outbreaks among people and cattle due to using the same water source.

3.2.3 Barrier identification and analysis for IBRM

a) Social and economic barriers

- Ineffective coordination mechanism between provinces and sectors, risk of conflicts in water use.

- Lack of awareness on water scarcity.

b) Technical barriers

- Requiring adequate information on water resources and environmental conditions of a river basin and sufficient rules on information sharing.

- Requiring rules and regulations on the river basin management committee modality.

3.2.4 Linkages of the barriers identified

Similar to Chapter 1, the linking and aggregation of the common barriers across the technologies of the sector helped to minimize overlaps and ensure that the process would flow smoothly, as shown in Table 43.

Table 43 - Common barriers and inefficiencies identified for technologies

Market linkage	
	No technology transfer network
	High technology transfer fees, while old technologies are cheaper and more available
	Lack of consideration for externalities such as environmental or social factors in calculating technology transfer costs
Enabling environment	
	Weak incentive policies for deployment and diffusion of new technologies
	Lack of rules, standards and implementation
	Appraisal and approval procedures are usually complicated, even not suitable
	Project locations are usually poor urban areas or hard-off rural areas
	Lack of incentives
Support actions	
	Lack of support for research and development
	Lack of information
	Limited project management capacity
	Limited local capacity to fill the expertise gaps
	Requiring financial mechanisms compatible with new or small-scale technologies compensate risks associated with new technologies

3.3 Enabling framework for overcoming the barriers

The buidling of a framework to overcome the technological barriers in the field of water resources is the same as described in Chapter Agriculture, Section 1.3. Below here is the framework to overcome the barriers for each technology.

3.3.1 Possible solutions to address the barriers for the transfer and diffusion of rooftop rainfall harvesting for household usage

3.3.1.1. Measures to support the creation of a stakeholder network for the development and transfer of the technology

Measure 1: Develop a network of technical experts

3.3.1.2. Actions to improve policies and creating measures for technology development and transfer

Measure 1: Develop support policies to encourage local deployment of the technology

3.3.1.3. Measures to strengthen functioning of organizations and institutions

Measure 1: Change water use behaviors

3.3.1.4. Measures to strengthen market, system support and financial services

Measure 1: Investigate climate and rainfall patterns, rainwater quality in target areas

Measure 2: Promote the technology and assess market potential

3.3.1.5. Measures to support skills training and education for technology development and transfer

Measure 1: Mainstream into the official educational program

3.3.2 Possible solutions to address the barriers for the transfer and diffusion of runoff water harvesting

3.3.2.1. Measures to support the creation of a stakeholder network for the development and transfer of the technology

Measure 1: Establish focal agencies

Measure 2: Develop a network of technical experts

3.3.2.2. Actions to improve policies and creating measures for technology development and transfer

Measure 1: Develop support policies to encourage local deployment of the technology

3.3.2.3. Measures to strengthen functioning of organizations and institutions

Measure 1: Strengthen capacity for water management, operation, protection and salinization

Measure 2: Issue rules on household water use

3.3.2.4. Measures to support skills training and education for technology development and transfer

Measure 1: Raise public awareness

3.3.3 Possible solutions to address the barriers for the transfer and diffusion of IRBM

3.3.3.1. Measures to support the creation of a stakeholder network for the development and transfer of the technology

Measure 1: Assign focal points for IRBM

Measure 2: Develop a network of experts

3.3.3.2. Actions to improve policies and creating measures for technology development and transfer

Measure 1: Integrate the technology into planning and development program at river basins.

3.3.3.3. Measures to strengthen functioning of organizations and institutions

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Measure 1: Change to management practices based on river basins.

Measure 2: Develop rules and regulations for coordination between organizations and localities

3.3.3.4. Measures to strengthen market, system support and financial services

Measure 1: Investigate environmental and socio-economic conditions in target river basins

Measure 2: Introduce IRBM modals that are currently used in the world

3.3.3.5. Measures to support skills training and education for technology development and transfer

Measure 1: International cooperation/International consultant/Overseas staff training

3.3.4 Recommended solutions for water resources management

It can be seen that in long, medium and short terms, priority technologies for water resources management need further research, development, innovation and modernization. This is a very urgent matter which requires a scientific approach.

In addition, international cooperation needs to be facilitated to strengthen management capacity and deploy world advanced technologies.

Continue to invest in high-quality human training, ensure human resources in short, medium and long terms. Science institutions and advisory experts advise the Government on making support policies for development and application of advanced technologies for better management of water resources.

3.4 Technology action plan, project ideas, and other issues in water resources management

3.4.1 Rooftop rainfall harvesting for household usage

3.4.1.1 Technology action plan for rooftop rainfall harvesting for household usage

a) Aggregation and rationalization of measures identified for technology acceleration

Similar to the above section, the list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table 44.

Table 44 - Aggregation for strategy formulation

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Creation of expert networks			
Developing a network of technical experts	X	X	X
Policies and measures			
Support policies for local deployment of the technology	X		
Organizational/behavioral change			
Change in water use behaviors	X	X	X
Market support actions			
Detailed Investigation of climate and rainfall patterns, rainwater quality in target areas	X	X	X

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Promoting technology and assess market potential	X	X	X
Skills training and education			
Mainstreaming into the official educational program	X	XX	XX

* Note: see Note under Table 25

b) Prioritization and characterization of technology acceleration measures for a national plan

Similar to the section above, the list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table 45.

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Table 45 - Prioritization and characterization of technology acceleration measures

Sector: Water resources management							
Specific Technology and category: Rooftop rainfall harvesting for household usage/Small scale, short-term							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
Creation of networks							
Developing a network of technical experts	1	Provides technical support for household in applying the technology	MOC; local People's Committees	Create a network of local experts Organize training course on technology application	2 years	MOC, MARD	38
Policies and Measures							
Support policies for local deployment of the technology	1	Initial supports for poor people or remote areas are needed Encourage deployment of technology in a larger scale	MOF, MARD	Develop and implement support policies for new technology development Create support funds	2 years	MOF, MARD	10
Organizational/behavioral change							
Change in water use behaviors	2	Urban residents do not have the habit of using rainwater or using water efficiently Freshwater becomes scarcer Helps reducing inundation in urban	TTTT, MONRE	Organize awareness raising campaigns for public communities. Organize workshops, meetings.	2 years	MONRE	5

		areas					
Market support actions							
Detailed Investigation of climate and rainfall patterns, rainwater quality in target areas	1	Develops a database to ensure feasibility and improve efficiency of technology	MONRE, MOC	Identify potential locations for the technology Investigate and collect rainfall data and conditions for technology application	3 years	MONRE	29
Promoting technology and assess market potential	2	Creates an enabling environment for technology	MONRE, media agencies	Organize technology exhibitions Organize awareness raising campaigns	2 years	MONRE, MOC	29
Skills training and education							
Mainstreaming into the official educational program	3	Helps to raise awareness on water saving and efficiency	MOET, MONRE	Prepare teaching materials Mainstream into official educational programs	5 years	MOET, MONRE	24

* Note: See not under Table 26

c) Finalizing national strategy

Based on the results of the technology action plan for each sub-sector, the national strategy and action plan to achieve the milestones for each period for rooftop rainfall harvesting for household usage are described in Table 46.

Table 46 - National Strategy (technology transfer and development for adaptation)

	0-5 years	5-10 years	10-15 years
Small-scale, short-term technology			
Rooftop rainfall harvesting for household usage			
Developing a network of technical experts	X		
Support policies for local deployment of the technology	X		
Change in water use behaviors		X	
Detailed Investigation of climate and rainfall patterns, rainwater quality in target areas	X		
Promoting technology and assess market potential		X	
Mainstreaming into the official educational program		X	

3.4.1.2 Brief summary of project ideas for international support (Annex 3)

3.4.2 Runoff water harvesting

3.4.2.1 Technology action plan runoff water harvesting

a) Aggregation and rationalization of measures identified for technology acceleration

Similar to the above section, the list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table 47.

Table 47 - Aggregation for strategy formulation

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Creation of expert networks			
Establishing focal agencies	X	X	XX
Developing a network of technical experts	X	XX	XX
Policies and measures			
Support policies to encourage local deployment of the technology	X	X	X
Organizational/behavioral change			
Capacity building for water management, operation, protection and salinization	X	X	X
Issuance of rules on household water use	X	XX	XX

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Skills training and education			
Public awareness raising	X	XXX	XXX

*Note: see Note under Table 25

b) Prioritization and characterization of technology acceleration measures for a national plan

Similar to the section above, the list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table 48.

Table 48 - Prioritization and characterization of technology acceleration measures for a national plan

Sector: Water resources management							
Specific Technology and category: Runoff water harvesting/Medium scale, short-term							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
Creation of expert networks							
Establishing focal points	1	There is need to rationalize and strengthen the role of organizations in the network Management and operation in localities should be coordinated	MOHA MARD Local People's Committee	Review functions of relevant organizations Establish focal points	2 years	MONRE MARD	5
Developing a network of technical experts	1	Provides technical support for local deployment of technology	MARD local People's Committee	Create a network of local experts Organize training courses on technology application	2 years	MONRE MARD	48
Policies and measures							
Support policies to encourage local deployment of the technology	1	Initial supports for poor people or people in remote areas are needed Provides encourage deployment of technology in a larger scale	MOF, MARD	Develop and implement support policies for new technology development Create support funds	2 years	MOF, MARD	10

Organizational/behavioral change							
Capacity building for water management, operation, protection and salinization	2	Ensure water sanitation and quality Water saving and efficiency	MONRE, MARD, local People's Committee	Organise training and workshops on management skills and experience sharing	3 years	MONRE MARD	14
Issuance of rules on household water use	2	Reduces conflicts in water use Ensures water efficient use and water quality	MONRE, MARD, local People's Committee	Consult with stakeholders Develop appropriate regulations Develop and implement regulations	2 years	MONRE MARD	5
Skills training and education							
Public awareness raising	2	Helps to diversify sources of water Enhances public community on efficient use of water	TTTT, MONRE, MARD, local People's Committee	Develop materials and programs for awareness raising Organize training courses to raise awareness	3 years	TTTT MONRE	43

* Note: (1): See Note under Table 26

c) Finalizing national strategy

Based on the results of the technology action plan for each sub-sector, the national strategy and action plan to achieve the milestones for each period in runoff water harvesting are described in Table 49.

Table 49 - National Strategy (technology transfer and development for adaptation)

	0-5 years	5-10 years	10-15 years
Small- and medium-scale, short-term technology			
Runoff water harvesting			
Establishing focal points	X		
Developing a network of technical experts	X		
Support policies to encourage local deployment of the technology	X		
Capacity building for water management, operation, protection and salinization	X	X	
Issuance of rules on household water use	X	X	
Public awareness raising	X	X	

3.4.2.2 Brief summary of project ideas for international support (Annex 3)

3.4.3 Integrated river basin management

3.4.3.1 Technology action plan for integrated river basin management (IBRM)

a) Aggregation and rationalization of measures identified for technology acceleration

Similar to the above section, the list of measures identified for formulation of a national strategy to accelerate the development and transfer of integrated river basin management can be seen in Table 50.

Table 50 - Aggregation for strategy formulation

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Creation of networks			
Assigning focal points for IRBM	X		
Developing an expert network	X	X	X
Policies and measures			
Integration into planning and development program at river	X	X	
Organizational/behavioral change			
Change to basin-based management practices	X	X	X
Developing rules and regulations for coordination between organizations and localities	X	X	X

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Market support actions			
Investigating environmental and socio-economic conditions in target river basins	X	X	X
Introducing successful IRBM modals	X	X	
Skills training and education			
International cooperation/International consultant/Overseas staff training	XX	XXX	XXX

* Note: see Note under Table 25

b) Prioritization and characterization of technology acceleration measures for a national plan

Similar to sections above, the list of measures identified for the acceleration of technologies and the innovation stage structured under the core elements of a national strategy are identified and aggregated in Table 51 below.

Table 51 - Prioritization and characterization of technology acceleration measures

Sector: Water resources management							
Specific Technology and category: Integrated River Basin Management/Large scale, medium- and short-term							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
Creation of networks							
Assigning focal points for IRBM	1	Facilitates uniform basin-wide socio-economic management Ensures water efficiency Improves monitoring	MOHA MONRE MARD	Review functions of relevant organizations Establish a focal point Determine the role of the focal point	2 years	MOHA, MONRE MARD	14
Developing an expert network	1	Interdisciplinary experts are needed Ensures effective application of technology Provides technical support for focal agencies	MONRE MARD	Create a network of experts from related research and management institutes Conduct training courses on technology deployment	2 years	MONRE MARD	29
Policies and measure							
Integration into planning and development program at river	1	Facilitates technology deployment Serves sustainable development	MPI MONRE	Review planning and socio-economic development programs in river basins Develop mainstreaming plan	3 years	MPI MONRE	29

			MARD	Integrate into programs and action plans of sectors and localities		MARD	
Organizational/behavioral change							
Change to basin-based management practices	1	Facilitates uniform basin-wide water management Helps to address limitations of administrative unit management of water resources	MONRE	Organize training courses on new management practices for managers	3 years	MONRE	29
Developing rules and regulations for coordination between organiztions and localities	2	Helps to avoid conflicts in water use Facilitates technology application	MONRE MARD MOIT Local People's Committee	Consult with stakeholders Develop appropriate regulations Develop and implement rules	3 years	GoV, MONRE	29
Market support actions							
Investigating environmental and socio-economic conditions in target river basins	2	Develops a database to ensure feasibility and improve efficiency of technology	MONRE MARD	Identify and choose typical river basins for technology application Investigate and gather data on natural and socio-economic conditions of the chosen locations	3 years	MONRE	29
Introducing succesful IRBM modals	2	Creates an environment for technology development and opportunities for cooperation between stakeholders	MONRE, media agencies	Introductory workshops on IRBM modals in the world Assess benefits of technology application in each basin	5 years	MONRE	48

Skills training and education							
International cooperation/International consultant/Overseas staff training	2	Helps to take advantage international experience, develop human resources, accelerate technology transfer and diffusion	MONRE MOET VAST	Develop international cooperation projects Organize training courses with participation of international experts	5 years	MONRE	72

* Note: (1) See note under Table 26

c) Finalizing national strategy

Based on the results of the technology action plan for each sub-sector, the national strategy and action plan to achieve the milestones for each period in IRBM are described in Table 52

Table 52 - National Strategy (technology transfer and development for adaptation)

	0-5 years	5-10 years	10-15 years
Large-scale, medium and short term technology			
River basin integrated management			
Assigning focal points for IRBM	X		
Developing an expert network	X		
Change to basin-based management practices	X		
Developing rules and regulations for coordination between organizations and localities		X	
Investigating environmental and socio-economic conditions in target river basins	X	X	
Introducing successful IRBM modals	X	X	
Introducing successful IRBM modals	X	X	
International cooperation/International consultant/Overseas staff training	X	X	

3.4.3.2 Brief summary of project ideas for international support (Annex 3)

3.5 Summary

The national technology action plan for water resources management will follow the following road map:

From now to 2025: Continue assessing potential for technology application as well as Vietnam's circumstances. Facilitate international cooperation in experience and knowledge sharing in management, especially between countries with the same level of development as Vietnam. Build human capacity development plans for operation of newly transferred technologies. Research how to apply water resources management technologies and pilot several technologies in certain areas to see how efficient it can be. Continue to develop and adapt the technology. Develop appropriate support policies and mechanisms for research of priority water resources management technologies. Develop guidelines on technical requirements and mandatory procedures for relevant projects.

Post-2025: Develop and deploy feasible priority technologies that are suitable to Vietnam's water resources management. Complete the application of modern, automated technologies in water resources management.

Chapter 4. Action Plans for Integrated Coastal Zone Management (ICZM)

In Part A, the technologies that are capable of adapting to climate change in the field of ICZM are taken into account before they were scored and evaluated to select as the most preferred technology. The table below shows arranged technologies in order of priority.

Table 53 - List of the technologies and their assessment to adapt to climate change in selected priority areas of ICZM

Availability/Scale	Technology	Adaptive potential of about 20 years	Assessment scores (MCDA)	Estimated investment costs for technology
Short term / large scale	Sea dyke	High	55.20	Upgrade: $ 1.5 million / km Refresh: $ 5 million / km
Short and medium term/ large scale	Wetland rehabilitation	High	54.90	Care: 41 USD / ha / year

4.1 The basic objectives in the development and demonstration of technology

The identification of objectives and milestones for the field of ICZM is the same as described in Chapter Agriculture (Section 1.1)

4.1.1 To reconfirm the objectives in the development and demonstration of technology [*]

a) General objectives

By 2020, the prioritized technologies for sectors should gradually be approach with the world level; increasing capacity and training of research staffs, skillful and professional managers; development and transfer technology; strengthening the construction system to ensure the socio-economic objectives of development and ecological environmental protection in coastal areas.

b) Specific objectives

Modernizing the management, design, construction and operation of coastal infrastructure at the world and regional level.

Gradually upgrading of degraded dikes, restoring coastal wetlands, enhancing the development of flood warning systems and capacity for integrated management of coastal zones management.

4.1.2 Construction of intermediate milestones to achieve the goal of technology development [*]

a) Building up land-markers for national ICZM

By 2015, in coastal areas nationwide, reviewing development plans suitable with adaptation; promoting research and application of technology for adaptation; raising awareness among community about the ICZM and sustainable development.

By 2020, issuing specific guidelines on ICZM, integrated adaptation technologies on ICZM plans for some key economic areas.

b) Building up land-markers for prioritized technologies of ICZM

Sea-dike technology

By 2015, reviewing existing sea-dike system available to adapt to sea level rise, surveying new construction project of sea-dike; researching and applying in the construction of sea-dike with advanced techniques; overall assessment the sustainability and benefits of the sea-dike projects.

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By 2020, strengthening and upgrading dike systems to meet the conditions of adaptation to climate change; implementing a number of new projects.

Technology of recovering coastal wet lands

By 2015, surveying the meteorological, geological and ecological conditions, environment of the areas that are applicable for recover technologies; researching appropriate technologies.

By 2020, applying advanced technologies for a number of important wetlands.

4.2 Analyzing the barriers

The review process and identifying barriers are as similar as described in the Agriculture sector (Section 1.2). The technological barriers in the field of ICZM are described in detail below.

4.2.1 Identifying and analyzing the barriers for transfer and demonstration of sea-dikes technology

a) Social-economic barriers

- Blocking the views, which reduces the value of the coastal tourism landscape.

- Requiring high initial investment and regular maintenance costs.

b) Technological Barriers

- Lack of long-term monitoring data on natural conditions, information on the impacts of sea-dikes to environment, ecology, socio-economy.

- Having difficulty in selecting appropriate design.

- Occupying a large area of space, which causes the response of local communities.

c) Environmental barriers

- Changing the ocean dynamics and shoreline.

- Creating negative impacts to the coastal ecosystem and the adjacent waters.

4.2.2 Identifying and analyzing barriers for transfer and demonstration of recovery technologies in coastal wetlands

a) Social-economic barriers

- High initial investment costs.

b) Technological Barriers

- Space requirement easily leads to conflicts of land use purposes.

c) Environmental barriers

- Restrictions on the community's awareness about the benefits of the wetland ecosystem.

4.2.3 The link among identified barriers

As described in Chapter 1, summary of the common barriers of technology in the field to minimize duplication and ensure coherence are presented in Table 54.

[*] Decision No.2139/QD-TTg dated 05 Dec, 2011 of Prime Minister on acceptance of National Strategy on Climate change.

Table 54 - The obstacles and general inefficiency of the identified technologies

Market chains	
	Lack of technology transfer network
	Lack of information on stakeholders and large projects as well as relation with external partners.
	The cost of new technologies is usually high. In addition, the older technology is cheaper and more available.
	When changing technologies there is often lack of the units accounting for external factors such as environment and society.
	It is required to have unfamiliar technologies tests and adaptation to economic conditions, social and local environment.
Available Environment	
	The encouraging policies on the application of new technologies often poorly synchronized and not strong enough.
	Lack of rules, standards and enforcement.
	Such processes as approval, license often complicated and sometimes inappropriate.
	Poor technical infrastructure.
	Lack of incentives.
The support services	
	Lack of support for research and development (R & D).
	Lack of information.
	Lack of ability to operate effectively project.
	Local capacity to fill the gap in expertise is limited.
	Having difficulties in language and culture support.
	Appropriate finance for new and small-scale technologies as well as compensation for the associated risks.

4.3 The framework to overcome the barriers

The building of a framework to overcome the technological barriers in the field of ICZM is the same as described in Chapter Agriculture, Section 1.3. Below here is the framework to overcome the barriers for each technology.

4.3.1 The available measures for overcoming the barriers of sea-dike technology

4.3.1.1. To identify measures that support development and transfer of technology by creating network of experts

Measure 1: To review, restructure and support the current network management;

Measure 2: To develop and expand the network of experts.

4.3.1.2. To identify actions to improve policies and measures for development and transfer of technology

Measure 1: To develop policies to support local technology application;

Measure 2: To test, evaluate and verify policies.

4.3.1.3. To identify measures to strengthen the operation of institutions and institutional

Measure 1: To increase management capacity;

Measure 2: To promulgate rules and regulations of coordination among agencies;

4.3.1.4. To determine measures to promote support systems and other financial services

Measure 1: To survey hydrological, geology and geomorphology conditions in the selected area.

4.3.1.5. To identify measures to support education and training skills for the development and transfer of technology

Measure 1: To training technology experts as supplement.

4.3.1.6. To identify measures to facilitate possible international cooperation and agreements on intellectual property rights (IPR)

Measure 1: International cooperation in training and transfer of technology.

4.3.2 Identified measures for overcoming the technological barriers in order to recover coastal wetlands

4.3.2.1. To identify measures that support development and transfer of technology by creating network of experts

Measure 1: To build and develop a network of experts.

4.3.2.2. To identify actions to improve policies and measures for development and transfer of technology

Measure 1: To develop policies to support and encourage research, testing and application of technology.

4.3.2.3. To identify measures to strengthen the capacity of organizations and institutions

Measure 1: To increase management capacity;

Measure 2: To promulgate rules and regulations of coordination among agencies.

4.3.2.4. To identify measures to support education and training skills for the development and transfer of technology

Measure 1: International cooperation, additional training of technical experts.

4.3.3 Recommendations for technologies in the field of ICZM

It can be seen that in the short, medium and long term, the prioritized technologies of ICZM need constructing, upgrading and modernizing step by step at first. These are extremely urgent tasks which required details and sciences. Besides, the promotion of international cooperation should be further promoted to enhance the management capacity, as well as absorb the advanced technology in the world. It is necessary to have continuous investment in training high-quality human resources in order to ensure potential knowledge in the short, medium and long term. The research units and the experts are responsible for consulting the State about the formulation of policies and legal framework, which will support the development and application of advanced science and technology for effectively ICZM.

4.4 Action plans, project proposals and other issues in the field of ICZM

4.4.1 Sea-dike technology

4.4.1.1 Action Plan for sea-dike technology

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a) Synthesis and rationalization the identified measures to promote technology

The list of measures to promote the development and transfer of technology have been compiled as a national strategy and integrated into the overall Table 55.

Table 55 - List of measures for building strategies

Strategic strategy	Innovation	Deployment	Demonstration
Establishment of networks			
Reviewing, restructuring and supporting the current network management	X	X	X
Building and developing network of experts	XX	X	X
Policies and measures			
Developing policies to support local technology application	X	X	X
Testing and evaluation policies	X	XX	XX
Change behavior / organization			
Strengthening management capacity	X	XX	XX
Promulgating rules and regulations of coordination among agencies	X	XX	XX
Actions to support market			
Surveying and hydrological, geology and geomorphology conditions in selected area	X	X	X
Skills training and education			
Additional training of technology experts	XX	XXX	XXX
International cooperation and intellectual property right			
International cooperation in training and transfer technology	X	XX	XX

* Note: The indicate symbols is similar to Table 25.

b) Prioritization and characterization of the measures to promote technology

The review process in detail by is described in Table 56 below.

Table 56 - Prioritization and characterization of the measures to promote technology

ICZM							
Specific technologies and categories: Sea-dike technology/Large scale, short and medium-term							
Stage innovation: Research - Deployment							
Measures (grouped by core elements)	**Prio-rity**	**Why is it important?**	**Who should do?**	**How?**	**Time-scale**	**Monitoring, reporting and verification measures**	**Estimated costs (1,000 USD)**
The establishment of networks							
To Review, restructure and support the current network management	1	To rationalize and promote the effective role of the existing network.	MARD MOHA	-To review the functions and tasks, competency assessment, restructure in the direction of depth. -To strengthen the capacity of existing networks.	2 year	MARD MOHA	10
Building and development network of experts	2	Technical assistance, building capacity of management and applying technology.	MARD People Committee of provinces	-Creating a network of experts. -Provide management and technical training.	5 year	MARD	48
Policies and measures							
Develop policies to support local technology application	1	-Policies should be locally appropriate. - Expanding the scope of application of technology.	MOF, MARD	-To develop and promulgate policies to promote the technologies. -To establish fund to support.	2 year	MOF, MARD	10
Testing, evaluating and verifying policies.	3	Increase the effectiveness of policies, timely adjustments for real.	MARD	-To check out the reviews. -To organize the workshop on the effectiveness and limitations of the policies	5 year	MARD	24

				issued. -To propose amendment.			
Change behavior / organization							
Strengthening management capacity	2	-The task-force to manage sea-dike is few. -The management level is still limited.	MARD	-To establish of additional coastal task-forces for sea-dike system. -To organize training management skills.	3 year	MARD	22
Promulgating rules and regulations of coordination among agencies	3	-To create consistency in management. -To facilitate the development of technology.	MARD	-To consult with stakeholders. -To develop appropriate regulations. -To promulgate and implement regulations	3 year	MARD	14
Actions to support market							
To survey and hydrological, geology and geomorphology conditions in selected areas	1	To create a full database and ensure the viability and improve the efficiency of applied technology.	MARD	-To identify and select potential areas to apply technologies. -To survey and collect hydrographic, geological, geomorphological conditions to apply technologies.	3 year	MARD	144
Skills training and education							
Supplement training of technical experts	3	-To ensure the process of technological innovation. -To create an important premise for the dissemination of technology	MARD MOET	-To evaluate the current capacity of expert. -To develop training programs. -To provide training.	5 year	MARD MOET	48
International cooperation and intellectual property							
International cooperation in training and technology transfer	1	Take advantage of international experience in human resource development, promoting technology transfer.	MARD	-To construct projects of international cooperation capacity building and technology transfer. -To train organizations with the participation of foreign experts.	5 year	MARD	72

* Notes: (1) The priority is similar to Table 26

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c) Completion of the National Strategy

The results of each priority technology for sub-domains obtained after the action plans were built will serve as a basis for the National Strategy and Action Plan on the sea-dike. Details are described in Table 57.

Table 57 - National Strategy (For the transformation and development of technologies aimed to adapt)

	0-5 year	5-10 year	10-15 year
Large-scale technology – medium and short-term			
Sea-dike technology			
Reviewing, restructuring and supporting the current management network	X		
Building and developing network of experts	X	X	
Developing policies to support local technology application	X		
Testing, evaluating and verifying policies	X	X	
Strengthening the management capacity	X	X	
Promulgating rules and regulations of coordination among agencies		X	
Surveying hydrological, geology and geomorphology conditions of the selected areas	X		
Additional training of technical experts	X	X	
International cooperation in training and technology transfer	X	X	

4.4.1.2 Brief summary of the project idea which has international support (Annex 3)

4.4.2 Recovery Technology of coastal wetlands

4.4.2.1 Action Plan on recovery technology for coastal wetlands

a) Synthesis and rationalization of identified measures to promote technology

The list of measures to promote the development and transfer of technology has been gathered to compile a national strategy and was integrated in Table 58.

Table 58 - Gather measures for building strategies

Strategic measures	Innovation	Deployment	Demonstration
Establishment of networks			
Building and developing a network of experts	X	XX	XX
Policies and measures			
Developing policies to support and encourage research, testing and application of technology	X	X	X
Change behavior / organization			

Strengthening management capacity	X	XX	XX
Promulgating rules and regulations of coordination among agencies	X	XX	XXX
Skills training and education			
International cooperation, additional training of technical experts	X	XXX	XXX

* Note: The indicate symbols is similar to Table 25.

b) Prioritization and characterization of the measures to promote technology

The review processes in detail of prioritized measures are described in Table 59 below.

Table 59 - Prioritization and characterization of the measures to promote technology

ICZM							
Specific technologies and categories: Restoration of coastal wetlands/Large scale, short and medium-term							
Stage innovation: Research - Deployment							
Measures (grouped by core elements)	**Prio -rity**	**Why is it important?**	**Who should do?**	**How?**	**Time-scale**	**Monitoring, reporting and verification measures**	**Estimated costs (1,000 USD)**
The establishment of networks							
Building and developing a network of experts	2	Technical assistance and building management capacity for localities to apply technology.	MONRE MARD Local People's Committee	-To build a network of experts. -To provide management and technical training about technology application.	5 year	MONRE MARD	48
Policies and measures							
Developing policies to support and encourage research, testing and application of technology	1	-Policies are needed to encourage appropriate support for each type of wetland to be restored. -Expanding the scope of application of technology.	MOF, MARD	-To develop and promulgate policies to support the promotion of technology. -To create fund for support.	2 year	MOF, MARD	10
Change behavior / organization							
Strengthening management capacity	2	-To manage experience and use of wetlands lacking. -There is lack of specialized units	MONRE MARD	-To establish specialized units, and supplement management force. -To organize training of management skills.	5 year	MONRE	24

To promulgate rules and regulations of coordination among agencies	3	-To create consistency in management. -To facilitate the development of technology.	MONRE MARD	-To consult with stakeholders. -To develop appropriate regulations. -To promulgate and implement regulations	3 year	MONRE	14
Skills training and education							
International cooperation, supplement training of technical experts	2	-To take advantage of international experience. -To ensure the process of technological innovation. -To create an important premise for the dissemination of technology	MONRE MOET	-To evaluate of the current expert capacity. -To develop training programs. -To provide training.	5 year	MONRE MOET	48

* Notes: (1) The priority is similar to Table 26

c) Completion of the National Strategy

The results of each priority technology for sub-domains obtained after the action plans were built will serve as a basis for the National Strategy and Action Plan on the recovery of coastal wetlands. Details are described in Table 60.

Table 60 - National Strategy (for the transformation and development of technology aimed at adapt)

	0-5 year	5-10 year	10-15 year
Large-scale technology - medium and short-term			
Recover of coastal wetlands			
Building and developing a network of experts	X	X	
Developing policies to support and encourage research, testing and application of technology	X		
Strengthening management capacity	X	X	
Promulgating rules and regulations of coordination among agencies		X	
International cooperation, additional training of technical experts	X	X	

4.4.2.2 Brief summary of the project idea which has international support (Annex 3)

4.5 Summary

The national Action Plan for the prioritized technologies related to roadmap development for ICZM has its preliminary application as follows by 2025:

- Continuing the evaluation of the potential application of technology as well as understand the conditions of Vietnam;
- Promoting international cooperation in exchanging experience and technical management, especially in countries with conditions and the level of development similar to Vietnam;
- Developing a team of highly qualified staffs that are ready to control and operate the complete technology transfer;
- Research technologies for ICZM, testing those technologies in several pilot locations and checking the results obtained;
- Continuing to study and complete and innovative technology to meet the conditions of Vietnam;
- Construction of sanctions, appropriate policies in support of prioritized technologies for ICZM in Vietnam;
- Develop guidance on technical requirements and required procedures for the related projects.

From 2025 onwards:

- Developing and applying prioritized technologies with suitable ICZM conditions for demonstration;
- Improving the application of technologies at high level of modernization and automatic.

PART III

Cross-cutting issues for the National TNA and TAPs

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Part B of action plans for adaptation technology has listed measures to overcome the barriers of adaptation technologies for each sector. Among these measures, there may be some common measures for the development of technology. For example, a method is not only for developing these technologies but also solving barriers for other technologies. Such measures have similarity as well as generally advantageous for technological development.

However, the implementation of one activity could lead to prevent other solutions. For example, an action is in place to implement a technology development may not be strict to that technology itself, but is important for several other technologies. Similarly, a number of actions to address barriers to technology can have a negative effect to the transfer and deployment of other technologies. This also should be reviewed and made recommendations in order to limit the negative impact of such actions.

The Steering Committee has conducted focus group discussions with core experts and stakeholders in order to point out the similarity measure, popularity or has the potentiality to become each other's barrier.

Following are the aggregate results by analyzing popularity / relevance of the measures as well as pointing out the possible conflict among them.

I. The measures to overcome common barriers in sectors

1.1 Agricultural sector

The aggregated measures which are popular / similar in the agricultural sector are summarized in Table 61

Table 61 - Popular / similar measures which become repair to agricultural technological barriers

Group of measures	These measures to overcome barriers for each technology			Common measures to overcome barriers of technologies
	Genetic Technology	Rice land into dry land crop	Switch from 3 rice to 2 rice + shrimp / fish / duck	
The network setup		To establish network of specialist agronomy, irrigation, industrial crops and fruit trees	To establish a network of experts in agriculture, aquaculture, plant protection, animal husbandry and veterinary	To establish network of experts
Policies and measures	To develop policies to support basic research and long-term		To develop policies to encourage the application of technology.	To develop policies to encourage, support
		To identify areas to be converted	To identify areas to be converted	To identify areas to be converted
	To develop pilot program of applied research results To consolidate and establish a national key center			

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Change behavior / organization		To strengthen Central and local government's direction	To strengthen Central and local government's direction	To strengthen Central and local government's direction
		Capacity building of extension agencies on climate change	Capacity building of extension agencies on climate change	Capacity building of extension agencies on climate change
	To support organizations and experts in technology research		To promulgate rules and regulations of coordination among agencies	
Actions to support market		Replication of successful models.	Replication of successful models.	Replication of successful models.
	To localize the area of genetic products by eco-region To assay extensive genetic products	To analyze the superiority of technological Introduction of plant varieties for higher economic efficiency rice	To establish markets for new products To plan and construct appropriate infrastructure.	
Skills training and education		Raising awareness of the people	Raising awareness of the people	Raising awareness of the people
	Capacity building in universities, colleges of agriculture		To promote education in the school system at all levels	

1.2 Field of forestry and land-use change

The aggregated measures which are popular / similar in the LULUCF sector are summarized in Table 62

Table 62 - Popular / similar measures which become repair to LULUCF technological barriers

Group of measures	These measures to overcome barriers for each technology		Common measures to overcome barriers of technologies
	Transfer and dissemination of selected biotechnology, plant breeding, seed trees drought, flood, high disease resistance	Agro-forestry Technology	
The network setup	To develop network of application technology	To build a team of forestry extension To propagate and educate people conscious of protecting natural resources	NA

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Policies and measures	To develop selection process	To develop selection process	NA
Change behavior / organization	Strengthening research to create new varieties with high adaptability to climate change	Land use planning for agro-forestry mountains To implement demonstration of land use sustainable agro-forestry	NA
Actions to support market	Disseminating research results Subsidized products	Building distributed systems, consumer products	NA
Skills training and education	To enhance the fostering for staffs	To enhance the fostering for staffs	To enhance the fostering for staffs
International cooperation and intellectual property	To strengthen bilateral and multilateral co-operations	To strengthen bilateral and multilateral co-operations	To strengthen bilateral and multilateral co-operations

1.3 Field of water resources

The aggregated measures which are popular / similar in the water resources sector are summarized in Table 63

Table 63 - Popular / similar measures which become repair to water resources technological barriers

Group of measures	These measures to overcome barriers for each technology			Common measures to overcome barriers of technologies
	Technology to collect rainwater from roofs for their daily needs	Technology to collection surface runoff for community reserves	Integrated river basins management	
The network setup		Building focal point units	Construction the focal point for integrated management of river basins	Building focal point units
	Construction and development of networks of technical experts	Construction and development of networks of technical experts	Construction and development of networks of technical experts	Construction and development of networks of technical experts
Policies and measures	To develop policies to support and encourage the local technology application	To develop policies to support and encourage the local technology application		To develop policies to support and encourage the local technology application

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			Integrating technology into the planning, socio-economic development programs in river basins	
Change behavior / organization	Changing water use habits	Strengthening the management, operation and protection of water sources and sanitary and phytosanitary		Capacity building and management approach
		To promulgate regulations between household water use	To change approach to river basin management To establish rules and regulations of coordination among agencies and between local	
Actions to support market	To conduct detailed survey of climate conditions, precipitation patterns, storm water quality plans to implement regional		To conduct detailed survey of natural conditions - including socio-economic river basin plans to implement technology	To conduct detailed survey of natural conditions
			Introduction of integrated management model river basins have been deployed around the world	
Skills training and education	To integrate into general education programs at all levels	To raise public awareness.	International cooperation / hire foreign experts / send people for training abroad	NA

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1.4 Field of coastal zone management (CZM)

The aggregated measures which are popular / similar in the CZM sector are summarized in Table 64

Table 64 - Popular / similar measures which become repair to CZM technological barriers

Group of measures	These measures to overcome barriers for each technology		Common measures to overcome barriers of technologies
	sea-dike technology	wetland recovery technology	
The network setup	Building and development network of experts	Building and development network of experts	Building and development network of experts
	To review, restructure and support the current network management		
Policies and measures	To develop policies to support local technology application	To develop policies to support and encourage research, testing and application of technology	To develop policies to support local technology application
	To test and evaluate policy		
Change behavior / organization	Strengthening management capacity	Strengthening management capacity	Strengthening management capacity
	To promulgate rules and regulations of coordination among agencies	To promulgate rules and regulations of coordination among agencies	To promulgate rules and regulations of coordination among agencies
Actions to support market	To carry out detailed survey of hydrological, geology and geomorphology conditions in the selected area		NA
International cooperation and intellectual property	Additional training of technical experts	International cooperation, additional training of technical experts	Additional training of technical experts

1.5 The common measures to overcome barriers of fields

Common measures to many fields are summarized in the following table:

Table 65 - Common measures to overcome barriers of fields

Group of measures	These measures to overcome barriers for each technology				Common measures to overcome barriers of technologies
	Agriculture	LULUCF	Water resources	CZM	

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The network setup	Building and development network of experts	NA	Building and development network of experts	Building and development network of experts	Building and development network of experts
			Building focal point units		
Policies and measures	To develop policies to encourage, support.	NA	To develop policies to support and encourage the local technology application	To develop policies to support and encourage the local technology application	To develop policies to support and encourage the local technology application
	To identify areas to be converted				
Change behavior / organization		NA	Capacity building in management approach	Capacity building in management approach	Capacity building in management approach
	Strengthening of central and local government's direction. Capacity building of extension agencies on climate change			To promulgate rules and regulations of coordination among agencies	
Actions to support market	Demonstration of successful models.	NA	To conduct detailed survey of natural conditions	NA	NA
Skills training and education	Raising awareness of the people	To foster the staffs	NA	Additional training of technical experts	NA
International cooperation and intellectual property	NA	Strengthen bilateral and multilateral co-operations	NA	NA	NA

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II. The measures can become barriers to other the measures / technologies

2.1 The measures can become barriers to the measures / technologies in each sector

2.1.1 Agricultural sector

In the agricultural sector, measures to develop the separate technology are synthesized in the table below and the common / similar measures to resolve barriers to the technology stated in Part I will not be mentioned in this table.

Table 66 - Separate measures to overcome barriers of the agricultural technologies

Group of measure	Measures to overcome barriers of separate nature of the technology		
	Genetic Technology	**Conversion of rice land to dry land crops**	**Switch from 3 rice to 2 rice + shrimp / fish / duck**
The network setup	To establish a national key center		
Policies and measures	To develop policies to support basic research and long-term To develop pilot program of applied research results		To develop policies to encourage the application of technology.
Change behavior / organization	To support organizations and experts in technology research		To promulgate rules and regulations of coordination among agencies
Actions to support market	To localize the area of genetic products by eco-region To assay extensive genetic products	Analysis of technological superiority Vietnamese Introduction of plant varieties for higher economic efficiency rice	Establishing markets for new products Planning and construction of appropriate infrastructure
Skills training and education	Capacity building in universities, colleges of agriculture		To promote education in the school system at all levels
International cooperation and intellectual property	International cooperation / hire foreign experts / send people for training abroad		

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From the measures to solve barriers due to special nature of the technology in the agricultural sector mentioned above, we can identify measures have potential to be barriers for other the measures / technologies and indicated in the table below.

Table 67 - The measures and actions can become barriers to technology in the agricultural sector

Technology	Measure	Action
Genetic Technology	To develop policies to support basic research and long-term	To raise fund to support research and technological development.
Conversion of rice land to dry land crops	Introduction of plant varieties for higher economic efficiency rice	Organizing exhibitions technology, introduces the capacity of service providers combined workshop
Switch from 3 rice to 2 rice + shrimp / fish / duck	To develop policies to encourage the application of technology.	To give scientific explanations and the necessary technology applications. To develop and promulgate policies, rules tax exemptions to promote appropriate technology application

Based on the measures to overcome barriers due to separate nature of each technology listed in the table above, and on the basis of considering the action to implement measures, each technology to become successfully implemented all need to financial support from the state through the relevant ministries. Specifically:

During the construction process and policies to support basic research and long-term genetic technology, there is a need of financial sources to fund research and support technology development. So do the measures such as infrastructure planning appropriate from 3-rice into 2-rice + shrimp / fish / duck conversion or recommending measures for crops with high economic efficiency of rice land conversion technology. Thus, all three measures are in need of financial assistance. This can cause difficulty in supporting investment and technology development at the same time, which leads to the transfer and technology development can be delayed compared to the plan.

2.1.2 LULUCF

Table 68 - The measures to overcome barriers in the field of LULUCF

Group of measure	Measures to overcome barriers of separate nature of the technology	
	Biotechnology in the selection, plant breeding, seed trees drought, flood, high disease resistance	**Agro-forestry Technology**
The network setup	Development of application technology network	Building a team of forestry extension Propaganda and education for people conscious of protecting natural resources
Policies and measures	To develop selection process like	Implementation of investment and development assistance
Change behavior / organization	Strengthening research to create new varieties with high adaptability to climate change	Land use planning for agro-forestry mountains To implement demonstration of land use sustainable agro-

		forestry
Actions to support market	Disseminating research results Subsidized products	Building distributed systems, consumer products

From the measures to overcome barriers of separate technologies in the field of LULUCF mentioned above, we can identify measures have potential to be barriers for other the measures / technologies and indicated in the table below.

Table 69 - The measures and actions can become barriers to technology in the field of LULUCF

Technology	Measure	Action
Biotechnology in the selection, plant breeding, seed trees drought, flood, high disease resistance	Subsidized products	To develop measures to support the product To raise capital funds to support forestry development
Agro-forestry Technology	Implementation of investment and development assistance	To review, formulate and implement policies and measures for preferential loans with convenient procedure

From the summary of the measures address the barriers for each technology and on the basis of reviewing the implementation of action measures, it can be seen that the subsidized product with funds raised from fund development assistance for forestry biotechnology in the selection, plant breeding, seed trees drought, flood, high disease resistance has the potential financial conflict to the development of agro-forestry technology when implementation measures to support investment and development for this technology.

2.1.3 Field of water resources

Table 70 - The measures to overcome barriers in the field of water resources

Group of measure	Measures to overcome barriers of separate nature of the technology		
	Technology to collect rainwater from roofs for their daily needs	**Technology rainwater collection surface runoff for community reserves**	**Integrated river basins management**
The network setup			Integrating technology into the planning, socio-economic development programs in river basins
Policies and measures	Changing water use habits	To promulgate regulations between household water use	To establish rules and regulations of coordination among agencies and between local
Change behavior / organization			To promote introduction of integrated management model river basins have been deployed around the world

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Actions to support market	Integration into general education programs at all levels	To raise public awareness.	International cooperation / hire foreign experts / send people for training abroad

From the summary of the measures address the barriers for each technology and on the basis of reviewing the implementation of action measures, there is no separate measure in the field of water resources that causes difficulties, affecting the development and transfer of other technologies in the field.

2.1.4 Field of coastal zone management

Table 71 - The measures to overcome barriers in the field of CZM

Group of measure	Measures to overcome barriers of separate nature of the technology	
	Sea-dike technology	**Wetland recovery technology**
The network setup	To review, restructure and support the current network management	
Policies and measures	To test and evaluate policy	
Change behavior / organization		
Actions to support market	Carrying out detailed survey and hydrological, geology and geomorphology conditions in the selected area	
The network setup		
International cooperation and intellectual property	International cooperation in training and technology transfer	

From the summary of the measures address the barriers for each technology and on the basis of reviewing the implementation of action measures, there is no separate measure in the field of CZM that causes difficulties, affecting the development and transfer of other technologies in the field.

2.2. Proposals to limit the negative impact of these measures which can become barriers to the technology

According to the analysis above, the measures to develop this technology affect negatively the development of other technologies that only involves financial matters.

To make all the technology at the same time, it needs a very large financial source, while the state's budget is limited. It is difficult to meet the financial needs for all other sectors in general and technological development respond to climate change in particular.

Thus, the requirement is to provide measures to support policy development based on the priority level for each measure of each technology in each sector. Those measures that have the level 1 priority will be first implementation than those have priority level 2 and 3.

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Table 72 - Table shows level of priority of the measures has the potential financial conflict with agro-forestry and LULUCF

Fields	Technology	Measure	Level of priority	Implementation time	Implementation phase
Agriculture	Genetic Technology	To develop policies to support basic research and long-term	1	5 year	0-5 year
	Conversion of rice land to dry land crops	Introduction of plant varieties for higher economic efficiency rice	2	5 year	0-5 year and 5-10 year
	Switch from 3 rice to 2 rice + shrimp / fish / duck	Planning and construction of appropriate infrastructure	1	5 year	0-5 year and 5-10 year
LULUCF	Biotechnology in the selection, plant breeding, seed trees drought, flood, high disease resistance	Subsidized products	2	5 year	5 - 10 year and 10 - 15 year
	Agro-forestry Technology	Implementation of investment and development assistance	2	3 year	0-5 year and 5-10 year

For the agricultural sector: The construction of support policies to basic research and long-term has No. 1 priority and is implemented in the period from 0 to 5 years. The investment of mobile technology communication is needed and done first, then comes measures to prioritize infrastructure planning appropriate 3-rice into 2 rice + shrimp / fish / duck conversion technology because with a similar level priority. However, the implementation phase of this measure can be extended to the period from 5 to 10 years. Finally, measure of plant varieties with high economic efficiency of the technology to convert rice-land to dry-land with priority level 2 will be done later.

For the field of forestry and land-use change: the implementation of investment support development of agro-forestry technologies combined with supports the product of biotechnology in the selection, plant breeding, selection forest plant drought, flood, high disease resistance have priority level 2. However, the need to prioritize measures to develop agro-forestry technology comes first because this measure is implemented in the period from 0-5 years and 5-10 years while the product measures of public support in selected biotechnology, plant breeding, seed trees drought, flood, high resistance is going to be done in the period from 5-10 years and 10-15 years.

Besides considering the above-mentioned priorities there is need to make a number of measures to reconcile the budget such as:

- To estimate total capital investment;
- To prepare detailed investment plans for each sector and each technology;
- To balance investments in order not to affect the investment fund for technology in each area and in the fields together;
- To call for financial resources from outside. /.

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ANNEXES

Annex I. Technology Factsheets

1 AGRICULTURE SECTOR

1.1 Plant genetics/plant breeding

Technology description

- *High-productivity crop varieties.* Genetic modification and species selection are usually carried out in parallel with the production process. Scientists have been searching for years for new varieties that produce higher yields than the existing ones.
- *Halotolerant crop varieties.* By selecting local salt-tolerant species that thrive in year-round saline habitats, scientists can breed and/or select the genes that define salt resistance in mangrove plants for breeding or revigorating existing mangrove species to create salinity-resistant species.
- *Flood-tolerant varieties.* Partial inundation due to rainfall or sea-level rise occurs very often in northern mountainous valleys, northern and central coastal zones, Southeast and the Mekong River Delta because of the low-lying terrain or inadequate drainage systems. Therefore, it is very important for developing flood-tolerant plants which can adapt to this condition.

Socio-economic benefits

- Developing new crop varieties to maintain or improve productivity is an optimal solution to secure food security and respond to climate change.
- Experiments show that salt-resistant crops are able to maintain the same productivity while tolerating higher salinity. From the OM5464 variety created by Tran Thi Cuc Hoa (2011) and Nguyen Thi Lang et al. (2011), three high salt-tolerant crop varieties were developed, namely OM5629, OM5981 and OM7368.
- It is important to carry out sufficient research on the selection and development of flood-tolerant species that can adapt to local conditions to maintain productivity or even increase in constantly inundated areas.

Environmental benefits

- High-yielding varieties have higher photosynthetic efficiency, thus increasing crop yields and biomass, which helps to capture more carbon dioxide from the atmosphere.

Status of technology

- Some salt-tolerant rice varieties have been created in Vietnam, such as OM5629, OM5981 and OM7368.

Application potential

- This technology has been widely applied over the last decade and proved to be effective. In the future, it will be applied for 8.1 million hectares of annual crops and 938 thousand hectares of perennial crops.

Barriers

- Requiring fast-track implementation on the basis of a long-term development plan that incorporates climate change.
- Inadequate infrastructure due to a low science and technology (S&T) background and unfocused development strategy with too many priorities.
- Lack of genetic materials, hence limited inputs for basic and long-term research.
- Little international cooperation and experience sharing, thus limiting the application of global achievements in Vietnam.
- Developing a new crop variety is very time-consuming. This is considered the most challenging barrier.

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Costs

Implementation and technology application costs

• The cost of construction, procurement of laboratory equipment, research staff.

Incremental costs to adapt to climate change (compared to conventional technology)

• The cost of additional studies of genetic materials suitable.

1.2 Water-saving irrigation

Technology description

- The basic difference between water-saving irrigation technique and traditional practices is that it keeps a thin layer of water on the field surface and allows more time for the surface to dry.
- Vietnam's agricultural area will grow from 6.6 million hectares in 1994 to 7.3 million hectares in 2010 and 8.0 million hectares in 2030. The principles of this technology are to actively supply a sufficient amount of water to the field during certain rice growth stages, using methods such as wet and dry irrigation. This will serve two goals: improving productivity and reducing methane emissions from the field.

Socio-economic benefits

- Reducing water costs, enhancing fertilizer efficiency, increasing tilling rates, and improving crop yield.

Environmental benefits

- Lower methane emissions compared to flood irrigation in every growth stage (which keeps a constant layer of water on the field surface in all growth stages of rice).

Application potential: Can be applied for 7.4 million hectares of rice.

Barriers

- The systems of fields and associated infrastructure, drainage and irrigation systems are incompatible. Difficult to meet the technological requirements. Only applicable to small scale areas, which are normally owned by small farmers, thus it might be difficult to apply regarding their limited capital.
- Most production areas are located far away from the water source.
- Communities are not fully aware of the importance of water sources.

Costs

Implementation and technology application costs

• High costs due to construction or renovation of irrigation systems. However, with the modernization of rural agriculture on the way, it is necessary work to be done in the future.

Incremental costs to adapt to climate change (compared to conventional technology)

• Saving water and energy and reducing GHG emissions from energy consumption for irrigation.

1.3 System of Rice Intensification (SRI)

Technology description

- SRI was introduced into Vietnam in 2003. So far, there have been 21 provinces in Vietnam practicing this method on an aggregated area of 85,000 hectares (PPD and MARD, 2008). This method eliminates the disadvantages of conventional practices currently applied in wet rice cultivation. On 15 October 2007, Ministry of Agriculture and Rural Development (MARD), via Decision 3062/2007/QĐ-BNN-KHCN, announced that SRI is an advanced technology that can be practiced in rice production in northern provinces..

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Socio-economic benefits

- This technology requires 70-90% less rice seeds, 20-25% less nitrogen fertilizer and chemicals than normal while increasing 10-15% of productivity.
- SRI helps to control pests and diseases (such as sheath blight, golden snail, root rots, etc.) while strengthening resistance to pathogens, and as a result, reducing costs of pesticide.
- On average, profit from SRI fields increased by more than VND 2 million (about 95 USD) per hectare while saving one third of water consumption.

Environmental benefits

- Saving about one third of water consumption compared to traditional practices.
- Methane emissions from an SRI field is estimated to be one quarter (30±18 µg CH4 m^{-2} h^{-1}) of a non-SRI field (125±28 µg CH4 m^{-2} h^{-1}).

Status of technology

- SRI was introduced to Vietnam in 2003. So far, it has been applied in 21 provinces and cities involved to an aggregated area at about 85,000 ha (PPD & MARD, 2009), and helped to overcome some shortcomings in rice cultivation practices. On 15th Oct 2007, the Ministry of Agriculture and Rural Development issued Decision No. 3062/2007/QD-BNN-KHCN on the recognition of SRI as applicable advanced techniques in rice production in the Northern provinces.

Application potential

- Can be applied to rice fields in Northeast, Northwest, Red River basin and North Central Coast.

Barriers

- Certain principles of SRI are not applicable to the natural conditions and current infrastructure.
- Hard to change local people's habits of using traditional methods.
- Only applicable to fields with good irrigation, difficult to be applied to low fields.
- Hard to apply sparse planting and weed control practices.

Costs

Implementation and technology application costs

- The cost of upgrading the system infrastructure, capacity building for farmers.

Incremental costs to adapt to climate change (compared to conventional technology)

- There is no incremental cost.

1.4 Organic fertilizer from agricultural residues/by-products

Technology description: This technology produces organic fertilizers from agricultural crop residues by using certain enzymes to accelerate the decomposition of cellulose.

Socio-economic benefits: Increasing crop yields and cutting down costs of fertilizers.

Environmental benefits

- Reducing GHG emissions from burning agricultural residues.
- Preventing environmental pollution and plant diseases.

Status of technology: the application of technology projects have been deployed in some provinces in Vietnam.

Application potential: Can be used for the entire area of rice, maize, peanuts, soybean and sugarcane nationwide.

Barriers

- Time between crops in multiple cropping regions is too short for the composting process to produce high-quality compost.
- Treating agricultural waste and residues is still a rather new concept to farmers and treatment process requires complicated procedures and techniques.
- Limited understanding of this technology at the community level.
- Benefits gained from this technology have yet to appeal to farmers.
- This technology may be difficult to apply in dry season conditions.

Costs

Implementation and technology application costs

- The cost of technology depends on the type of yeast used. Average cost to produce 1 ton of fertilizer is 372000 VND (19 USD).

Incremental costs to adapt to climate change (compared to conventional technology)

- There is no incremental cost.

1.5 Minimal tillage

Technology description:

- *On steep slopes*: Minimum tillage is widely applied in mountainous areas to save labor costs; it is usually coupled with advanced weed control techniques.
- *On flat terrain*: Minimum tillage is applied only for winter crops, such as soybean, potato and winter maize. This practice was first used for growing maize between main crops. It is later employed in soybean no-till production.

Socio-economic benefits: Labor-saving; increasing land use factor and farming household income.

Environmental benefits

- Reducing GHG emissions as it eliminates the use of plough machines, decreasing soil erosion and soil carbon loss.
- Preventing water eutrophication and reducing methane emissions from flooded field.

Status of technology: In the past, farmers have applied measures to dig holes plowed seeded without tillage, which significantly reduced soil erosion, land degradation and crop damage. Today there are many technologies being introduced for sustainable production and economic efficiency as high as no-tillage soybean, and no-tillage potato.

Application potential: Can be applied to the entire farming area on steep slopes, winter, industrial and fruit crops, and agro-forestry systems.

Barriers: Likely to meet community resistance as this requires change from conventional practices (intensive tillage, slash and burn, weeding or hoeing on steep lands etc.).

Costs

Implementation and technology application costs

-The cost of network construction and training of technical staffs.

Incremental costs to adapt to climate change (compared to conventional technology)

- There is no incremental cost.

1.6 Biochar technology

Technology description: Biochar has a porous structure and highly stable carbon form, which prevents it from releasing GHGs (carbon dioxide or methane). In addition, it can retain soil moisture, nutritious matters and useful bacteria, raise soil fertility and agricultural productivity while functioning as a natural carbon sink.

Socio-economic benefits

- Producing biochar from agricultural residues can be beneficial for addressing environmental problems because the end products are friendly to the environment.
- Incorporating biochar into the soils will increase germination and growth rates and boost productivity. For example, annual crop productivity can increase by 200% by using high-quality biochar.
- Biochar can also increase the pH and reduce the content of Al_{+3} in acid soils, or tropical farmlands where soil is severely mineralized due to intensive farming. Using biochar will raise the pH of different soil texture, with a maximum increase of up to 1.2 pH unit.

Environmental benefits: By transforming carbon in plant biomass to carbon sequestered under the ground, biochar-applied soils will act as a long-term carbon sink.

Status of technology: The soybean technologies and no-till potato are being applied and extended to many areas.

Application potential: Vietnam has a considerable biomass potential with 38 million tones of straw, 6-7 million tones of rice husk, 1.4 million tones of sugarcane leaves and stalks, and a significant amount of other agricultural by-products such as grass, leaves, sawdust, or bagasse, etc. This makes a diverse source of materials for biochar production.

Barriers: Hard to change from traditional practices, difficult to collect materials and lack of experience or technical support

Costs

Implementation and technology application costs

- The technology development costs are low because local natural material resources can be used.
- Compared to conventional technology, this technology has higher costs
- For design of the application and the application of different technologies, development of documentation, training sessions and demonstration program for farmers learning.

1.7 Agricultural by-product, foliage and plastic mulching

Technology description: This technology is popular in areas that are water-intensive, arid, or have heavy evaporation or sandy soils with poor moisture retaining capacity. Inputs for this technology include: i) post-harvest straw or hay; ii) foliage from agro-forestry systems; and iii) plastic mulch.

Socio-economic benefits

- Speeding up seed germination and shorten time requirement, increasing crop yields.
- Enhancing land use efficiency, reducing damages due to season-end droughts.
- Cutting down weed and pest management costs and irrigation budget.

Environmental benefits

- Increasing fertilizer efficiency
- Reducing nitrogen volatilization and nitrous oxide emissions,
- Controlling weeds
- Protecting field environment.

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Status of technology: This technology is practiced by farmers in the KWS and now with the available materials such as straw, leaves, etc., there are many types of materials and advanced technologies that can protect the commodity chain production of plants better.

Application potential

- Potential for large-scale application in coastal sandy lands, which have low levels of organic contents and nutrients, or in drought-prone areas at the beginning of spring and summer crops.
- It can also be applied to steep arable lands, especially in vegetable farms in Da Lat, or in the mountains and highlands.

Barriers

- Difficult to change the traditional practices.
- Capital-intensive.

Costs

Implementation and technology application costs

-Costs can vary from according to the cost of materials (high costs for expensive materials and low costs for cheap materials).

Incremental costs to adapt to climate change (compared to conventional technology)

-It can increase crop yields, save water, nutrition, maintain and improve soil fertility.

1.8 Shifting from rice to upland grains

Technology description: This technology is popular in some parts of Vietnam. Combining the garden-pond-barn (VAC) model with the field systems, many farms of this type have been established in flood-prone low-lying lands, where rice productivity is poor due to constant inundation and low productivity potential.

Socio-economic benefits

- Addressing water shortage in the dry season in areas that lack adequate irrigation infrastructure, particularly during spring crops on the mountains or highlands, in water-stressed coastal zones, or low-lying lands.
- Reducing costs of irrigation.

Status of technology: Currently this technology has been used in households, farms and is being extended through parcel consolidation movement.

Application potential: Can expand to water-stressed areas in highland, mountainous, or salt-affected coastal areas.

Barriers:

- Small-scale; difficult to be expanded to a larger scale.
- Hard to find outlets for products.

Costs

Implementation and technology application costs

- Initial investment for planning, infrastructure construction and initial production costs are high.

Incremental costs to adapt to climate change (compared to conventional technology)

- Development of new sectors and issues arising.

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1.9 Shifting from triple cropping to double cropping and a shrimp/fish/poultry crop

Technology description: This is a transformation from the system of triple cropping to double cropping and a shrimp/fish/poultry crop.

Socio-economic benefits

- Generating higher income than growing 3 continuous crops a year .
- By cutting one crop, pesticide and fertilizer costs can be reduced.
- Recycling agricultural residues to make inputs for aquaculture.

Environmental benefits

- Preventing eutrophication in fish farms due to excess food and fecal waste from fish or shrimp, thus preventing diseases.
- Enabling farmers to adapt to climate change and utilize flooded land in the rainy season.

Status of technology: This technology has been practiced in small scale in the Mekong Delta, and scattered in Northern Vietnam. It tends to thrive in the Mekong Delta in recent years.

Application potential: Can be applied to inundated areas in the Mekong River Delta where growing crops in the later half of the year is impossible, especially in the context of sea-level rise.

Barriers: As there are many uncertainties in the timing and degree of inundation, it is very hard to predict inundation to make concrete plans for application of this technology.

Costs

Implementation and technology application costs

-The cost depends on the kind of technology that people choose, and can be very high if good infrastructure, long-term investment are required but can also be low if the technique is taken advantages.

Incremental costs to adapt to climate change (compared to conventional technology)

- Development of new seafood market, building standards and norms for new techniques.

2 LULUCF SECTOR

2.1 Insect and pest control

Technology description: Insect and pest control is an efficient method in agricultural production. However, in forestry, integrated pest and insect management has just started to be piloted in several material plantations.

Social – economic benefits:

- Reducing pest and diseases for crops, thus reducing pesticide costs.
- Enhancing crop productivity and quality.

Environmental benefits: Preventing pollution by reducing pesticide use.

Status of technology: Currently, the technology has only been applied a number of individual measures in a narrow range of agricultural production in forestry or the nursery or forest research. For production forests, it is not attractive to investors and therefore, it has not been applied.

Application potential: High thanks to integrated insect and pest management in material plantations susceptible to pests and diseases such as pine corn, acacia, or eucalyptus.

Barriers: Requiring high management skills, large capital costs while forestry production activities usually have low budget and high risks.

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Costs

Implementation and technology application costs

- The cost of technology is difficult to determine, it depends on the ecological characteristics, forest type, tree species, natural conditions, socio-economic areas.

Incremental costs to adapt to climate change (compared to conventional technology)

- Pest Management Integrated has higher initial costs compared to normal Insect Pest Management and the efficiency is usually much slower.

2.2 Plant genetics to select and create new drought-, flood-, and pest-resistant species for climate change adaptation

Technology description: Biotechnology is widely used in forestry, such as plant cutting, tissue culture, cross-breeding, genetic engineering or the recent genetic modification technology. Techniques to develop new genes that define resistance to pest and diseases have been applied successfully in Vietnam and produced some results. Crossbred or genetically modified plants that can tolerate drought and resist diseases have been created. This technology is applied in many pulp plantations on a large-scale to produce pulp materials for paper manufactures with high productivity..

Social – economic benefits

- Having high economic benefits, increasing productivity and reducing the risks of pests and diseases.

- Increasing income of local people.

Environmental benefits

- Promoting afforestation and reforestation in degraded lands.

- Preventing pest and diseases.

- Reducing pesticide use in production.

Status of technology

- Several national biotechnology research and development programs are going to be underway by 2020 and the Government has decided to increase investment in science and technology in Vietnam. Although actions have been taken to increase the economic value of goods and services, generally the results are not positive; in fact, there have not been an industry and market for biological products.

- There are many overlaps in biological research over the years due to the lack of coordination between research institutes, thus wasting investment in biotechnology.

- Although there are many programs on developing biotechnology in agriculture and aquaculture, there is not enough attention to the content industry development biology.

- Assisting-industries support for bio-industry has not developed.

Application potential: Large-scale; highly potential in forestry; requiring further research for development.

Barriers: High costs, leading to high prices while forestry production activities usually have low budget, which may prevent access from poor people.

Costs

Implementation and technology application costs

-Implementation costs of research and application of this technology depends on the characteristic species of each subject, scale transfer research. Average cost approximately 143.000 USD / species (including the cost of research, technology transfer).

Incremental costs to adapt to climate change (compared to conventional technology)

-None because the technology itself creates products to adapt to the environment.

2.3 Agro-forestry

Technology description: Agro-forestry is a land use system in which the growing and management of perennial trees (forest trees, industrial long-range trees, fruit trees) exist in harmony, in terms of time and space. The technology can combine the plantation of short-term industrial trees and keeping livestock to create a sustainable system in terms resources, ecosystem and social and economic development.

Socio-economic benefits

- Increasing and diversifying sources of income

- Creating more jobs and enhancing income for local people.

Environmental benefits: Ensuring sustainable use of land and environmental protection.

Status of technology: It has been applied in Vietnam since 1960 and will continue to apply in the future.

Application potential: Having been in use in Vietnam since 1960 and will continue to be used in the future.

Barriers: Limited forestry extension resources and lack of technical experience and support.

Costs

Implementation and technology application costs

- The costs associated with implementing agro-forestry applications cannot be specifically identified but it is easy to deploy and very inexpensive.

Incremental costs to adapt to climate change (compared to conventional technology)

- No incremental costs required to adapt because this technology was adapted itself.

2.4 Forest Fire control by the geographical positioning system (GPS) and remote sensing

Technology description: The geographical positioning system (GPS) consists of three parts: signal receivers, handy self-recording device, and computer with data processing software. The self-recording devices will collect data at specific positions and send signals to the receivers; the signals will be coded and sent to computer, where they will be processed and synthesized by software.

Socio-economic and environmental benefits

- Reducing costs and increasing efficiency in wildfire control.

- Meeting the demand for continuous, up-to-date information on forest status in large and complex areas.

Status of technology: GPS and GIS technologies have been applied in many industrial fields, not just forestry. Technology improvements have been new advances of great help for the executive management and other jobs.

Application potential: This technology is a priority in forest fire control as it can meet the demand for access to information of a large area.

Barriers

- Requiring qualified technical staff.

- High prices due to expensive satellite images.

Costs

Implementation and technology application costs

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-Currently there is no research that shows the cost of implementing the technology application per unit area of forest.

Incremental costs to adapt to climate change (compared to conventional technology)

- Undefined.

2.5 Super water-absorbent products AMS-1

Technology description: Super water absorption product was named AMS-1 by Assoc. Prof. Nguyen Van Khoi et al. (Polymer Lab of Institute of Chemistry - Vietnam Academy of Science and Technology) researched and manufactured from the graft polymerization acrylic acid combined with denaturant starch and had two registered products were AMS - 1 and AMS – 2 (trademarks copyright). A small amount of AMS-1 applied to the soil can retain water in the soil 400 times more than normal soil and provide water for root of plants. When the stored water was consumed by plants and evaporation, the AMS-1 material shrinks to the original volume and then continues to save water from rains or irrigation..

Social – economic benefits: Cheap, high economic efficiency (a hectare with 25-35 kg of AMS-1 can save a few million VND (several thousand USD) from irrigation).

Environmental benefits:

- Saving water.

- Allowing planting on arid lands to improve climate and environmental conditions.

Status of technology: In Vietnam, this technology has been used in coastal afforestation, anti-dry sand programs in the South Central Region.

Application potential: Applied in planting in coastal zone and preventing dust wind in arid land in South Central Region.

Barriers

- Large capital costs

- Not appealing to people

Costs

Implementation and technology application costs

-The cost is about 25 to 35 kg / ha, the product of about 1 USD/ kg. Time comes after about 18 months; the cost will increase to 35 to 50 USD /ha/year.

Incremental costs to adapt to climate change (compared to conventional technology)

- No incremental cost.

3. COASTAL ZONE MANAGEMENT SECTOR

3.1 Closing bank-protection bank and intercepting sewer

Technology description

- Large-scale storm surge barriers with movable bulkheads have been used efficiently in several projects in developed countries in Europe , for e.g. The Netherlands, but still have not in use in developing countries;
- Medium-scale closure dams: have been already in use in developing countries due to lower investment capital and operation costs. In Vietnam, there are several riparian small-scale tidal lock structures built on rivers.

Socio-economic benefits

- Coastal zones were in better protection, which increasing local socio-economic development; reducing investment capital and maintenance costs for other protection structures.

- Providing other services such as freshwater supply, entertainment and tourism by reducing impacts of tides and waves.
- Such constructions can be integrated into hydropower structures, which providing renewable energy, securing energy security.

Environmental benefits

- Preventing flood and natural hazards, salinity intrusion into rivers and low-lying lands.
- Naturally cleansing lagoons water by using wind and tide by taking on water.

Status of technology

- In Vietnam, there were a number of sluices to prevent tide a small scale which were built on the river;
- The condition current only available to invest and build small-scale works in the rivers not large-scale works in estuaries and coastal lagoons.

Application potential

- At present: only available in building small-scale constructions due to lack of resources to build large-scale structures.

Barriers

- High construction, maintenance and operation costs.
- It is only suitable in narrow estuaries or lagoons but not a wide-spread application technology.
- Obstructing traffic and transportation, altering physical, chemical processes and impacting native ecosystems such as migration routes of birds or seeking food of fishes across the river to the sea.
- Too complicated in design and operation for local people and, requiring support from the Government.

Costs

Implementation technology application costs

The cost of the protection construction works depends on:

- Type of construction;
- Geological characteristics in dam area;
- Protecting rising level of water column;
- The heavy-duty due to predicted wave and storm action;
- Height and width of the work;
- Construction of single-stage or multi-stage;
- The cost of labor and experts;
- Costs for raw materials;

Increasing costs to adapt to climate change (compared to conventional technology)

- Investment costs and maintenance the work due to sea level rise problems in the future. The height will be lift; solid level also will be increased.

3.2. Beach nourishment

Technology description

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- Widely used in The Netherlands, Belgium, Germany, Denmark, the USA and Australia, etc.; under research in developing countries such as Nigeria, Ghana or Malaysia, etc...
- Feasibility studies in provinces namely Hai Hau, Ca Mau, and Kien Giang and some islands in Vietnam.

Socio-economic benefits

- Maintaining, restoring beaches to stop coastal erosion and breaking winds. Although erosion still happens, beaches are provided with sediments and kept stabilized, which helps to protect the coastline and its structures,
- Maintaining the landscape and providing tourism, entertainment benefits, increasing income for local community,
- Flexible, providing access to future sustainable coastal management.

Environmental benefits

- A structural measure without disturbing coastal natural processes or having adverse impacts on neighboring areas in contrast to dikes or dams,
- Providing ecological benefits to coastal zones.

Status of technology

- In Vietnam, there have been studies to review the applicability in areas such as marine coastal Hai Hau landslide, Ca Mau and Kien Giang ... and the islands.

Application potential

- Can be combined with other adaptation technologies and even used as protection for structural measures such as dikes or dams,
- Utilizing sediment materials associated to dredging projects for coastal structures and marine transportation,
- Applicable in small islands with highly-needed for beach nourishment.

Barriers

- Requiring high investment capital costs, periodic re-investments and provision of beach sediments. Large-scale application may lead to increases in nourishment material prices and capital costs.
- External beach nourishment materials may result in negative impacts, such as increasing turbidity in water column, to the local environment and ecosystem.
- Requiring experts specialized in ecology and natural conditions of the area.
- Limited understanding of local community.

Costs

Implementation technology application costs

- According Linham et al. (2010), the costs in developed countries range from 3-15 USD/m^3 for materials (2009 constant prices). The costs in the developing countries may be similar to or higher because the coastal technologies have not really developed.

- The cost of technology is more flexible, depending on the specific conditions of each country. Major factors affecting the cost include the following:

- Project scope, socio-economic efficiency;
- The distance from the dredge material to raise beach area;
- The cost of transporting materials;
- Beach topography and conditions of transport routes;

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- Breeding grounds Materials;
- Loss of material;
- The cost of dredging (type, size can use the machine, the machine is not readily available);
- The accessibility of the area dredged material taken (waves, wind ...);
- Tidal water level;
- The requirements of a third party;

- Costs of monitoring, supervision and management of the collection work should be included in the cost of raising dumps. This cost depends largely on the labor costs of local, national projects, so it is quite large fluctuations (Mason, pers. Comm.).

Incremental costs to adapt to climate change (compared to conventional technology)

- When there is climate change, sea level rise would increase material costs by increasing the volume of materials and labor.

3.3 Artificial Sand Dunes and Dune Rehabilitation

Technology description

- Artificial sand dunes simulate the function of natural dune ecosystems. Dune rehabilitation is considered as a mitigation technology to stop soil erosion, wind effects, storm surges and flood in coastal zones and an adaptation technology to climate change,
- Applied in a large scale in several countries such as the UK, or the USA, etc. In Vietnam, there have been some case studies on its ability to protect and rehabilitate Central Coast's sand dunes.

Socio-economic benefits

- It can be done with minimal capital costs as it relies on increasing sand supplement to natural direction of the dune or adjusting the height of or shaping the dune according to the development.

Environmental benefits

- A safe interface between the sea and the land, protecting coastal ecosystems and a sand storage.
- Conserving diverse, unique biodiversity and landscapes.
- Barely altering natural conditions or destroying original landscapes.

Status of technology

- In Vietnam, there have been some studies to protect and renovate the central coastal sand dunes.

Application potential

- Vietnam has four generations of dune: red (oldest, only in Ninh Thuan and north of Binh Thuan), saffron, white and grey (the youngest). The over development of shrimp farming and titan exploitation in sand dunes have destroyed large dunes across the coast, which take years to restore to the original state. Therefore, dune rehabilitation is very important.
- Less costly than other technologies, thus potential in seeking funds and community support.

Barriers

- Limited awareness of community or policy-makers.
- Asking for understanding of rules of local ecology and community.
- May affect the natural interaction process between seawater and beach.

- Causing conflicts between different purposes of usage.

Costs

Implementation technology application costs

Factors affecting the cost of building sand dunes are:

- The cost of building materials, sand recovery, or the cost of building fences or vegetation to promote the accumulation of sand to form dunes;
- The cost of moving building materials from the location on the shore or offshore to building place;
- The material, size and availability;
- Building fences for creating dunes to prevent erosion;
- Planting of vegetation to create;
- The number of additional artificial sand dune;
- Scope of the project and its economic efficiency.

Incremental costs to adapt to climate change (compared to conventional technology)

- The additional cost for breaking ecosystems, vegetation and material handling will increase when natural conditions become more severe due to climate change.

3.4 Sea dikes

Technology description

- Applied in a large scale in countries such as The Netherlands, the USA, Bangladesh or Thailand, etc.
- Many seas dikes have been built in Vietnam since 1960, but have been degraded in many parts ever since. Currently, Vietnam has more than 2000 km of dikes that need strengthening.

Socio-economic benefits

- Protecting low-lying coastal lands, coastal zones, preventing flood due to sea-level rise.
- Low investment capital costs compared to other structural measures.

Environmental benefits

- Offering protection against water pressure, storm surges and flood waters, minimizing adverse impacts and stabilizing the coastline.

Status of technology

- Sea-dike in Vietnam was built in the 60s of 20th Century so there are many passages have deteriorated. The current weakest or most incidents passage occur as long as 30 km, passing the Giao Thuy, Hai Hau and Nghia Hung districts in Nam Dinh province. The design of Vietnam's sea-dike can only withstand strong storms and tidal average 9-level. If it cross 9-level storm, combined with high tides, the dike cannot stand. There is urgent need to improve sea-dikes in Vietnam.

Application potential

- Two sea dike upgrade programs have been approved to repair levees from Quang Ninh to Quang Nam starting in 2006 and from Quang Ngai to Kien Giang during 2009-2020, with a total investment cost of 19,481 billion VND (934 million USD).

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Barriers

- Altering sea dynamic processes, reshaping the coastline due to changes in deposit layers; affecting coastal ecosystems; freshening coastal wetlands; destroying structures of conservation areas and biodiversity reserves; blocking migration routes of marine animals; and losing benefits from sea and ocean species.
- Insufficient observation data or long-term research on natural conditions (wind, storm, tide or sea-level rise, etc.); lack of social, economic and environmental impact assessments when building sea dykes.
- Difficult in choosing appropriate designs.
- Occupying a wide area which may lead to the community's objection.
- Blocking the visibility and landscape value for sea tourism, especially in areas with highly potential value of tourism.
- Large investment and maintenance costs.

Costs

Implementation technology application costs

- Investment costs are cheap compared to other hard protection structures but the volume of sea-dike construction is large and expensive. According to Department of Dike Management, it takes 100 billion VND (4.8 million USD) per km to withstand 12-level hurricane and Vietnam has 2,000 km of sea dikes.

- According to a comprehensive scheme to upgrade the sea dike system, there is stage 1 from Quang Ninh to Quang Ngai and stage 2 from Quang Ngai to Kien Giang. The total investment cost is 10,000 billion VND (480 million USD) for each phase and for the 5-year implementation period. According to a calculation by Hillen et al. (2010), to build 1-meter high sea dikes in Vietnam we have to invest from 0.9 to 1.6 million / km in length (USD 2009).
- (Hillen, 2008) stated that dike maintenance costs each year in Vietnam is 0.03 million USD / km long, the Netherlands is 0.14 million USD / km long (AFPM, 2006).

Incremental costs to adapt to climate change (compared to conventional technology)

- Also according to Hillen, the sea dike maintenance cost will increase significantly due to climate change and sea level rise.

3.5 Seawalls

Technology description

- Seawalls are used to avoid erosion in coastline; generally are the type to retain soils and prevent wave impacts and floods.
- In the South, several seawalls have been being built as constructions as well as temporary solutions. There are such types of seawalls as rock dike, mole, concrete dike etc…

Socio-economic benefits

- Minimizing area of land used and investment capital costs of structures behind the seawalls as well as protecting the landscape and developing tourism and services.
- One of the adaptive technologies thanks to flexible heights with sea levels that helps to maintain structure and can be connected with new adaptation structures.

Environmental benefits: Reducing erosion across the coastline, in islands or long-term protected areas and protecting landscape.

Status of technology

- In Vietnam, many embankments are used as the band-aid solutions. There are many forms of embankment such as bulkheads, embankments wire mesh, and concrete. Embankments have various forms as parallel to the

coastline, embankments standard wave soldering, coastal embankments and embankments in the coastal islands, offshore.

- Some coastal embankments in the Southern provinces were initially formed.

Application potential: Several local projects are in development.

Barriers

- Having adverse impacts to the environment;
- Lack of data on natural conditions, wind, storm frequency for optimal planning.

Costs

Implementation technology application costs

- Structural embankment has high longevity and reasonable maintenance cost;
- The cost of large investments and long construction: According to research by Linham et al. (2010) cost of building 1 km embankment is from 0.4 km to 27.5 million USD. In Vietnam, 2 km long embankment in Lien Chieu - Thuan Phuoc, Da Nang (from +608 to km 9 +641 Km7) has a total investment of 72 billion VND (3.45 million USD). In Bac Lieu province the 2 km long breakwater embankment to cope with sea level rise and landslides have cost about 50 billion VND (2.4 million USD) investment.

Incremental costs to adapt to climate change (compared to conventional technology)

- Depending on the maintenance and reinforcement and the height of the embankment.

3.6 Technologies for Coastal wetland rehabilitation

Technology description

- Mangrove swamps can be restored by growing types of saline grass. Grass roots can stabilize and protect mangrove swamps. Mangrove trees like *Melaleuca leucadenra Myrtaecae*, plants of *Rhizophoraceae (Bruguiera), Avicenniaceae, Myrsinaceae (Aegiceras), Rubiaceae (Ixora)* are adapted to saline habitats and popularly used in Vietnam. Choosing the right mangrove plants for a particular ecological environment to serve protection purpose is important.

Socio-economic benefits

- It cost less as wetland ecosystems can adapt to gradual sea-level rise.
- Increasing fish catching yield in neighboring seas, increasing income for coastal community and contributing to local sustainable development.
- Developing ecotourism and entertainment.
- Reducing construction capital and maintenance costs for coastal structures.

Environmental benefits

- Reducing wind forces, storm, and soil erosion; creating new habitats; improving the environment.
- Restoring functions of wetland ecosystems and protecting coastal zones.
- Improving water quality, climatic conditions, retaining sediments, eliminating land pollutant discharge, increasing carbon storage and providing necessary nutrients.

Status of technology

- On 03/16/2009, the Prime Minister has approved the *Restoration and development of mangrove forests for 2008-2015* project. In the first phase, there will be 32.870 ha of forest to be expanded or improved, and 97.554 ha of

new forest, bringing the total forest area of coastal flooding is the country from 209.741 ha to 307.295 ha in 2015. The scheme was implemented in 29 coastal cities. Priority is for planting and protecting mangrove belt before dike.

Application technology

- Increased community interest in ecosystem conservation.
- Cheap and beneficial in terms of landscape.
- On 9 October 2007, the Prime Minister signed Decision 158/2007/QĐ-TTg to establish the *Program on Integrated Management of North Central Coastal Zone and Central Coast by 2010, with vision towards 2020*, which forms a legal framework for 14 provinces and centrally controlled cities alongside the Northern Central coastal strip and Central Region to manage their beaches in an integrated manner.

Barriers

- Requiring large space, leading to conflicts in land use.
- Limited understanding of community on wetland benefits.
- Lack of comprehensive programs and plans.

Costs

Implementation technology application costs

- Dr. Nguyen Hoang Tri et al (1998) shows that the initial capital investment and cost for forest care (including forest trimming costs from year 6 onwards) was estimated 41 USD per hectare of mangrove forest (2009 constant prices).

- The cost of wetland restoration is complex and depends on a large number of factors. The cost of the project should be calculated separately in each specific case. The main factors affecting the investment costs are as follows:

• Type of wetland to be restored, expertise, your chances of success,

• The level of wetland degradation and restoration requirements,

• Expected level of recovery (for example, it is difficult to restore all the functions of wetland ecosystems once it is located in the urbanized area where is highly industrialized and recovery solutions cannot be expected higher).

• Cost to purchase land if the land to convert wetlands,

• The labor costs,

• Cost of transport seedlings from the nursery where the planting,

• Survival rate of seedlings (from seed collected until after planting),

• The cost of cultivation saplings,

• The cost of monitoring and protection after planting.

Incremental costs to adapt to climate change (compared to conventional technology)

- Subject to changes due to natural climate conditions and the extent of its impact to the wetland ecosystem.

3.7 Flood warning systems

Technology description

- Have been developed to predict the situations of storms and floods in order to plan in time to minimize negative impacts;
- Have an important role in developing countries with poor infrastructure and prone to flood;
- Coastal flood warning systems in Vietnam are not efficient and advanced due to out of date technologies.

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Socio-economic benefits

- Reducing risks for community.
- Helping to evacuate vulnerable people.
- Protecting people's properties to safety places.
- Operating protection structures in time and strengthening infrastructure.

Environmental benefits: Providing access to information and guidelines to cope with natural hazards to community, reducing damages and providing sanitation guidelines to avoid epidemic.

Status of technology

- In Vietnam the flood warning system has been built in some coastal areas, but these systems do not really work effectively. There are no conditions for the application of advanced technologies.

Application potential: There have been many projects on upgrading and modernization of flood warning systems in Vietnam, especially in the Central Coast.

Barriers

- Limited community understanding.
- Demanding high warning accuracy.
- Underdeveloped information and communication systems.

Costs

- Implementation and technology application costs

- Depending on the investment costs of equipment and building monitoring systems, data analysis, forecasting floods, building communication networks, training and communication to raise awareness of local communities.;

Incremental costs to adapt to climate change (compared to conventional technology)

- Depending on the operating costs in extreme weather conditions due to climate change.

3.8 Integrated coastal zone management (ICZM)

Technology description

- ICZM have been developed over the last four decades in many countries. Many successful ICZM programs and projects took place in Europe, America, Latin America, Australia, Asia and The Caribbean.
- It is the multi-sector field that requires both management and civil technologies.

Socio-economic benefits

- Solving multi tasks and conflicts in using coastal zones thanks to sustainable and efficient coastal management;
- Most appropriate measure to address short and long-term challenges in coastal zones, enhancing living standards in many developing countries;
- Advanced adaptation technology, long-term and financially beneficial.

Environmental benefits

- Reducing ecosystem degradation due to climate change impacts;
- Conserving the gene pool, maintaining existing ecosystems.

Status of technology

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- In Vietnam, integrated coastal zone management (ICZM) is increasingly receiving attention in the management of natural resources and protecting the coastal environment both at central and local levels.
- The project on integrated coastal zone management has been implemented in some areas of Vietnam, especially in coastal areas in the North Central and Central Coast. Prime Minister signed Decision No. 158/2007/QD-TTg on approving the program on integrated management of coastal areas in the North Central and Central Region in 2010 towards 2020, creating the legal framework for the 14 provinces and cities directly under the Central Government in coastal North Central and Central Coast implement integrated coastal zone management.
- Some provinces and cities have developed strategies and action plans for integrated coastal zone management, established databases and information systems management; and raised awareness for officials as well as local people on integrated management of coastal zone.

Application potential

- ICZM is attracting more attention of both national and local natural resources and environmental managers in Vietnam;
- Several ICZM projects area underway in some areas in Vietnam, and on 9 October 2007, the Prime Minister signed Decision 158/2007/QD-TTg to establish the *Program on Integrated Management of North Central Coastal Zone and Central Coast by 2010, with vision towards 2020*, which forms a legal framework for 14 provinces and centrally controlled cities alongside the Northern Central coastal strip and Central Coast to manage their beaches in an integrated manner ;
- Provinces started to develop ICZM strategies and action plans, build database on coastal natural resources and environment, and organize awareness raising activities for officials and people.

Barriers

- Requiring comprehensive management between local and central authorities, international cooperation and coordination between public and private sectors.
- Requiring such interdisciplinary knowledge as ecology, geology, marine biodiversity, economy, technology, politic and laws etc...

Costs

Implementation and technology application costs

- The cost of deployment depends on the cost of information collection, database construction in coastal areas and the cost of training, capacity building, organizational structure and coordination costs to hire experts. Incremental costs to adapt to climate change (compared to conventional technology)
- Depending on the cost increase due to increasing number of situations, scenarios need to build and increased manpower to deploy content management arisen in the integrated management of coastal.

4 WATER MANAGEMENT SECTOR

4.1 Harvesting rain water from rooftop for household usage

Technology description

- A local traditional technology in developing countries to supply water for domestic activities to local communities when there is no central water supply system. In developed countries, people store harvested rain water in tanks for gardening, toilet flushing, or washing. This technology is being developed in Germany, the Netherlands and the US.
- In Vietnam, people have been storing rain water from rooftop in cement tanks or barrels for domestic usage.

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Social-economic benefits

- Diversifying water supplies for households.
- Meeting water demand in dry periods.
- Cutting costs on water purchase and saving time to transport water from long distance.

Environmental benefits

- Reducing flood risks in the wet season, supporting adaptation to climate change.
- Reducing pressure on water to avoid surface and ground water degradation.
- Preventing water-borne disease.
- Reducing energy consumption and GHG emission.

Status of technology

- It is the endogenous technology and used as a source of water supply of the traditional rural communities. Farmers have long-known taken rainwater from the roof patio area in concrete tanks, water jars for daily use.
- In urban areas there has been research on collecting rainwater for garden irrigation, toilet and laundry.

Application potential

- Traditional technologies: it has high potential in rural areas, where there is no central water supply system;
- Harvesting rainfall from rooftop for watering, toilet use, or washing: under research for application in house designing and construction in urban areas.

Contribution for adaptation: It diversified sources of water supply for households and reduced floods by collecting runoff from the rooftop during storms.

Barriers

- Rooftop materials, house design and rooftop are not suitable for collecting and storing rainfall; lack of space for storing collected water;
- Air pollution affects rainfall water quality.

Costs

Implementation and technology application costs

- Capital invested about 200 USD/ water tank (for households in remote areas). For urban areas the cost depends on the cost of terrace design, construction and size of the project.

Incremental costs to adapt to climate change (compared to conventional technology)

- It will increase operating costs and maintenance collection systems and rain water tanks.

4.2 Harvesting runoff rain water for public storage

Technology description

- It is used to harvest rain water from mountain cracks, rivers, streams etc... to store in small reservoirs or public tanks, or household barrels for household uses or production in dry periods.
- Commonly used by villagers in mountainous areas in the north such as Cao Bang, Ha Giang and the Central Highlands. Small reservoirs are under construction for agricultural and domestic uses in northern highlands or the central region.

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Socio-economic benefits

- Securing water supply for households and production in dry season periods.
- Reducing costs and time spent on long distance water transportation.
- Stabilizing domestic and production activities in agriculture or livestock in dry areas.

Environmental benefits

- Reducing flood, erosion, helping to adapt to climate change
- Reducing energy consumption and GHG emission.

Status of technology

- Commonly used by villagers in mountainous areas in the north such as Cao Bang, Ha Giang and the Central Highlands. Small reservoirs are under construction for agricultural and domestic uses in northern highlands or the central region.

Application potential: Highly applicable in arid areas, semi-arid areas, rural areas, in the mountains or highlands.

Barriers

- Possible conflicts over access the water sources.
- Negative impacts on the environment and ecosystem in the downstream of the reservoir.
- Risks of spreading epidemic for human and animals due to using the same public source of water.
- Difficulty in locating and determining the proper scale of reservoir or public's storage to meet the requirements.
- Projects are normally needed survey, planning, designing, and construction many technical items while the poor local conditions make it difficult to demonstrate.
- Requiring high investment cost that the poor local community cannot afford.

Costs

Implementation and technology application costs

- Investment funding requirements often depend on building location, size of the reservoir, type of work (backfill, concrete dams), pipe costs and other factors. The initial investment cost for the reservoir typically ranges from 6USD/m^3 for soil dam and 270USD/m^3 for concrete dam.

Incremental costs to adapt to climate change (compared to conventional technology)

- It increased operating costs and maintenance process is designed with the ability to adapt to climate change.

4.3 Deep well water extraction in the dry season

Technology description

- New technical skills of drilling for deeper intrusion into the ground in order to extract water more efficiency; fixing the damaged wells; drilling provision wells for dry season.
- Widely used in place of surface water in rural households.

Socio-economic benefits

- Supplying fresh water, adding to the deficit in water balance in dry periods.
- Reducing negative impacts on public health, preventing epidemic diseases.
- Reducing household costs due to the cut of the water used.

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Environmental benefits: Ensuring the environment and sanitation; limiting epidemic diseases among the community.

Status of technology

- It has been popular development instead of other surface water sources in daily life in rural areas.

Application potential: High potential in rural areas, where there is no centralized water supply system. In dry areas along the central coastline, on the Central Highlands, or constantly flooded areas in the rainy season in the Red River Delta or the Mekong River Delta.

Barriers:

- Lack of hydro-geological data.
- Arsenic and fluoride contamination in deep wells.
- Low community awareness on sanitation.

Costs

Implementation and technology application costs

- The cost of implementation vary greatly, depending on the depth of water table, geological drilling area, the cost of materials as well...

Incremental costs to adapt to climate change (compared to conventional technology)

- The cost increases due to adapt to climate change and is determined depending on the depth of the wells based on the fluctuation of forecast groundwater level.

4.4 Household Water Treatment and safe Storage (HWTS)

Technology description

- Widely used with traditional methods like boiling water to modern technologies such as disinfecting drinking water by ultraviolet, RO filtration, or chemical disinfection, etc. and safely storage (sanitized bottlers or tanks).
- Marketed with a wide range of treatment equipment, filters or safe storage equipment for households. Purified water, bottled sterilized mineral water are highly commercialized.

Socio-economic benefits

- Increasing drinking water and improving life quality.
- Cutting costs in treating supply water.
- Helping to market fresh, purified water.

Environmental benefits: Preventing the public from outbreaks of epidemic diseases

Status of technology

- The traditional approaches have been widely applied, the modern methods have been commercialized for many kinds of devices.

Application potential: Can be applied in households and in production.

Barrier: Lack of awareness in sanitation in rural or remote areas.

Costs

Implementation and technology application costs

- The cost for deploying technology depends on the method of application and application scale of technology.
Incremental costs to adapt to climate change (compared to conventional technology)

- It depends on design costs, change of specifications, replacement of the drain devices such as filters.
- The cost of training, raising awareness of the community.

4.5 Recovering and reusing water

Technology description

- There are central wastewater treatment facilities in urban residential areas and in industrial areas. Treated wastewater will be reused in industries and agriculture later.
- Laws and regulations on industrial and urban wastewater treatment have been issued before discharging wastewater.

Socio-economic benefits

- Diversifying sources of water supplies;
- Reducing production costs by recycling water.

Environmental benefits

- Environmentally-friendly, reducing wastewater discharge and pollution, preventing diseases.
- Sustainable development of surface and ground water resources.
- Protecting wetland ecosystems;
- Reducing energy consumption and GHG emission.

Status of technology

- The technology has been applied in the wastewater treatment plant concentration of urban residential areas or the industrial wastewater treatment plant.

Application potential: There is a huge demand in urban and industrial areas

Contribution for adaptation: The recovered and reused water helps to diversify and conserve sources. By using retreated water for multi purposes (except to drinking) can reduce degradation of water sources and prolong their longevity. Moreover, retreated water can be pumped directly to the ground for recharging and preventing salinity intrusion in estuaries.

Barriers

- Institutional capacity and policy is not strong; there are many overlapping views in the policies and cannot meet the fact.
- Low awareness of environmental protection.
- Increased production costs due to wastewater treatment.
- Lack of confidence in the quality of reused water.
- Most cities do not have a wastewater treatment plant that meet requirements.
- Many technologies are still under research; therefore the technology has not been fully commercialized.

Costs

Implementation and technology application costs

- The investment cost of water treatment systems, technology transfer and operating costs as well as water quality requirements for the output to be reusable.

Incremental costs to adapt to climate change (compared to conventional technology)

- The cost to adapt to climate change depends on process technology and operating costs, maintenance, equipment maintenance in terms of more severe climate change.

4.6 Controlling water leakage and preventing loss in water supply

Technology description

- Water loss control: decentralization; water level meters are installed at the sub-regional level.
- Leakage detection: technologies such as acoustic detectors, infrared, chemical marking or hydraulic principles are being used.
- Fixing leaks: research and study on applications and use of new materials (for pipes, solder mount) and handling leaks.

The concept of preventing water loss has appeared in Vietnam for 15 years. There have been researches and programs to prevent water loss, with limited success as the rate of water loss remains high (30%). The Ministry of Construction has submitted the proposal for a national program to prevent water loss until 2025 to the Government for approval.

Socio-economic benefits

- Allowing water supply companies to enhance their pipeline management, client database metadata system and reduce leakage ratio.
- Reducing treatment, maintenance and pipe replacement costs.
- Reducing costs of water supply.
- Improving management capacity of water supply systems.
- Improving customer services.
- Reducing operating costs.
- Preparing a long-term plan to replace the pipes.
- Developing the asset management system of the water supply system.

Environmental benefits

- Reducing pressure on water resources and water conservation.
- Reducing energy consumption.

Status of technology

- The concept of preventing loss of water occurs only in Vietnam for 15 years. There are many studies and many programs against water loss, but the effectiveness is limited and the rate of water loss is very high (30%). National Program against water leakage by 2025 of Ministry of Construction is submitted to the Government for approval.

Application potential

- Great potential in older urban areas with old pipe systems that have not been synchronized and badly damaged.
- There is potential develop this system in parallel with fresh water programs in rural areas.

Barriers

- Economic efficiency is not high compared to the cost of implementation.
- The capacity of the water supply entity is limited.
- Lack of data on underground work in areas that need of repair or replacement;
- Lack of effective policies and regulations.

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Costs

Implementation and technology application costs

- It depends on training costs, training, raising awareness of the community, cost management, operating and equipment costs.

Incremental costs to adapt to climate change (compared to conventional technology)

- The cost to adapt to climate change depends on the cost of replacing pipes, equipment costs change more durable and consistent with the extreme weather conditions caused by climate change.

4.7 Managed aquifer recharge (MAR)

Technology description

- Types of MAR such as absorption through the walls, absorption through the dunes, the lake, seepage tank, rainwater collection tank, sand dams, underground dams; replenishment, aquifer storage recovery (ASR) , aquifer storage transfer and recovery (ASTR) have been studied in Vietnam.
- Has been effectively deployed in many countries around, the world especially developed countries like USA, Japan, Germany and some developing countries like Mexico ...

Socio-economic benefits: Storing water to secure water demand of household uses and production.

Environmental benefits

- Storing water in the aquifer for future use.
- Balancing water demand and water use.
- Reducing water loss due to evaporation and surface runoff.
- Preventing runoff flows from rain and soil erosion.
- Improving water quality, maintaining flows in rivers and streams.
- Management of seawater intrusion.
- Transporting water; aquifers acting as plumbing systems.
- Maintaining a stable water table, reducing the risk of land subsidence.

Status of technology

- The technology has been being researched in Vietnam.

Application potential: There are potential applications in areas where groundwater is being exploited, or there are such occurrences as subsidence, water table lowering in Hanoi and Ho Chi Minh City and the central coastal strip.

Barriers

- Must be implemented in parallel with other technical and management solutions.
- Only feasible in some areas with suitable conditions.
- Profit and distribution of economic benefits is unclear.
- Awareness of the people.

Costs

Implementation and technology application costs

- The cost of application deployment technology depends on the technological options are selected, the conditions of the deployment area, the cost of equipment, technology transfer, training...

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Incremental costs to adapt to climate change (compared to conventional technology)

- Up to now, there is not enough information to evaluate.

4.8 Desalinization of sea water for fresh water

Technology description

- A promising technology which has been applied to large water filtration plants in Israel, Singapore, Australia and Korea, the United States.
- There are water purification plants in Hon Tam, Nha Trang with a capacity of 1,000 m^3/day. Water purification technology is mostly under research. Small-scale studies on applications of water supply services to offshore islands, rigs and vessels at sea have been conducted.

Socio-economic benefits

- Diversifying water supply to meet the demand in water-scarce areas such as islands, rigs and vessels.
- Reducing the cost of transportation to areas of water scarcity.

Environmental benefits

- Reducing energy consumption in transportation of water.
- Reducing pressure on water resources, water shortage droughts.

Status of technology

- In Vietnam, there was the sea water purification plant on the islands of Hon Tam, Hon Tre in Nha Trang with capacity of 1,000 m^3/day. However, sea water purification technology is in the majority of research and development applications in the context of Vietnam. There have been research and application of small-scale water supply services to the islands and drilling platforms and ships at sea.

Application potential

- Can be applied to large-scale water supply in water-scarce areas such as islands, rigs and vessels;
- Can be applied in a small scale in the drilling rigs and ships.

Barriers

- More expensive than normal technologies;
- May impact on waste discharge to the environment;
- Has to import equipment, high capital costs, high maintenance and operation costs;
- Requiring complicated operation and maintenance techniques;
- Consuming a lot of energy to operate, thus releasing higher amount of GHG.

Costs

Implementation and technology application costs

- The cost depends on regional conditions of deployment, the salinity of sea water, equipment used, the size of water supply.

Incremental costs to adapt to climate change (compared to conventional technology)

- It depends on design costs, material redundancy design, maintenance procedures, maintenance to cope with the harsh conditions due to climate change.

4.9 Safe water supply plans

Technology description

- Technical procedures of this technology have been completed, including: systematic assessment, observation and management of water sources;
- In 2006, Vietnam carried out pilot projects of safe water supply and capacity building activities such as staffing, guiding, monitoring and implementing the plan and roadmap to safe supply; studying how to incorporate the plan into existing programs and projects; raising public awareness on safe water supply.

Socio-economic benefits

- Helping water supply entities to flexibly cope with changes in water quality.
- Supporting the development of sustainable water extraction plan of water supply entities.
- Preventing risks of water-borne epidemics.

Environmental benefits

- Helping to control toxic substances which make it more vulnerable to climate change.
- Restoring polluted water.

Status of technology

- In 2006, Vietnam has built a pilot water safety plan and organize training in a few localities. In 2011, Ho Chi Minh City has implemented water safety plans include all team events, guide, inspect, supervise and implement the roadmap plan and safe water supply; integrated study of water safety plans in programs, plans and projects already underway, building advocacy programs to raise awareness of water safety.

Application potential: A new, underdeveloped technology which lacks of full assessment and needs testing to assess its potentiality.

Barriers

- Water supply entities' capacity and infrastructure is limited.
- Low awareness of water managers on water quality importance to public health.
- Weak coordination between sectors and sub-sectors.
- Increased costs for technology transformation, monitoring and management.
- Can not duplicate the safe water supply plan because it is very peculiar to a particular system.

Costs

Implementation and technology application costs

- It depends on training costs, training, transfer and equipment changes.

Incremental costs to adapt to climate change (compared to conventional technology)

- Up to now, there is not enough information to evaluate.

4.10 Integrated river basin management (IRBM)

Technology description

- It is the interdisciplinary technology which integrates all other management and technical methods for sustainable development in a river basin.

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- Currently, there are legal frameworks and research on IRBM. IRBM committees have been established. Some river basin environment protection committees have been active.

Socio-economic benefits

- Balancing social and economic benefits in a certain locality.
- Guaranteeing social benefits and equality.,
- Avoiding conflicts on the access and use of water.
- Facilitating balanced, harmonious social and economic development plans.

Environmental benefits

- Is an optimal option to manage, develop and save water resources.
- Conserving biodiversity,
- Protecting the local environment, habitats and landscapes.

Status of technology

- Currently in Vietnam there were legal provisions and research on integrated management of river basins. It has been decided to establish a plan of management basin. A committee of environmental protection in river basins were formed and put into operation.

Application potential: High potential for application in river basins.

Contribution for adaptation: Facilitating the conservation and efficient use of the available water resources to cope with climate change.

Barriers

- Not enough data to develop a management plan; lack of a database on water resources and basin environment.
- No adequate IRBM and water resources management framework.
- Limited coordination between local communities and central authorities.
- Conflicts on the access and use of water.
- Lack of regulations and an appropriate modality for the river basins management committee; the decentralization process is still very slow.
- Lack of understanding of water shortage.

Costs

Implementation and technology application costs

- The cost of deployment and application of technology depends on cost databases, construction coordination model of river basin management, training, labor.

Incremental costs to adapt to climate change (compared to conventional technology)

- There is not enough information to evaluate.

Annex 2. Market mapping

A proposed method for technology innovators to find barriers and problems is mapping market.

By this method, the group of experts discussed and exchanged information to build up a comprehensive picture of the entire existing system elements related to the development of new technologies and the linker / binding can cross between them. The relevant factors are mainly considered include:

- Environment that allows the introduction of new technologies (such as legal, institutional, organizational, cultural, geographical, economic and social conditions ...)
- The relevant object in the system (such as manufacturers, wholesalers, retail dealers, consumers, households producers ...)
- Supporting services (such as finance, quality management, performance, standards, etc ...).

Based on this picture, the Steering Committee and other stakeholders to identify existing problems in the system, from which barriers would be found out for each technology and common barriers to all technologies in the same field of sector. Next, by simple voting groups, implementation groups have pointed out the barriers that need to be addressed prior to deciding which measures short-term, medium term and long term for each field..

The market mapping is only applied for technologies which are classified by consumer and capital goods. For mitigation technologies, there is not any technologies of capital goods categories, and there are 5 technologies of consumer goods categories as Shifting from rice to upland grains; Genetic; Shifting from triple cropping to double cropping plus shrimp/fish/poultry farming; Application of biotechnology in selecting forest tree breeding to adapt to drought, floods and have high disease resistance and Agro-Forestry.

For technology of shifting from rice to upland grains, the market chain includes application, production; household producers; merchants; retailers and consumers. Next, the main related-market chain factors in the transfer and diffusion process of new technology are defined as: geographical conditions, cost, production cycle, infrastructure, For geographical conditions factors, we can see each region, locality has different natural conditions and following that, agricultural crops are also not the same. For this reason, we have to determine whether the geographical conditions of that locality is appropriate to convert or not? Therefore, the geographical conditions can be considered as a barrier in the transfer and diffusion of this new technology. On the basis of identified barrier, we can also provide some solutions to overcome the barrier such as identifying possible areas of conversion, pilot demonstration or researching to develop technology that can suitable for many localities. Or for cost factor, whether technology of shifting from rice to upland grains needs high investment or not and if the investment is high, this will be an obstacle for households making them think consider carefully before they invest. Therefore, cost is also considered as a barrier. Accordingly, one of the solutions is given as: setting up of the funds ... Similarly, the barriers are determined and the solutions overcoming barriers are also given in parallel in the transfer and diffusion of this new technology.

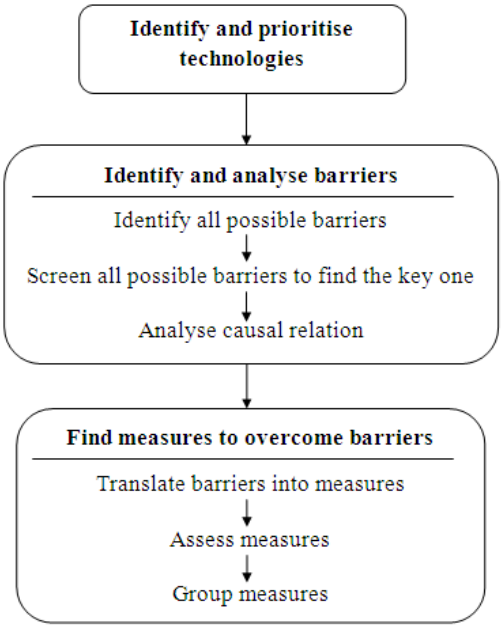
For genetic technology, market chain is the same as technology of shifting from rice to upland grains. The main factors related to the market chain are also basically similar, but there are also other factors in genetic technology such as socio-economic conditions ... That the gene is modified, the new breeds are developed is whether suitable for socio-economic conditions in the locality or not? This is considered as a barrier during the transfer and diffusion of new technology. The solutions coming to overcome the barrier can be: regionalization of products follow ecological area and pilot demonstration ... On this basis, a number of barriers and the solutions are determined to transfer and diffuse this new technology.

For the three remaining technologies - Shifting from triple cropping to double cropping plus shrimp/fish/poultry farming; Application of biotechnology in selecting forest tree breeding to adapt to drought, floods and have high disease resistance; and Agro-Forestry, the market chain is like which of two above technologies. The main factors related to the market chain are also basically similar, however there are also some other factors such as the coordination among agencies, culture, awareness, information systems ... For culture factor, depending each region, the people had had cultural traditions for a long time, whether the application of the new technology in agriculture has been changing their farming culture ever or not? Or for the awareness factor, how to popularize

knowledge for the farmers so that they understand the benefits of new technology application, because the farmers were not well-educated and their farming practices are also retrasmitted by their fathers, therefore it is difficult for them to acquire new ones. These are considered as barriers in the transfer and diffusion of new technologies. On the basis of the barriers, some solutions to overcome barriers are given such as opening training classes to expand knowledge, strengthen staff of agriculture and forestry encouragement ... Similarly, other barriers and solutions to overcome barriers were also determined together.

Specific market map for each adaption technology is presented below respectively. Following that, maps of analysing framework condition for them are shown in parallel.

Map of analysing framework condition for consumer goods and capital goods of adaptation technologies which based on two processes: Identifying and analysing barriers process and measures to overcome barriers process is given in the below figure:



Identifying and analysing barriers

Based on the analytic barriers in the actions plan for adaptation technologies to find the major barriers. Using causal relation hierarchy based on Logical Problem Analysis (LPA) to find the causes which affects to the main barriers. The purpose of the LPA method is to arrange the cause of barriers to a system. To link causes and barrier together into a tree diagram “causal relations” which shows why technology is not optimal. Causal factor tree is described as follows:

Cause → Barrier → Technology not optimal

Finding measures to overcome barriers

Having established a thorough understanding of the barriers, the next step is to analyse how the barriers can be removed or overcome.

Because of using Logical Problem Analysis in the barrier analysis, so the “causal relations” of the causal factor tree are converted into “measure-result relations” is described as follows:

Measure → Result (overcome barriers) → Technology optimal

However, the measures to overcome barriers in “measure-result relations” diagram must be suitable to solve the causes in the “causal relations” diagram, which lead to a complete system.

Thus, by dint of using the above measures, the process of identifying and analysing barriers came through "causal relations" diagram, and the process of finding measure to overcome barriers came through "measure-result relations" diagram.

The market map and map of analysing framework condition for each technology classified by consumer and capital goods are presented as follow:

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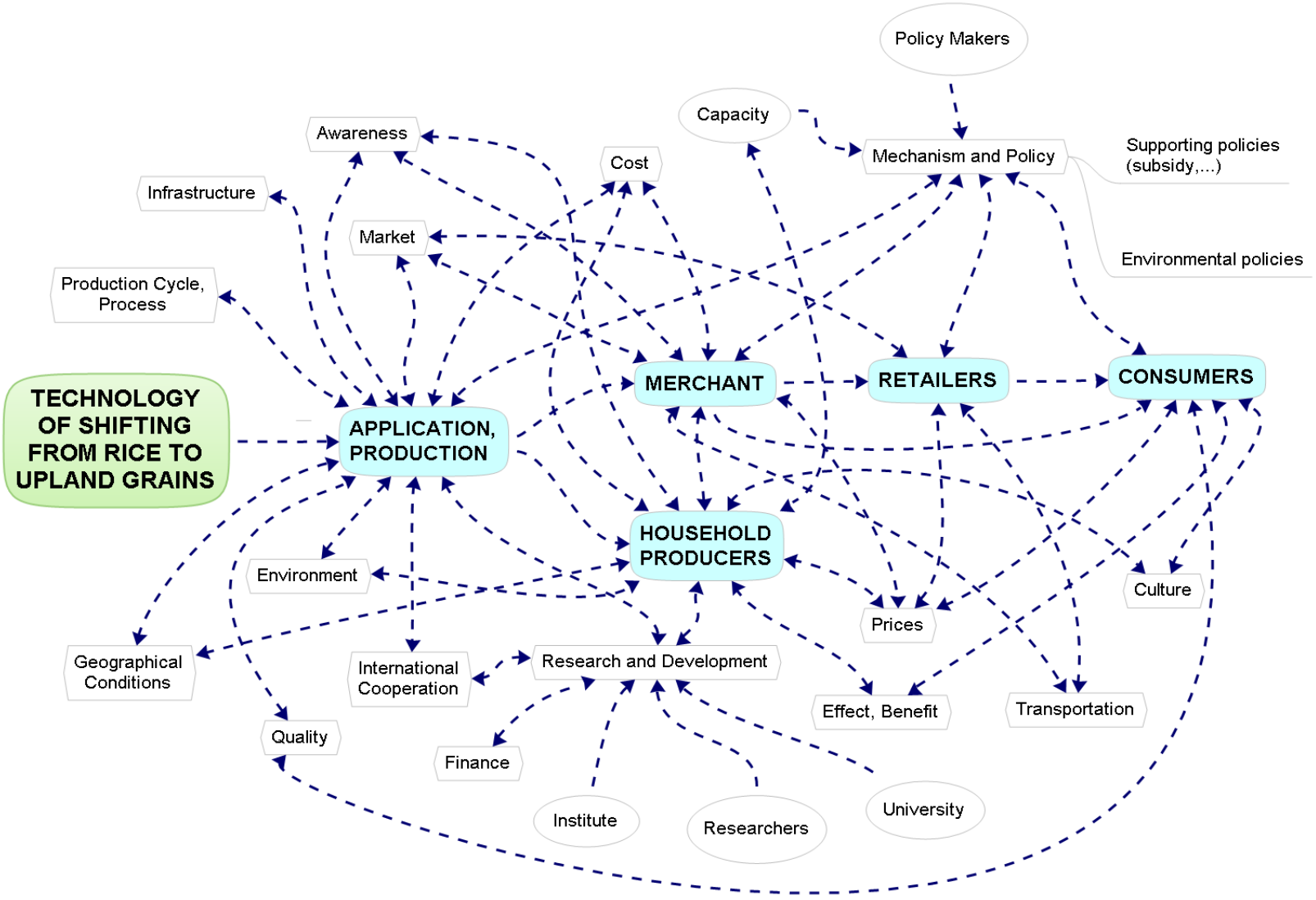

Figure 16 - Market map for Technology of Shifting from Rice to Upland Grains

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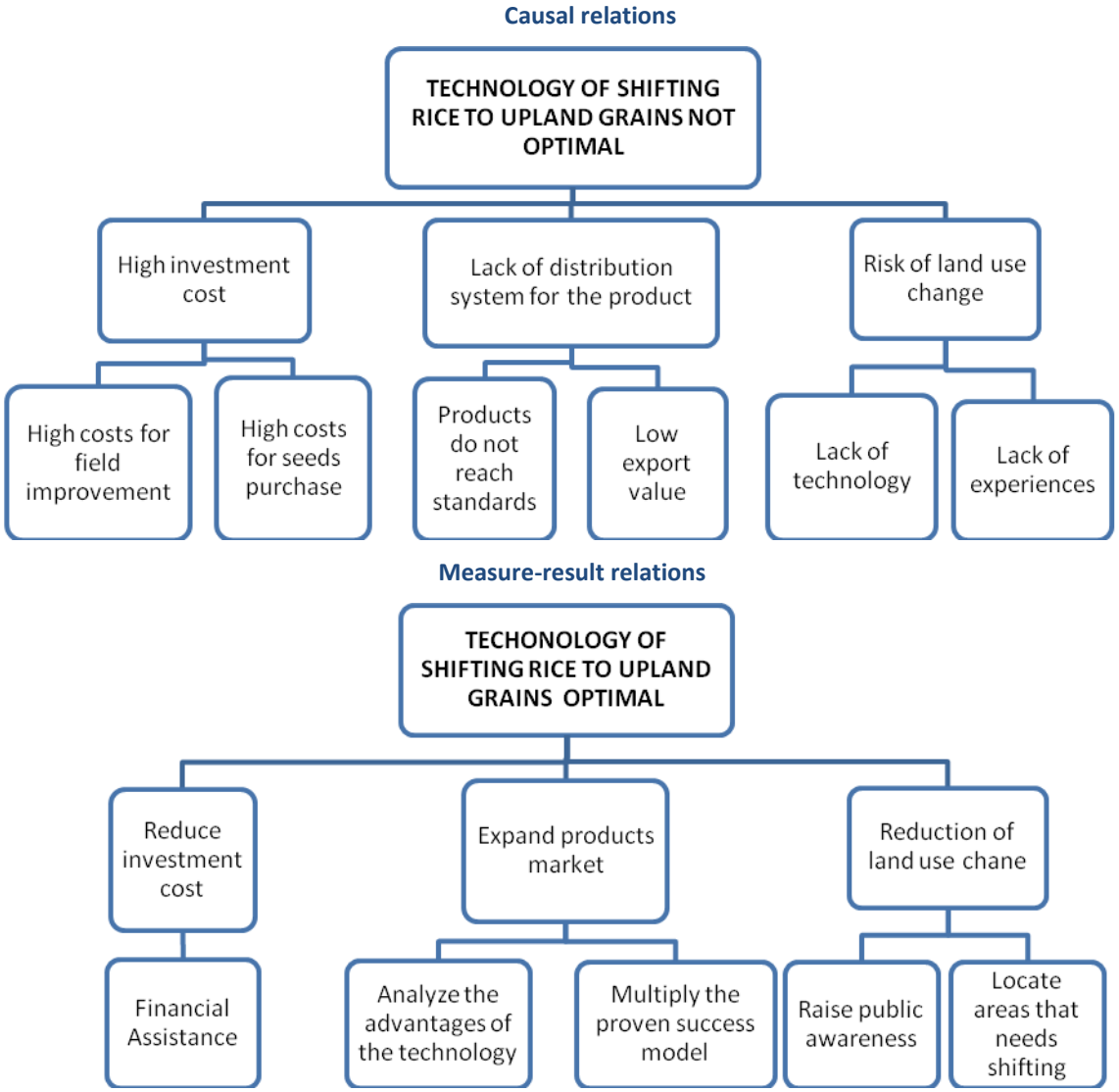

Figure 17 - Map of analysing framework condition for Technology of Shifting from Rice to Upland Grains

Annex 2

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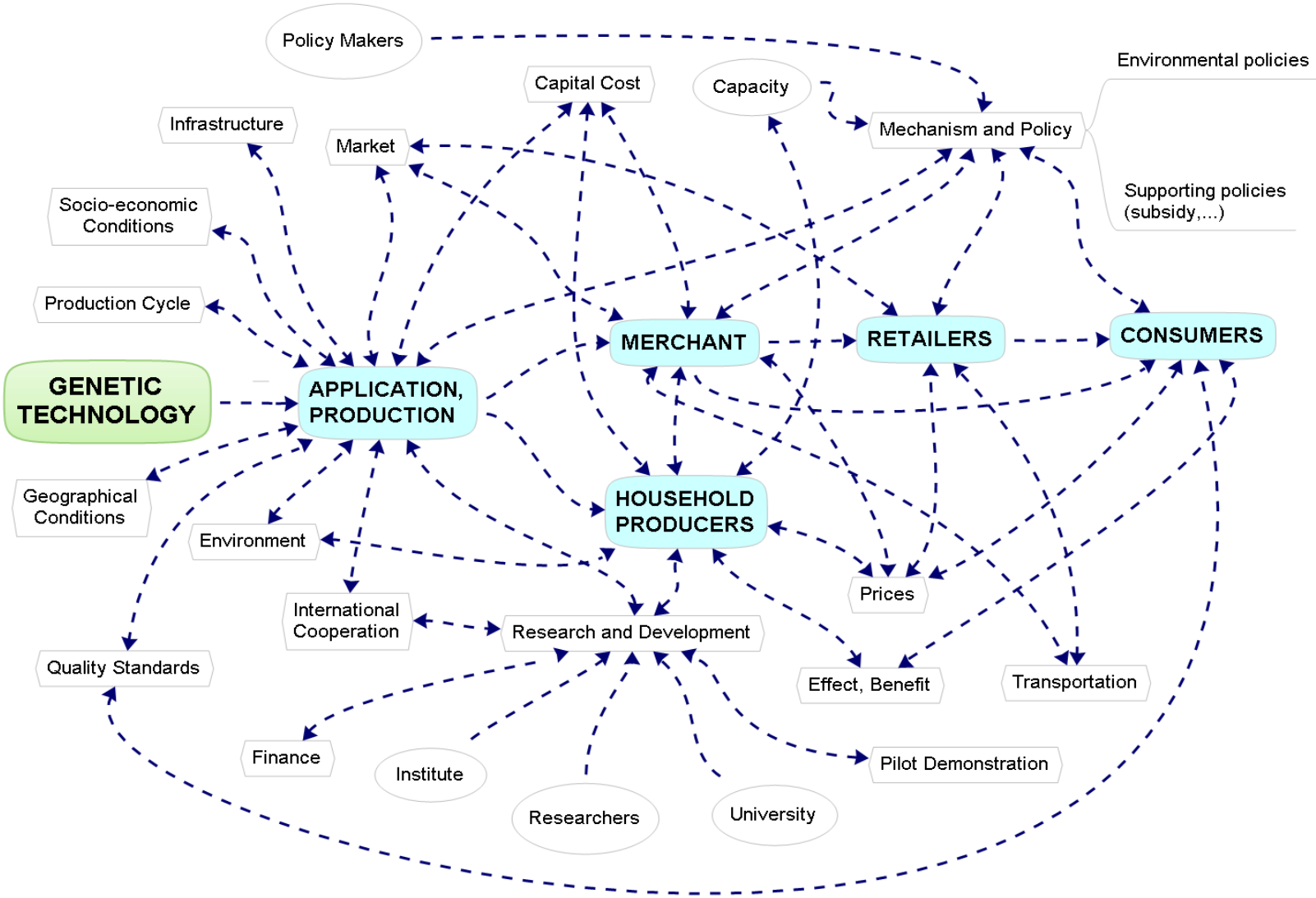

Figure 18 - Market map for Genetic Technology

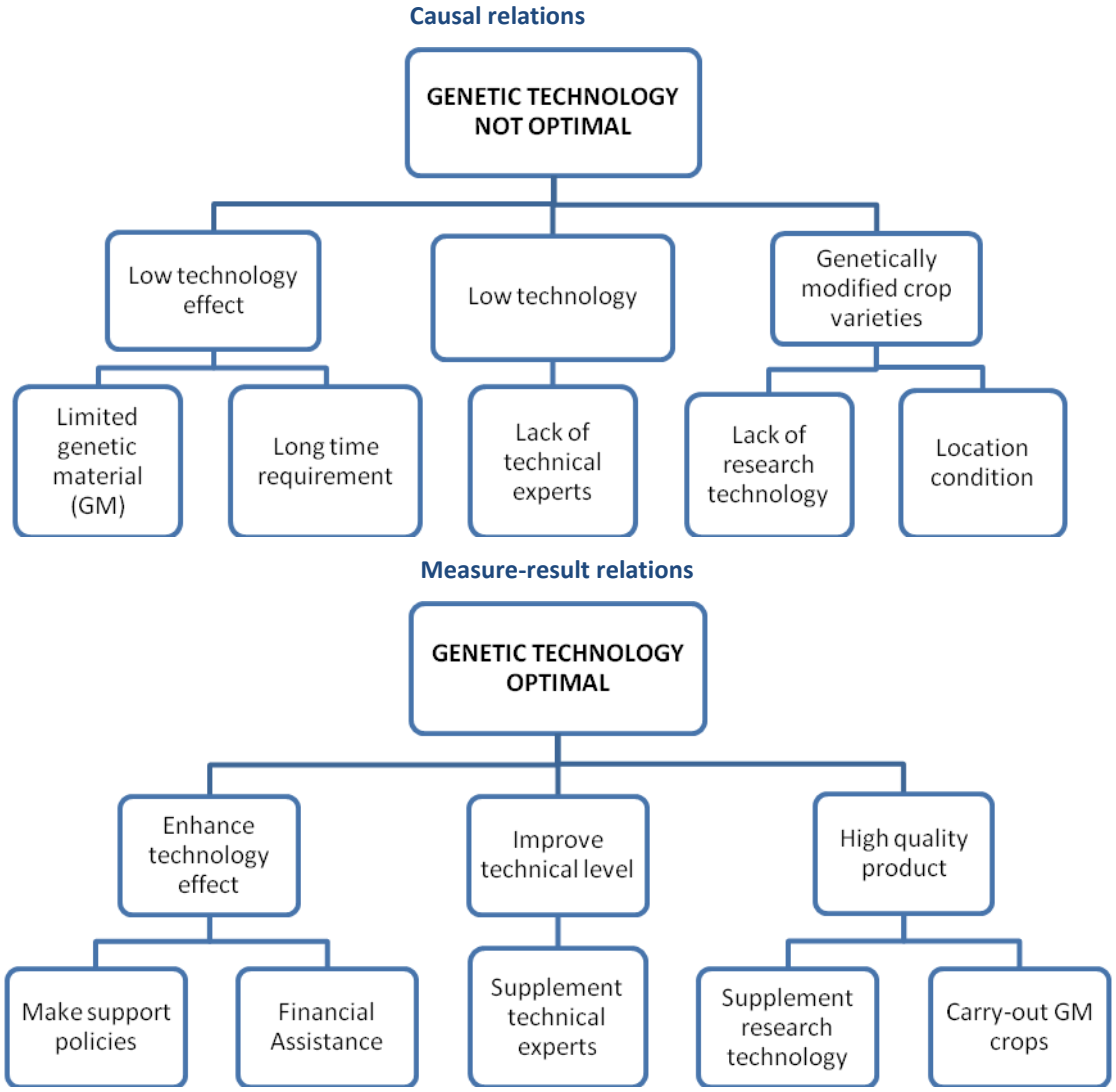

Figure 19 - Map of analysing framework condition for Genetic Technology

Annex 2

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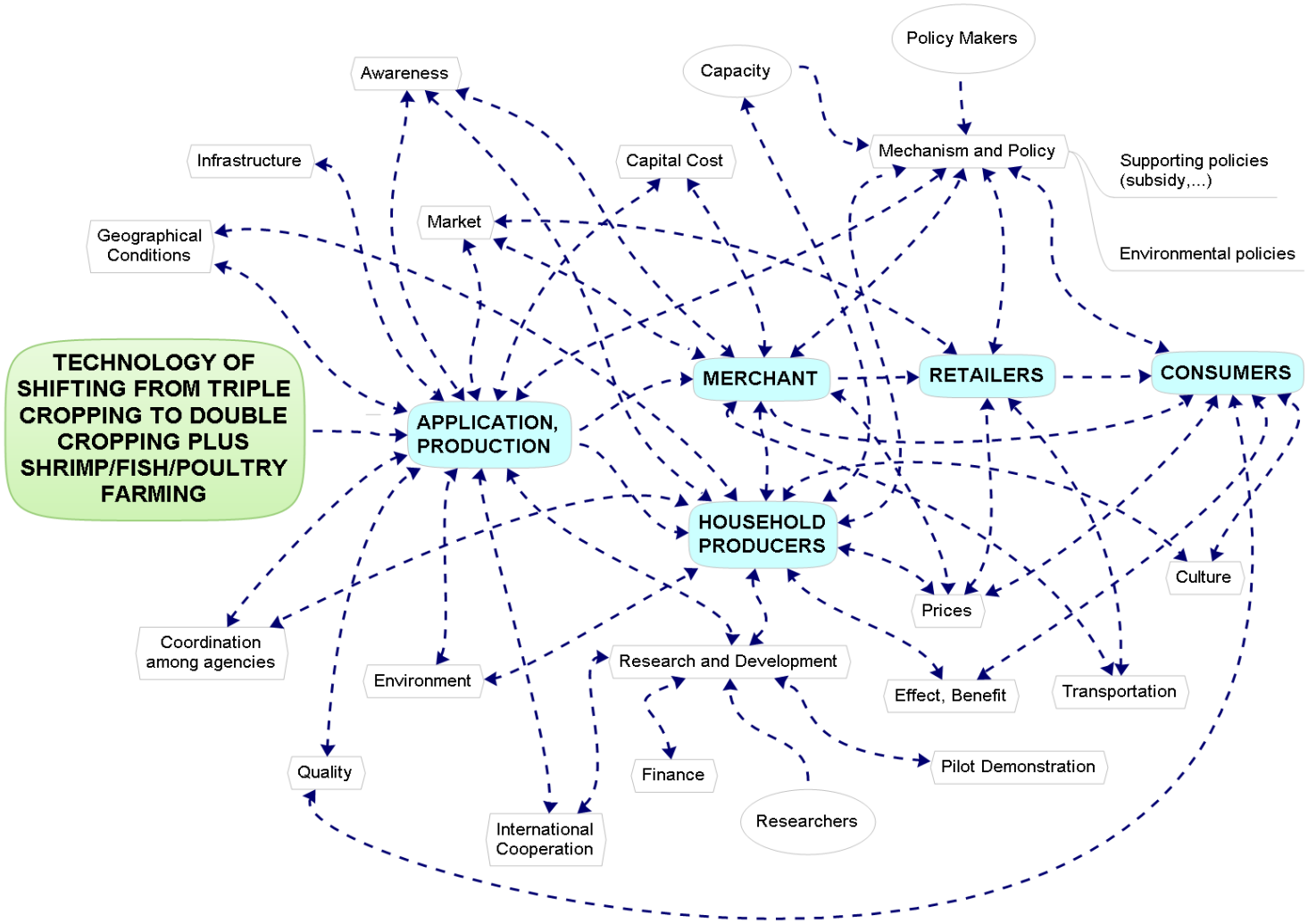

Figure 20 - Market map for Technology of Shifting from Triple Cropping to Double Cropping plus Shrimp/Fish/Poultry Farming

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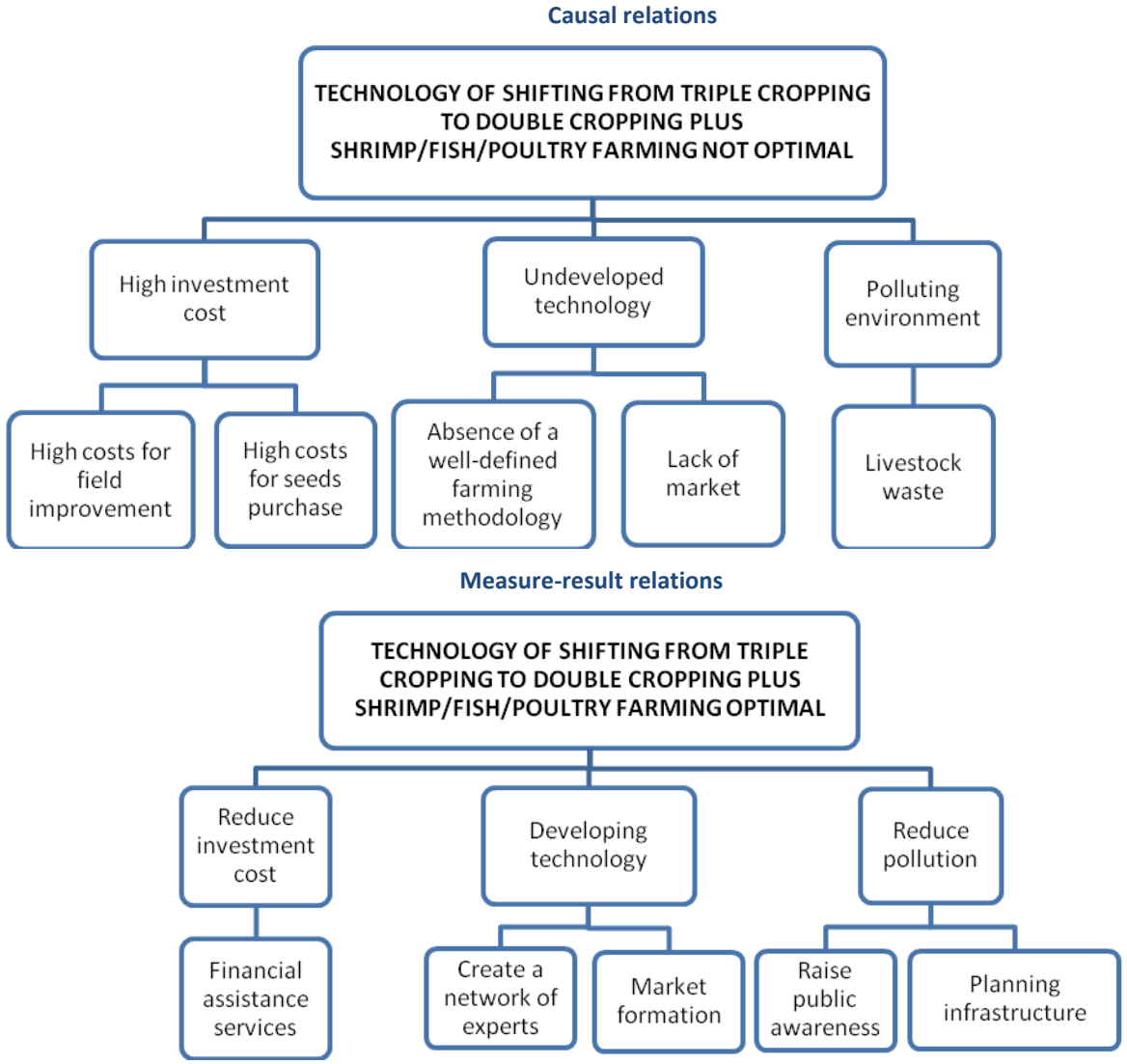

Figure 21 - Map of analysing framework condition for Technology of Shifting from Triple Cropping to Double Cropping plus Shrimp/Fish/Poultry Farming

Annex 2

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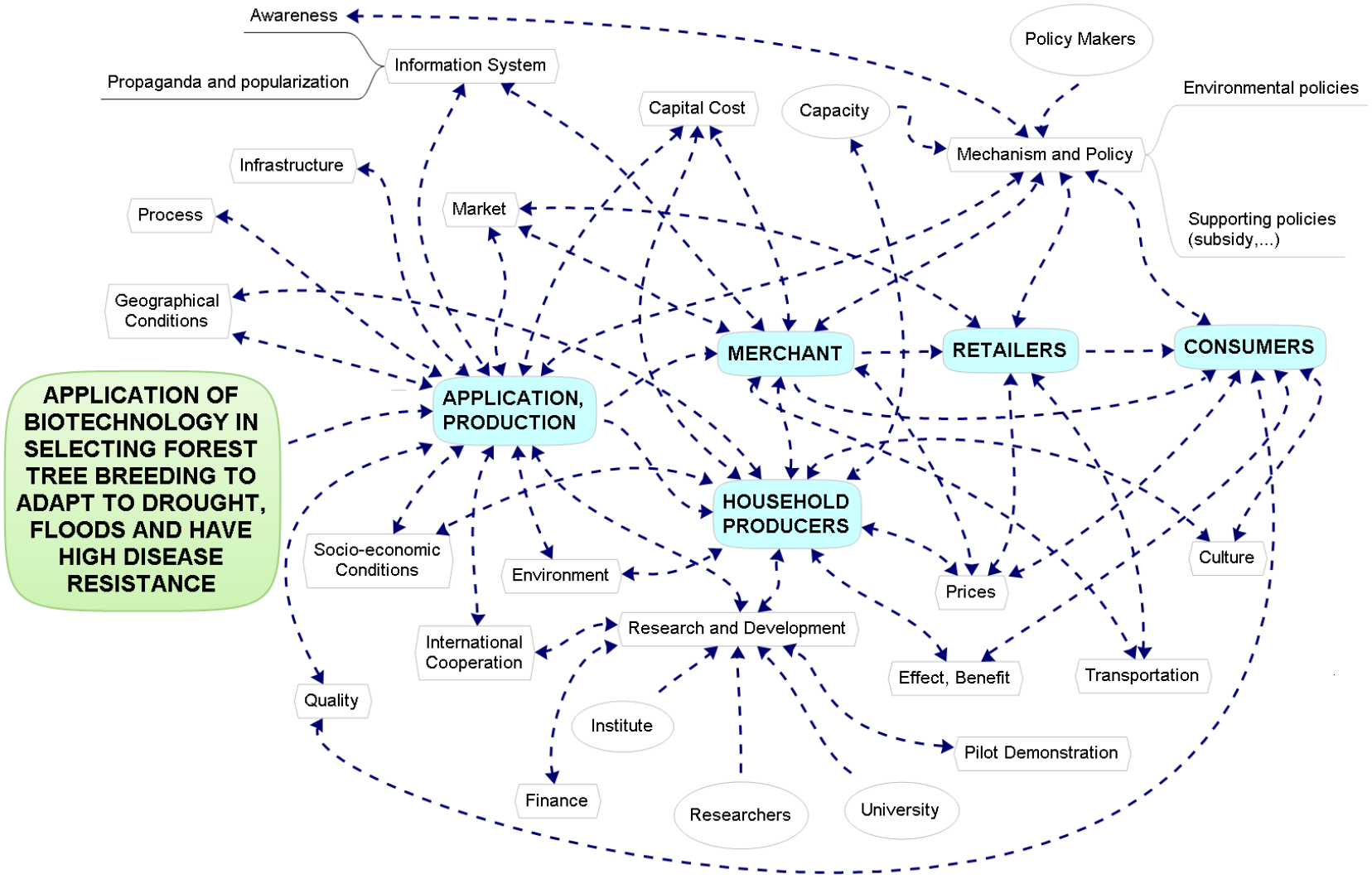

Figure 22 - Market map for Application of Biotechnology in Selecting Forest Tree Breeding to Adapt to Drought, Floods and Have High Disease Resistance

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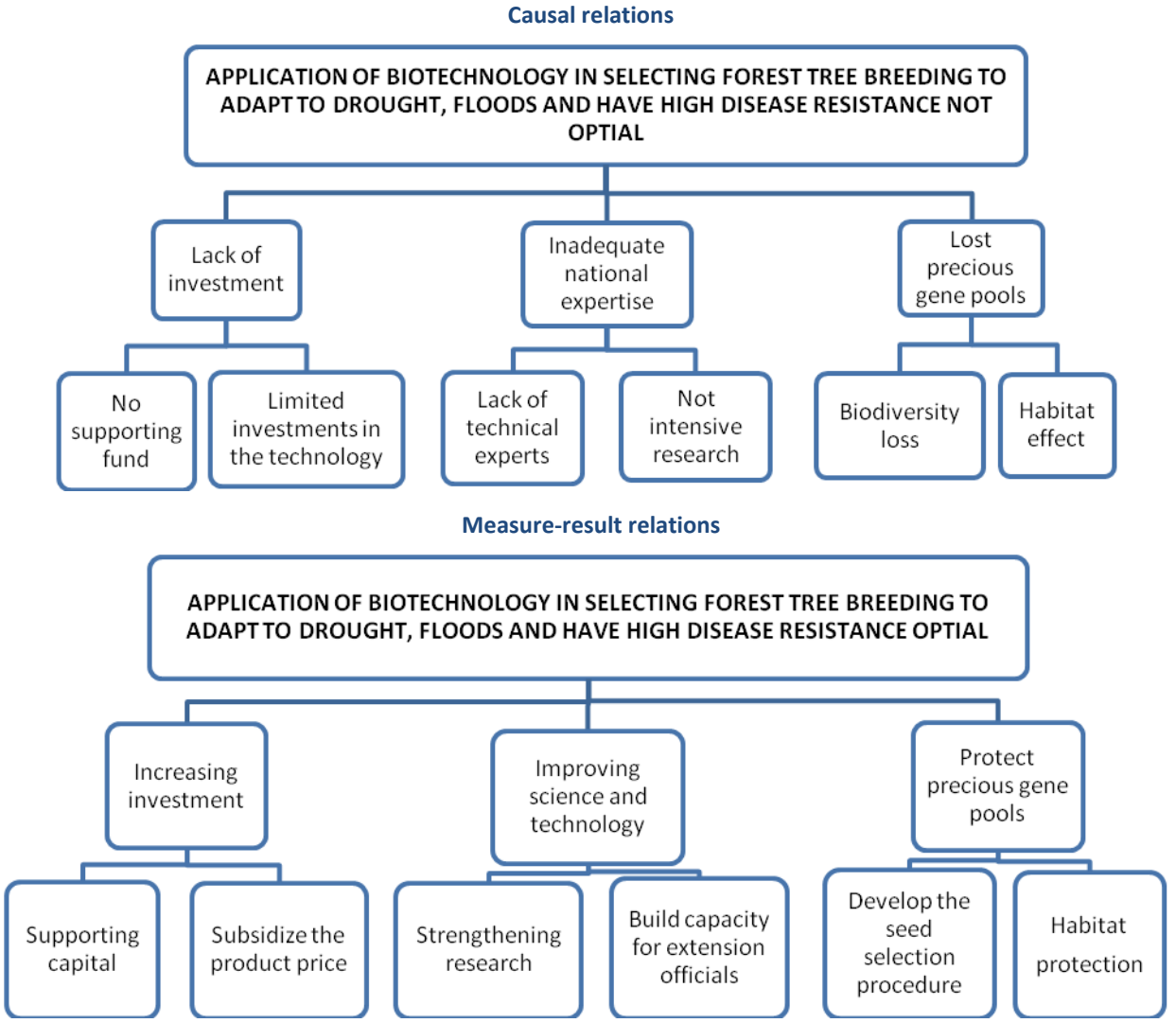

Figure 23 - Map of analysing framework condition for Application of Biotechnology in Selecting Forest Tree Breeding to Adapt to Drought, Floods and Have High Disease Resistance

Annex 2

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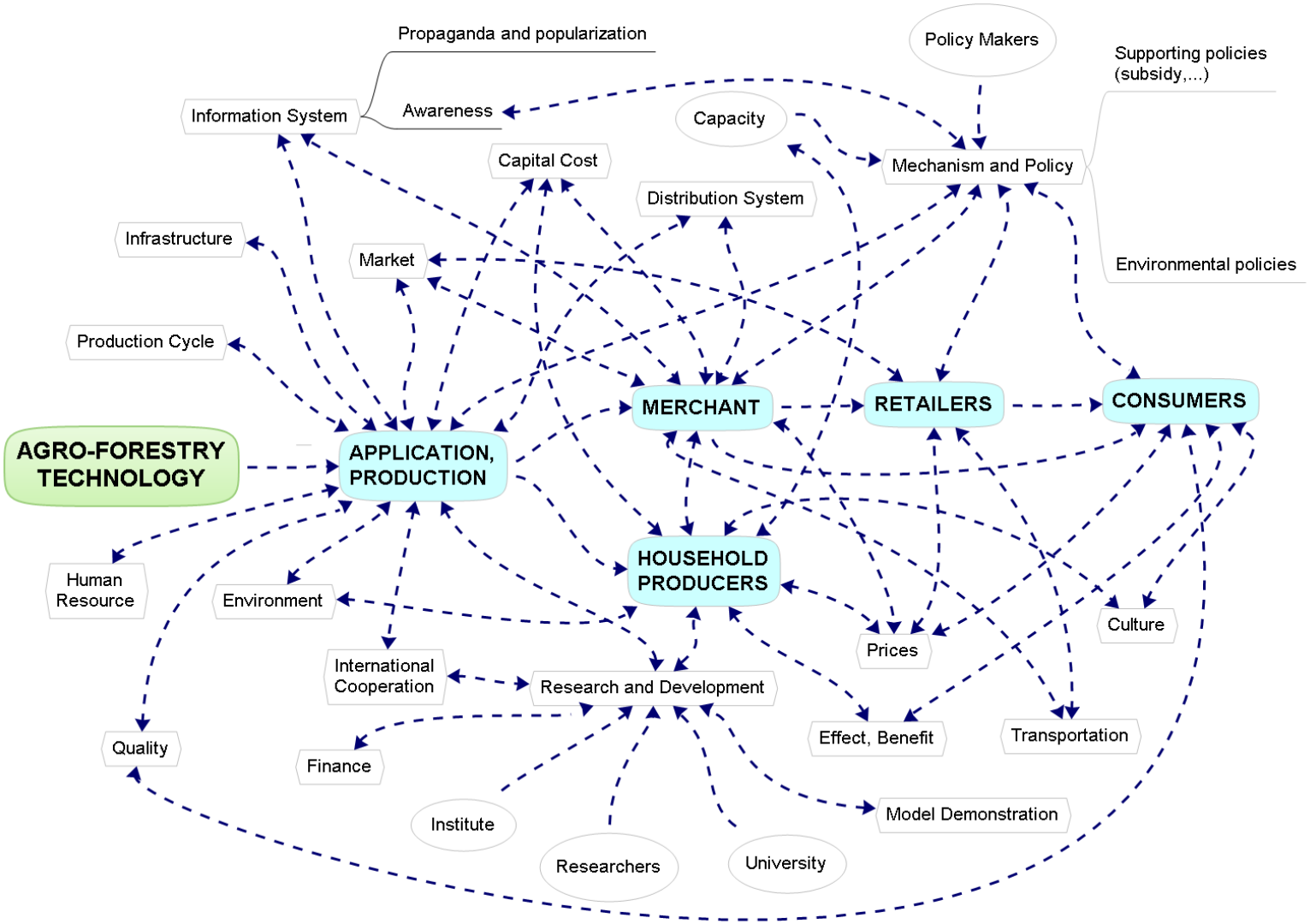

Figure 24 - Market map for Agro-Forestry Technology

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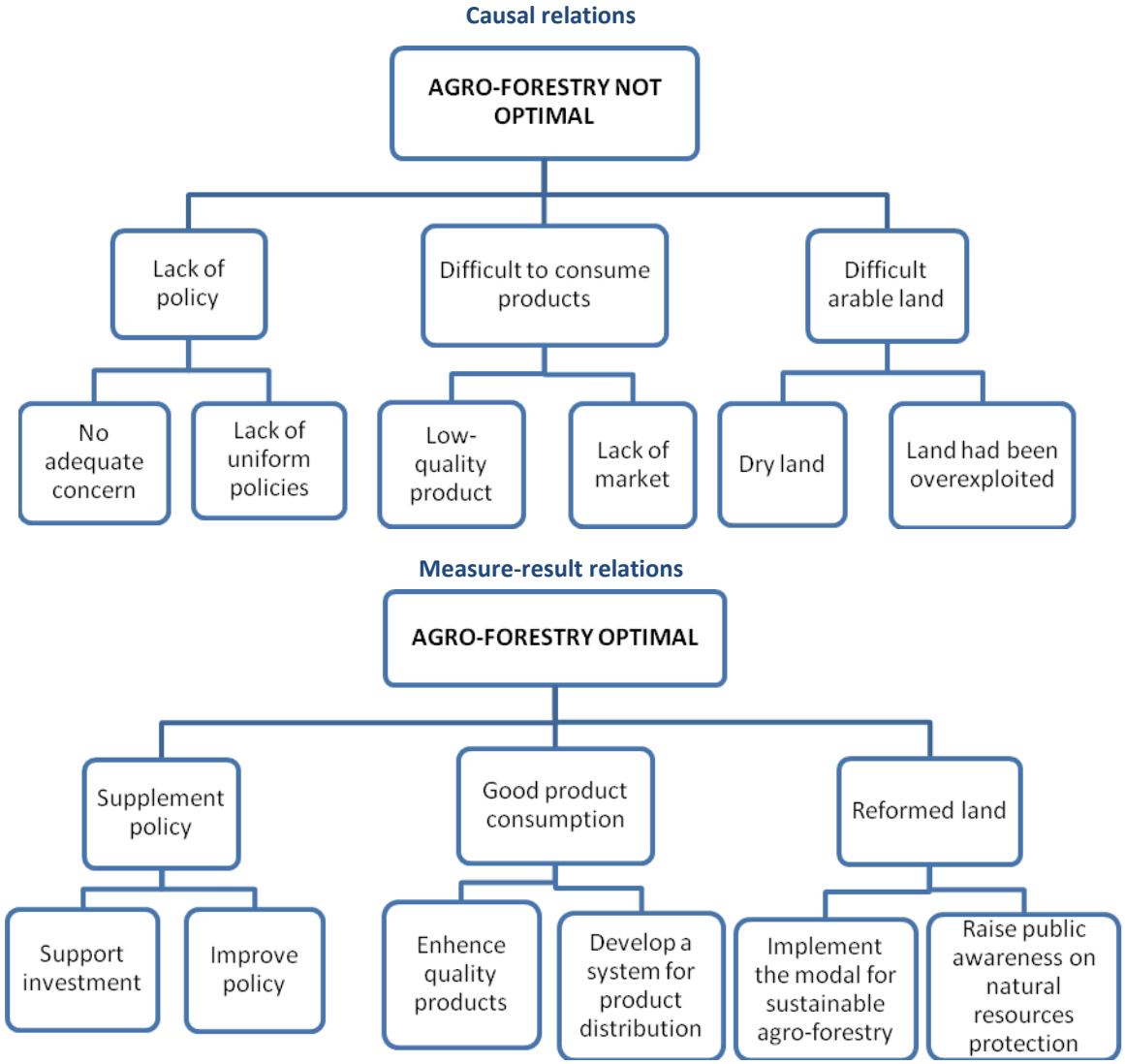

Figure 25 - Map of analysing framework condition for Agro-Forestry Technology

Annex 4

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Annex 3. Project Ideas

1 The project idea on genetic engineering which has the international support.

a) Title of project proposals for technology development

"Research on creating new high-yield and salt-and-drought-tolerance rice variety"

b) Project's information

- Introduction / Background: Starting from the actual needs:
    - Construction of a core genetic laboratory which includes molecular lab, tissue-culturing rooms, genetic-breeding room;
    - Capacity building for genetic-breeding officials;
    - Building a network of breeding ecosystems and research institutes;
    - Building testing networks and quick transfer to field production.
- Goals and objectives:
    - Goals: To collect the genes of the high-yield group; especially high-tolerant varieties;
    - Objective: To create dominant hybrids that can resist the external conditions such as salinity, flooding and drought.
- Relations of project with the priorities in sustainable development of the country:

  The project is related to food security and agricultural exports of the country
- Things that are obtained from the project as the value / benefits / messages:
    - Standard laboratory service for effectively breeding
    - Breed-working team
    - Diverse materials for the selection
    - New varieties for intensive cultivation and increasing productivity, yield stability for saline and alum areas.
- The scope and feasibility of the project:

  The project will positively affect the agricultural sector, particularly farmers, who have income primarily from farming.
- Timeline: 2012 - 2020
    - 2012-2015: Increasing facilities and strengthening human resources;
    - 2016-2018: Start putting equipment into operation, collecting genetic sources;
    - 2019-2020: Resulting resistance genes for testing.
- The requirements for budget / resources: $100,000,000 USD
- Estimated / measured: 10 research institutes specialized in rice, maize, beans, nuts, industrial crops
- The problems / challenges that may arise: undesired product
- The responsibilities and coordinate in the implementation:

  Ministry of Agriculture and Rural Development (MARD) is responsible for linking stages, connecting science and technology products and organizing the demonstration, testing and scaling.

2 The project idea on rice land conversion which has the international support.

a) Title of project proposals for technology development

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"Building a conversion model to change rice-land into fruit-trees land"

b) Project's information

- Introduction / Background:

Due to the impact of climate change, land has not enough irritation water in the dry season. That is why land is unsuitable for rice crops due to drought, low productivity and salinization/ chemical alum. Transferring the rice to dry crops will not need to invest more for irrigation, lowering production costs as well as achieve high-value merchandise, economic efficiency

- Goals and objectives:

- Goals: Successful conversion of paddy land limited by climate change (CC) into dry land crops that achieve economic efficiency;
- Objective: Researching suitable crops than rice; master plan development for the area, and building demonstration model.

- Relations of project with the priorities in sustainable development of the country:

The project is related to food security and adaptation program to CC.

- Things that are obtained from the project as the value / benefits / messages:

Achieving higher economic efficiency, overcoming yield unstable and inefficient

- Timeline: 2012 - 2013

- The requirements for budget / resources: 15 billion VND (750,000 USD)

- Estimated / measured: 150,000 ha of paddy land will be converted into dry land crops

- The problems / challenges that may arise: The income of upland crops is lower than rice

- The responsibilities and coordinate in the implementation: Responsibilities of the MARD, the agricultural departments

3 The project idea on 3 rice crops in 2 + 1 for fish / prawn / duck which has the international support.

a) Title of project proposals for technology development

"Planning for the cultivation 2 rice + fish / shrimp / 3 duck land converted from the 3 rice-crop land in Mekong Delta"

b) Project's information

- Introduction / Background:

During the rainy season in the land that has 3 rice crops, there are often floods which bring about uncertain yield and low economic efficiency. If this old crop can be used to breeding waterfowl and aquatic products (because of large area of water), it will make use of water and food sources in the flood water to feed the fish and shrimp. Duck and fish will be harvested in late rainy season and soil is released for the other two crops. This new technique will ensure both ecological change and higher incomes than rice monoculture.

- Goals and objectives:

- Goals: To successfully convert 3-rice-crop land includes an uncertain crop in the rainy season into 2-rice-crop and a crop planted waterfowl (ducks), seafood (fish / shrimp);
- Objective: Master planning for 3-rice-crop land into 2-rice-crop and a crop planted waterfowl (ducks), seafood (fish / shrimp), making the adaptation assessment of the intensive conversion.

- Relations of project with the priorities in sustainable development of the country:

- Stabilizing the rice-planting area and production;
- Adaptation to flooding regime and submerged by the impact of sea level rise.

- Things that are obtained from the project as the value / benefits / messages:

- Avoid damage due to flooding, salinity intrusion in the lowland rice-planting area;
- Replacing unstable rice production by aquatic /waterfowl production with higher incomes and more ecological sustainable.

- The scope and feasibility of the project:

The entire lowland rice production uncertain of the Mekong Delta and South East Regions

- Timeline: 2012 - 2020

- 2012-2015: Survey, impact assessment and prediction of floodplain areas;
- 2016-2018: Testing the potential models;
- 2018-2020: Newly planning and demonstration of models on a large scale.

- The requirements for budget / resources: $150,000,000 USD

- Estimated / measured: 1-1.5 million ha

- The problems / challenges that may arise: Time and level of submerge change yearly, monthly and affect the production.

- The responsibilities and coordinate in the implementation: MARD is responsible for deploying

4 The project idea on selected plant breeding with biotechnology with which has the international support.

a) Title of project proposals for technology development

"Developing high-quality timber trees for plantation economy"

b) Project's information

- Introduction / Background:

- Forest seeds in Vietnam do not have high quality but their demand for forestation are big;
- The project is expected to build a center in the South with modern laboratories that has biotechnology applications in breeding and selection and transfer of high technologies.

- Goals and objectives:

- Goals: To raise the value of forest production;
- Objective: To build centers able to transfer high-quality varieties for production facilities nationwide.

- Relations of project with the priorities in sustainable development of the country:

The project is suitable with forest seed program of MARD and improvement for program of forest protection and development by 2020.

- Things that are obtained from the project as the value / benefits / messages: Creating original basis for the development strategy of forest seeds, which replicate the model towards structure fundamental change of forestry planting varieties nationwide.

- The scope and feasibility of the project:

The proposed project is located in the priority programs of the MARD on plant varieties development in forestry and forestry development plans from now to 2020.

- Timeline: 2014 - 2020

- 2014-2015: Project Preparation;
- 2015-2018: Building the technical facilities, staffing and training;;
- 2018-2020: Investment in the development and expansion.

- The requirements for budget / resources: $ 2.6 million USD with resources mobilized from ODA and investment from the Government.

- Estimated / measured: To provide 30 million seedlings per year of timber species to serve as high quality raw material for forest and timber forests;

After 10 years, 70% of forest seeds are created can reach quality and technical standards.

- The problems / challenges that may arise:

- Technology transfer can have trouble on the mechanism and method;
- Difficulty in raising capital cost;
- Vietnam still lacks qualified staff expertise on this technology.

- The responsibilities and coordinate in the implementation: MARD has the acting part, other ministries related are MOST, MOP, MOF.

5 The project idea on agro-forestry technology with which has the international support.

a) Title of project proposals for technology development

"Develop the agro-forestry ecosystem combined with improvements on livelihood and environment in the two arid provinces of Ninh Thuan and Binh Thuan".

b) Project's information

- Introduction / Background:

Current status of desertification is a challenge in Ninh Thuan and Binh Thuan. The income of local people is low, mainly based on agriculture with low productivity.

The Project is expected to build 30 eco-villages with specific activities as forest protection and development of agro-forestry models in two provinces of Ninh Thuan and Binh Thuan.

- Goals and objectives:

- Goals: To assist people in arid regions in Ninh Thuan and Binh Thuan develop agro-forestry model;
- Objective: To improve ecological sub-regional climate and restore the fertility of degraded land areas in 30 villages participating in the projects.

- Relations of project with the priorities in sustainable development of the country:

- Suitable with the program of new rural construction;
- Serving poverty reduction programs, national programs to combat desertification prevention.

- Things that are obtained from the project as the value / benefits / messages:

- After 5 years, 30 typical eco-village are built in which farmers will actively integrate farming in adaptation to climate change;
- Setting up integrated farming system according to eco-village model in the project area in order to recover vegetation, improve the fertility of the soil and restore ecological environment.

- The scope and feasibility of the project:

- The scope of the project impact and feasibility of it: Creating jobs for local people in the project. Annually, thousands of worker are attracted to forestry, tourism and raise their income;
- To develop awareness of forestry in the community, environmental consciousness, landscape and improve the general forest as well as protection forest in particular.

- Timeline: 2014 – 2018 and divided into 3 components

- The first component: To develop criteria for classification, selection and design of eco-village;
- The second component: To construct eco-villages;
- The third component: To develop farming capacity, consumption and improve livelihoods.

- The requirements for budget / resources: $ 18 million USD with local budget is $ 2 million.

- Estimated / measured:

  - Increased productivity of agricultural crops by 20-50% compared to current, contributing to increased revenue GDP per capita in the project area increased from 266 USD / person / year now up to 484 USD/ person / year after 5 years;
  - 30 typically ecological villages are built.

- The problems / challenges that may arise:

  - Lack of overall planning and system link among modules of model;
  - Requires high initial investment;
  - Lack of forestry staffs and limited in level of ability.

- The responsibilities and coordinate in the implementation: MARD co-operates with National Target Program in Desertification and the two provinces of Ninh Thuan and Binh Thuan.

6 The project idea on rainfall and surface runoff collection technology to serve the community with which has the international support.

a) Title of project proposals for technology development

" Building 15 pilot rainwater collection systems for residents in the Northern mountainous of Vietnam"

b) Project's information

- Introduction / Background:

In some residential areas in Northern Vietnam, there are severe shortage of water for living and farming in the dry season, while redundant rainfall in the rainy season. The terrain is fine for construction rainwater tanks with big volume and low cost. Investigation and survey to locate and construct rainwater collection system for runoff that help improving the lives of residents in areas is essential.

- Goals and objectives:

  - Goals: To study a number of technologies for gathering rainwater runoff in accordance with geological and hydrology conditions in a mountainous are of Northern Vietnam;
  - Objective: To build and put into use a rainwater collection system for daily runoff and agriculture for some residential areas in a mountainous are of Northern Vietnam.

- Relations of project with the priorities in sustainable development of the country: Diversification of water sources.

- Things that are obtained from the project as the value / benefits / messages: To do poverty reduction in some mountainous residential areas.

- The scope and feasibility of the project: Some projects have been implemented in Vietnam.

- Timeline: 5 years

- The requirements for budget / resources: The cost of surveys, models, equipment installation, consult experts, building a collection system are estimated as 15 million USD.

- Estimated / measured: Build 15 rainfall collection systems. Each system cost 1 million USD according to the price \$20/m^3 and volume of each system is 50,000 m^3.

- The problems / challenges that may arise: Some reservoirs can be affected due to infiltration. Normally reservoir bed or walls depending on reservoir type and its location.

The responsibilities and coordinate in the implementation: MARD, Irrigation Department, local People's Committees.

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7 The project idea on Integrated River Basin Management (IRBM) technology with which has the international support.

a) Title of project proposals for technology development

"Climate change and integrated management of river basins in Vietnam"

b) Project's information

- Introduction / Background:

Climate change leads to the important changes on water resources in river basins. There have been studies on the effects of climate change scenarios on water resources for a specific river basins in Vietnam. The question is to study and propose methods of water management and scenarios of socio-economic development in the river basin in accordance with those changes.

- Goals and objectives:

- Goals: To analyze the effects of climate change on water resources in river basins, especially the change in water resources and water quality;
- Objective: To apply model for integrated management of river basins taking into account the climate change scenario for some river basins in Vietnam and give suggestion about the application of technological measures to climate change suitable with researched basin.

- Relations of project with the priorities in sustainable development of the country: Safe management and use water efficiently is one of the top priorities in the sustainable development objectives of Vietnam.

- Things that are obtained from the project as the value / benefits / messages:

- Specialist training in integrated management of river basins;
- Raising awareness of the community on effective use of water resources and the effects of climate change.

- The scope and feasibility of the project: Affecting the planning of socio-economic development in the watershed.

- Timeline: 3 years

- The requirements for budget / resources: The cost of surveys, models, equipment installation, and time of consultant and experts is about 10 billion VND (about 500,000 USD).

- Estimated / measured: Applying the model for two typical river basins in Vietnam.

- The problems / challenges that may arise:

- Inadequate hydrometeorological data and socio-economic development in the watershed;
- Responsibility for the river basin management is not clear.

  - The responsibilities and coordinate in the implementation: MONRE, MARD, VAST.

8 The project idea on sea-dike technology with which has the international support.

a) Title of project proposals for technology development

"Research on scientific bases to assess impacts of sea dike system for sustainable development"

b) Project's information

- Introduction / Background:

Sea dikes in Vietnam have developed quite fast in recent times. However, effect of the sea dike system towards national's goal of sustainable development has not adequate attention. It is necessary to summarize world experiences and science-based research on the impact of sea dikes to apply in Vietnam.

- Goals and objectives:

- Goals: To establish scientific impact assessment and socio-economic environment of the sea-dike system;

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- Objective: To review the lessons in the world about the impact of sea dikes on socio-economic development and the environment; To assess Vietnam's sea-dike system on economy and social environment in the context of climate change.

- Relations of project with the priorities in sustainable development of the country: Sea dikes protecting important national economic zones where the economy is associated with the sustainable development of the country.

- Things that are obtained from the project as the value / benefits / messages:

- To raise awareness of the community about the pros and cons of sea technology;
- To adjust the plan of socio-economic development of coastal areas in line with the objectives of sustainable development.

- The scope and feasibility of the project: To affect the development plans of socio-economy in coastal areas.

- Timeline: 3 years

- The requirements for budget / resources: The cost of surveys, models, equipment installation, and time of consultants and experts is about 10 billion VND (about 500,000 USD).

- Estimated / measured: Applying one sea-dike project in Vietnam.

- The problems / challenges that may arise: Difficulty in getting consensus of experts and managers in planning for sustainable development.

- The responsibilities and coordinate in the implementation: MONRE, MARD, VAST.

9 The project idea on recovery of coastal wetlands technology with which has the international support.

a) Title of project proposals for technology development

" Building a model of sustainable management of coastal wetlands of Vietnam"

b) Project's information

- Introduction / Background:

Vietnam has many coastal wetlands that have the critical resources and ecosystems. In recent years, the ecology of some wetlands are seriously degraded by such different causes as: environmental pollution, climate change and hydrological regimes, over exploitation ... Management issues for sustainable development of wetlands are matters of urgency.

- Goals and objectives:

- Goals: To develop a model of sustainable management of wetlands;
- Objective: To review current and proposed zoning some important wetlands in Vietnam, application management model for sustainable development of wetlands.

- Relations of project with the priorities in sustainable development of the country: The wetlands have high biodiversity and environmental importance to serve as a basis for the country's sustainable development.

- Things that are obtained from the project as the value / benefits / messages:

- Biodiversity conservation for wetlands;
- To raise community awareness about the importance of wetlands for the natural environment and socio-economic development.

- The scope and feasibility of the project: Vietnam has joined the Ramsar Convention for 10 years, experts have deep understanding of wetland areas. The wetlands have an important role in socio-economic development in most provinces in the country.

- Timeline: 5 years

- The requirements for budget / resources: The cost of surveys, models, equipment installation, consult experts is about 10 billion VND (about 500,000 USD).

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- Estimated / measured: Building models of sustainable development management for 02 important wetlands in Vietnam.

- The problems / challenges that may arise: Biological diversity and other conditions of each wetland is very different.

- The responsibilities and coordinate in the implementation: MONRE, MARD and research institutes.

Annex 4. List of stakeholders involved and their contact

P.o	Agency	Contact
1	Ministry of Natural Resources and Environment:	
	- Department of Meteorology, Hydrology and Climate Change	No. 8 Phao Dai Lang street, Hanoi, Vietnam
	- Department of Science and Technology	No. 83 Nguyen Chi Thanh street, Hanoi, Vietnam
	- Institute of Strategy and Policy for Natural Resources and Environment	No. 1116 Hoang Quoc Viet street, Hanoi, Vietnam
	- International Cooperation Department	No. 83 Nguyen Chi Thanh street, Hanoi, Vietnam
	- Vietnam Environmental Administration	No. 67 Nguyen Du street, Hanoi, Vietnam
	- Science Institute of Meteorology, Hydrology and Environment	No. 62/23 Nguyen Chi Thanh street, Hanoi, Vietnam
2	Ministry of Foreign Affairs: Department of International Organizations	No. 6 Chu Van An street, Hanoi, Vietnam
3	Ministry of Planning and Investment: Department of Science, Education, Natural Resources and Environment	No. 2 Hoang Van Thu street, Hanoi, Vietnam
4	Ministry of Agriculture and Rural Development:	
	- Department of Science and Technology	No. 2 Ngoc Ha street, Hanoi, Vietnam
	- Vietnam Administration of Forestry	No. 2 Ngoc Ha street, Hanoi, Vietnam
	- Institute of Agricultural Environment	Thanh Tri, Hanoi
5	Ministry of Science and Technology: Department of Social and Natural Science	No. 113 Tran Duy Hung street, Hanoi, Vietnam
6	Ministry of Finance: Department of Legislation	No. 28 Tran Hung Dao street, Hanoi, Vietnam
7	Vietnam Academy of Science and Technology:	No. 18 Hoang Quoc Viet street, hanoi,

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	- Institute of Environmental Technology - Institute of Geological Sciences	Vietnam
8	Hanoi University of Technology	No. 1 Dai Co Viet street, Hanoi, Vietnam
9	Voice of Vietnam	No. 45 Ba Trieu street, Hanoi, Vietnam
10	Vietnam Television	No. 43 Nguyen Chi Thanh street, Hanoi, Vietnam
11	JSC of Consultancy Service and Technology for Natural Resources and Environment	No. 160 Nguyen An Ninh street, Hanoi, Vietnam
12	Research Centre for Climate change and Sustainable Development	Trung Hoa, Nhan Chinh, Hanoi, Vietnam
13	Vietnam Union of Science and Technology Association	

For more information please contact:

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