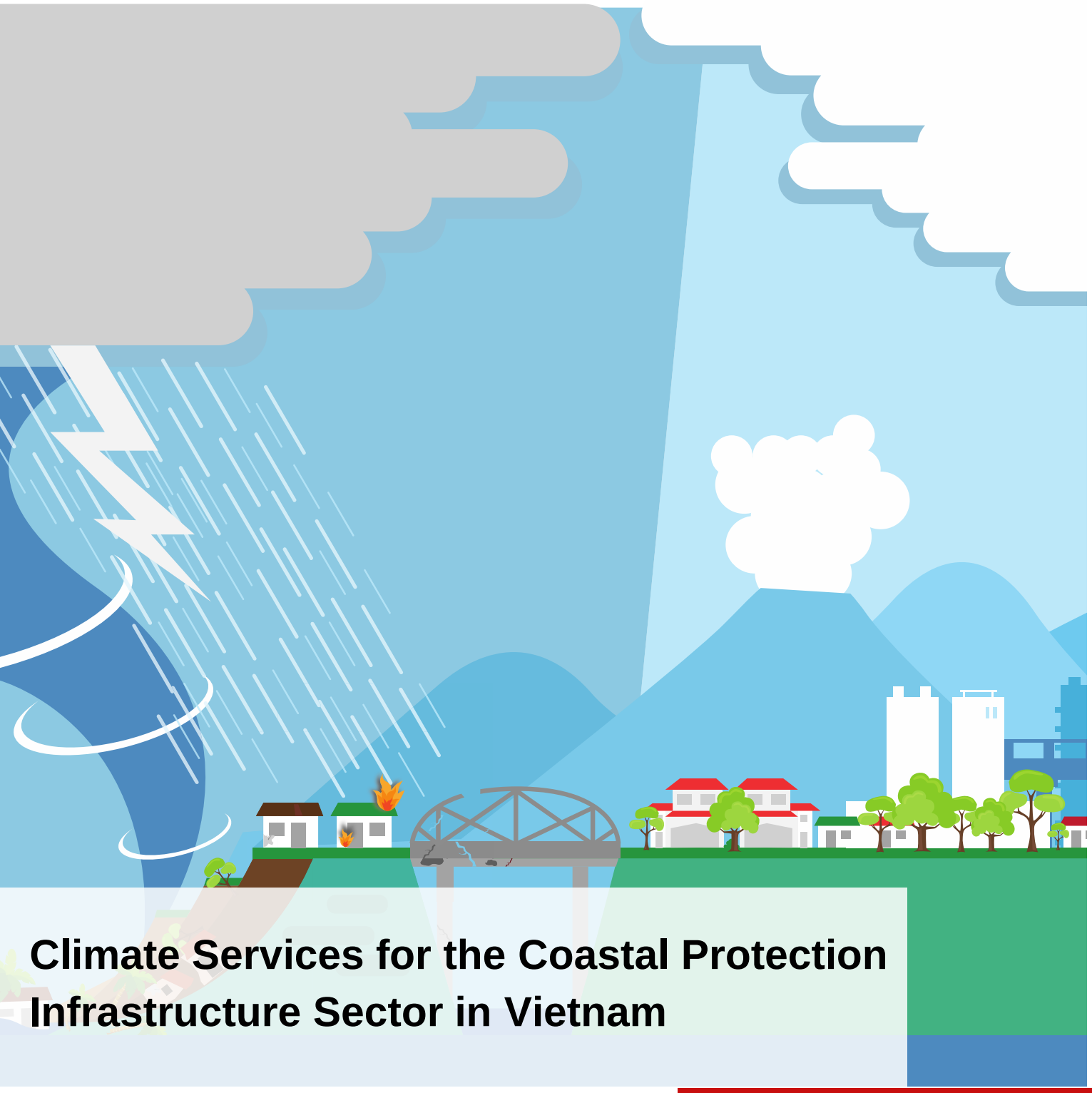

Climate Services for the Coastal Protection Infrastructure Sector in Vietnam

Baseline Assessment Report

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ABBREVIATIONS

ADPC	Asia Disaster Preparedness Centre
AfDB	African Development Bank
ASEAN	Association of Southeast Asian Nations
ASEANCOF-9	ASEAN Regional Climate Outlook Forum
ASMC	Asean Specialised Meteorological Centre
AusAID	The Australian Agency for International Development
BMU	Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit
BOM	Australian Bureau of Meteorology
CBO	community-based organization
CC	Climate Change
CCP	Coastal Protection Plan
CD	Capacity development
CORDEX	Coordinated Regional Climate Downscaling Experiment
CPC	United States Climate Change Centre
CRM	Climate Risk Management
CSIRO	Australia's Commonwealth Scientific and Industrial Research Organisation
CSIS	Climate Service Information System
CSI	Climate Services for Infrastructure
DMC	Disaster Management Committee
DWD	German Meteorological Service (Deutscher Wetterdienst)
ECMWF	European Centre for Medium-Range Weather Forecasts
ECV	Essential Climate Variable
EIA	Environmental impact assessments
ENSO	El Niño-Southern Oscillation
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GCM	Global Climate Model
GDP	Gross Domestic Product
GIZ	German Development Cooperation
GFCS	Global Framework of Climate Services

IKI	Germany's International Climate Initiative
IMHEN	Vietnam's Institute of Meteorology, Hydrology and Environment
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IRI	International Research Institute for Climate and Society
IWRP	Institute for Water Resource Planning
KG-DPI	Kien Giang Department for Planning and Investments
KG-DARD	Kien Giang Department for Agriculture and Rural Development
KG-DWR	Kien Giang Water Resources Sub-department
MARD	Ministry of Agriculture and Rural Development
MOC	Ministry of Construction
MONRE	Ministry of Natural Resources and Environment
MOST	Ministry of Science and Technology of Vietnam
MoU	Memorandum of Understanding
MPI	Ministry of Planning and Investment
NAP	National Adaptation Plan
NBI	Nile Basin Initiative
NCCS	National Climate Change Strategy
NCHMF	National Centre for Hydro-Meteorological Forecasting
NCS	National Climate Service
NDC	National Determined Contributions
NFCS	National Framework for Climate Services
NGO	Non-Governmental Organization
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Administration
NTPRCC	National Target Program to Respond to Climate Change
OECD	Organisation for Economic Co-operation and Development
OM	Observations and Monitoring
PHMC	Provincial Hydro-Meteorological Centre
PIEVC	Public Infrastructure and Engineering Vulnerability Committee
PPC	Provincial Peoples Committee
RCC	Regional Climate Centre
RCC RA II	Regional Climate Centre of Regional Association #2

RCM	Regional Climate Model
RCOF	Regional Climate Outlook Forum
RCP	Representative Concentration Pathways
RHMC	Regional Hydro-Meteorological Centre
RMP	Research, Modelling and Prediction
SCM2	Second Steering Committee
SCOT	Strength, Challenges, Opportunities and Threats
SEAFFG	Southeast Asia Flash Flood Guidance
SDG	Sustainable Development Goals
SIWRP	Southern Institute for Water Resource Planning
SIWRR	Southern Institute for Water Resources Research
SRHMC	Southern Regional Hydro-Meteorological Centre
SRES	Special Report on Emissions Scenarios
ToR	Terms of References
TLU	Thuy Loi University
UIP	User Interface Platform
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
UNRE	University of Natural Resources and Environment of Vietnam
UNS	University of Natural Sciences of Vietnam
UWR	University of Water Resources of Vietnam
NMHS	Vietnamese Meteorological Hydrological Service
WB	World Bank
WCC-3	World Climate Conference 3
WFP	World Food Programme
WMO	World Meteorological Organisation

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I Executive Summary

The Vietnamese Mekong Delta is one of the most vulnerable regions in Vietnam and among the most vulnerable river deltas in world with distinct differences compared to the rest of the country. Intensive land use from continuous extension of the delta's canal system during French colonial times to an over utilization of the soil and groundwater resources until today's construction of upstream river dams and hydropower stations are the human interventions and contributions that do not only increase the value of the land but also make it more vulnerable. In order to protect and guarantee the socio-economic services in the future and minimize costs for maintenance and amendments measures, climate proof infrastructure systems are required. Climate risk management processes require the availability of adequate climate information which can be incorporated into development decisions and policy at relevant scale.

The CSI project (Enhancing Climate Services for Infrastructure investments) aims to empower decision-makers of the coastal protection sector in Vietnam to make greater use of Climate Services when planning infrastructure investments and adapt engineering designs in order to raise the resilience of infrastructure objects and systems in the context of climate change.

In order to enhance the provision and use of climate information the current state of a National Climate Service for the context of the coastal protection sector needs to be assessed and analysed. The baseline assessment is based on the concept and structure of the Global Framework of Climate Services. The assessment report provides an overview of the Climate Service inventory which encompasses currently available Climate Service capacities and specific products. It furthermore reflects the current use and demands of Climate Services from the coastal protection sector. And finally analyses the sector-specific climate-value-chain which comprises the interaction of relevant stakeholders for climate information provision and key actors of the coastal protection sector.

The assessment results are based on question catalogues which address climate information providers and users. The information was collected via surveys, workshops and interviews. Interview partners are representatives of the National Hydro-Meteorological Service (NMHS), the Southern Regional Hydro-Meteorological Centre (SRHMC), Ministry of Agriculture and Rural Development (MARD), the Southern Institute for Water Resources Research (SIWRR), the Southern Institute for Water Resource Planning (SIWRP), the Kien Giang Department for Planning and Investments (KG-DPI), the Kien Giang Water Resources Sub-department), DARD and the Thuy Loi University (TLU).

The results from the Climate Service inventory indicate that NMHS together with IMHEN adopts a central position as major stakeholder within the national network of climate information providers. Fundamental results can be summarized by the following statements:

- The observation and monitoring network of Vietnam is completely operated and managed by NMHS and is subject of comprehensive optimization programs.
- NMHS research concentrates on the enhancement of tools and knowledge to support everyday tasks and processes. Research related to climate change and the development of sector-specific climate services is done by IMHEN and national universities.
- The Vietnamese Climate Service product portfolio and the dissemination-structure focuses on the provision of forecasts and warning of climate related hazards and is mainly aligned for the needs of the disaster risk and agriculture sectors. The provision of data and analyses products are yet of minor importance.
- A user interface is yet very basic and limited to single events. Activities regarding user interaction are basically limited to a mostly one-way communication of especially forecasts and warnings to mainly political stakeholders from the disaster risk and agricultural sector.
- Capacity development programs are yet very dependent on externally funded programs often provided by international organizations. The NMHS long-term strategy envisages a commercialization of the service and respectively aligns development activities and programs.

General characterizations of use and demand for Climate Services can be summarized by the following statements:

- The consideration of climate and climate change for coastal protection issues is tackled by a high number of laws and regulations. However, there is little information about the regulation of the use of specific climate information and data.
- The motivation to use climate data and information for decision-making is dominated by the obligation to consider laws and regulations.
- Climate information is predominantly used for decision-makings processes which refer to infrastructure planning and implementation as well as the development and implementation of risk management plans. Most favourable risk management strategies are risk prevention by protection and by transformation as well as awareness creation.
- The entire product portfolio of climate information products is provided as well as used by stakeholders from the coastal protection infrastructure sector. Greatest needs regarding climate information provision refers to a lower extend to the prevision of additional products but rather to the dissemination process, access and availability of data and information as well as quality and tailoring of data and information.
- The most important reason for not using climate information is the limited access to freely available climate information, the fact that products are not available when required or the information content is not understandable as well as the cost-benefit value of the use of climate information is not profitable and missing capacities to deal with climate information.

The results from analysis of the climate value chain can be summarized by the following statements:

- Main sources of climate-related information for users from the coastal protection sector are the NMHS and IMHEN for general climate data and SIWRR and SIWRP for sector-specific information.
- MARD/DARD takes a central position within the climate-value chain of the coastal protection sector, regarding several concerns: the coordination of sectoral tasks and processes, the final decision-making on sector-specific climate information as well as the regulation of climate information within the sectoral context.
- SIWRR and SIWRP adopt key-functions as climate service intermediates which imply the provision of value-added climate information products for the final decision-makers.
- The climate-value chain of the coastal protection sector in Vietnam is very compact with a well-defined pool of stakeholders with pronounced competencies regarding the development and production of sectoral Climate Services referring to all issues of the infrastructure planning process. However, this value-chain can only be activated for the context of specific projects on the initiative of central planning authorities like MARD. Direct relationships between climate information providers and sectoral stakeholders which are essential for the development of sector-specific Climate Services are no provided in terms of MoUs or other agreements which favour the development and production of such services by institutionalized, non-bureaucratic channels for interaction and data-exchange.

The fundamental recommendation regarding the baseline assessment refers to the establishment of a sectoral branch within the prevalent National Climate Service of Vietnam specifically for the coastal protection sector. This sectoral branch envisages an incorporation of sectoral and political partners which adopt various functions in the development, provision and communication of Climate Service products relevant for the coastal protection sector. Other recommendations mainly refer to details of the implementation of such a sectoral NCS-branch.

II Introduction

Infrastructures are the fundamental basis for the sustainable development of a society's economic prosperity and social well-being. In order to preserve the function of infrastructure, countries all over the world are going to invest public and private resources to preserve and upgrade existing infrastructure and to build new infrastructure networks. Infrastructure of all types is vulnerable to current climatic events. These climatic events do already have an impact on existing infrastructure networks, causing physical damage as well as the disruption of their functionality, which may have knock-on effects on other infrastructures and economic sectors. The infrastructures' vulnerability will increase due to both, neglected management and maintenance of existing infrastructures as well as changing climate conditions in the context of climate change. As climate change may cause a change in magnitude and frequency in extreme weather and climate events as well as gradual changes like sea-level rise and changing eco-systems, design thresholds and management processes of infrastructure networks may not be adopted to future climate conditions and may be breached more often. Operational and organizational processes will have to function within tighter margins between "normal" states and "extreme situations" which will result in decreased efficiency of equipment and production processes and more frequent periods of restricted operation or even failure of the infrastructure's function. Finally, impacts climate change will result, among others, in asset deterioration and reduced asset lifetime, loss of income and increased risks of environmental damage and litigation which will require an adaptation of operational and capital expenditures and thus a change in investment strategies. In order to mitigate additional future costs, such investment strategies need to be adapted to changing climate conditions and changing risks. Climate risk management frameworks for infrastructure investments and respective policies need to be developed and established to support investment strategies for resilient infrastructure. Such frameworks need to support decisions on the design, location and operation of existing and planned infrastructure and help to enhance resilience and avoid locking-in vulnerability (OECD 2016).

Climate risk management processes require the availability of adequate climate information which can be incorporated into development decisions and policy at relevant scale. This kind of "climate-smart" development necessitates a broad range of Climate Services. However, current gaps in information, communication, policy, practice, and institutional capacity prevent the production and provision of useful and usable climate information at various levels (IRI 2012).

II.1. The Vietnam context

For the period from 1996 until 2015, Vietnam was ranked as the 8th country in the world most affected by climate change with an average 0.62% GDP loss related to climate change and with the second highest number (206) of extreme weather events worldwide (Germanwatch, 2017:6). Similarly, according to the Climate Change Vulnerability Index, Vietnam is currently considered one of 30 “extreme risk countries” in the world (CCVI, 2016).

The Vietnamese Mekong Delta, is one of the most vulnerable regions in Vietnam and among the most vulnerable river deltas in world with distinct differences compared to the rest of the country. As a river delta, the region is low lying and alluvial. It has ever since offered great potentials for agricultural production, such as two and even three rice crops per year. By now the region is feeding more than 245 million people in Asia and worldwide. However, the delta has also always been exposed to many threats (GIZ, 2017). Historical accounts report about land subsidence, annual flooding and saline water intrusion, dating back to even precolonial times, when first settlers had arrived in the region (Biggs, 2010:128). Intensive land use from continuous extension of the delta’s canal system during French colonial times to an over utilization of the soil and groundwater resources until today’s construction of upstream river dams and hydropower stations are the human interventions and contributions that do not only increase the value of the land but also make it more vulnerable. In order to protect and guarantee the socio-economic services in the future and minimize costs for maintenance and amendments measures, climate proof infrastructure systems are required. The implementation of climate proof coastal protection infrastructure requires the existence of appropriate and usable climate information in order to consider current and future climate risks in the planning process of such infrastructure objects. This comprises e.g. information on current and future magnitudes, frequencies and inundation areas of flood events but also information on temperature extremes in order to adapt location, height, design and material of dykes, dams and sluice gates and other protection and management structures.

Furthermore, national policies and regulations need to be developed or reviewed to guarantee the production and availability of climate information for decision-makers and further the use and implementation of this information in infrastructure planning processes. The Vietnamese Nationally Determined Contributions (NDC) already cover this to some extent. 14 tasks formulated in the context of NDC implementation relate to integrated coastal protection, climate proofing of infrastructure and also the commitment to new and necessary planning procedures. Another important step in this direction has been the updated law on Hydro-Meteorology and the related upgrade of the National Meteorological-Hydrological Service (NMHS) to Hydro-Meteorological Administration with increase competencies and responsibilities in the area of Climate Services.

II.2. Kien Giang Project background

The project Enhancing Climate Services for Infrastructure Investments (CSI) forms part of Germany's International Climate Initiative (IKI). In accordance with a resolution by the German Bundestag the IKI receives backing from the country's Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU).

The BMU has commissioned the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH to implement the CSI project from 2017 until 2020 with its partner countries and region Brazil, Costa Rica, Vietnam and the Nile Basin Initiative (NBI). GIZ's main international implementing partners are the German Meteorological Service (DWD) and Engineers Canada.

CSI aims to empower decision-makers to make greater use of Climate Services when planning infrastructure investments and thus helps to raise infrastructure resilience. In this way, CSI also supports achieving the UN Sustainable Development Goal (SDG) 9.

To accomplish its objective, CSI brings together all relevant private and public-sector actors along the Climate Service value chain. This includes climate data providers and the stakeholders, including decision-makers and engineers, who work with this data. All activities are purposefully integrated into the National Adaptation Plans and Policies (NAP) and (I)NDCs to promote NAP and (I)NDC development and implementation.

CSI prioritises four areas. Specifically, it

i) supports the provision and use of Climate Services
Establishing a sustainable interface between users (e.g. infrastructure planners, operators and owners) and Climate Service providers – referred to as a Climate Service User Interface Platform (UIP) – enables potential Climate Service users to participate in the development process. At the same time, it involves providers in the use of the information for infrastructure planning. The German Meteorological Service (DWD) advises Climate Service providers and users on the delivery and use of Climate Services.

ii) **supports the integration of the use of Climate Services into infrastructure planning in line with national plans and strategies**
CSI also focuses on climate-sensitive infrastructure planning methods that take climate risks into account. Together with decision-makers, the project develops recommendations for adapting planning procedures and regulations in line with the climate-proofing approach, e.g. via cost-benefit analyses, the development of building standards or environmental impact assessments (EIA).

iii) **pilots climate risk assessments for infrastructure**
To identify climate risks, CSI is piloting a climate risk assessment for a specific infrastructure type in each of the partner countries, thereby creating a starting point for prioritising the various adaptation options. Engineers Canada is advising the partner countries on the risk assessment rollout. Based on the Public Infrastructure Engineering Vulnerability Committee (PIEVC) protocol that Engineers Canada developed to analyse climate risks to infrastructure, the project aims to build local capacity by means of a learning-by-doing approach. At the same time, it is compiling handouts and training materials to disseminate this approach and to operationalise the adapted planning procedures and regulations.

iv) **promotes international knowledge transfer and exchanges**
Furthermore, CSI shares its experience and best practices with national and international forums and posts them on AdaptationCommunity.net, amongst other sites.

CSI project partners

In Vietnam CSI's political partner is he Ministry of Planning and Investment (*MPI*) is in charge of the functions of state management over planning and development investment, including the provision of general advice on strategies and plans for national socio- economic development. In the context of the project, the MPI is the lead executing agency in Vietnam and in charge of the political and strategic level of project implementation.

In the area of Climate Service provision, CSI works with the the National Hydro-Meteorological Service *(NMHS)*, which recently officially became the Hydro meteorological Administration (HMA, but the more generic abbreviation of NMHS will be used throughout this report). HMA works in close cooperation with the CSI-project. As the major institution which collects and archives climate data and as mandated Climate Service provider in Vietnam, NMHS is a key stakeholder in the climate information provider group of Vietnam's National Climate Service.

The CSI project, including all project partners, identified the coastal protection sector as priority sector for its efforts related to the adaptation of infrastructure to climate change. The object of choice for the climate risk assessment pilot is a sluice gate at the Cai Lon – Cai Be channels in the province of Kien Giang. Respectively, the Climate Service baseline assessment will focus on the supply and demand for the coastal protection sector.

II.3. Background and structure of the report

II.3.1. *Purpose*

In order to enhance the provision and use of climate information the current state of a National Climate Service (see II.5) needs to be assessed and analysed as a basis for the identification of appropriate recommendations. The state of a NCS is defined as a snap-shot of the current network of climate information stakeholders which constitute and facilitate the basic infrastructure for climate information provision. It furthermore reflects the portfolio of currently provided and used climate information products and services on a national level. Such a baseline highlights actual and specific strengths, challenges, opportunities and threats of the prevalent NCS and constitutes a starting

point for the development or enhancement of a National Framework of Climate Services[1] (NFCS) (see II.5).

II.3.2. *Scope*

The concept of a NCS applied for this assessment refers to the implementation of the Global Framework for Climate Services (GFCS) (see II.4.2) on the national level. This assessment report provides no comprehensive baseline of the NCS of Vietnam. Instead, it focuses on the coastal protection infrastructure sector as priority sector selected by the national partners of the CSI project (see II.2). Object of the assessment is the inventory of climate information products and services, which are actually or potentially relevant and currently available for the coastal protection infrastructure sector. Furthermore, current organizational structures of how climate information is provided for the coastal protection infrastructure sector are analysed and discussed.

II.3.3. *Outputs and Objectives*

The baseline report provides an abstract of the current state of the NCS in the context of the coastal protection infrastructure sector. It provides an overview of relevant stakeholders for climate information provision and key actors of the coastal protection infrastructure sector as well as their relationships and interactions. It furthermore lists currently available and used Climate Services for the specific sectoral context and identifies and classifies prevalent gaps and shortcomings in climate information use and provision. Beyond that, strengths and opportunities of the prevalent NCS are highlighted which qualify the report to provide recommendations for short- and long-term measures and strategies to enhance Climate Services for infrastructure investments in the coastal protection infrastructure sector in Vietnam. Finally, recommendations are given on the way a National Framework of Climate Service can be established in Vietnam for the context of the coastal protection infrastructure sector.

II.3.4. *Structure of report*

The baseline report is structured as follows: in the following chapter (II.4) the theoretical background for Climate Services is provided. This includes a definition and introduction into the concept of Climate Services and the concept of the Global Framework of Climate Services (GFCS). In *chapter III* the assessment concept is explicated and applied methods of data collection and analysis are presented as well as processes and procedures of implementation. *Chapter IV* provides information on the national background which comprises the presentation of project partners and

1 An NFCS is an institutional mechanism to coordinate, facilitate and strengthen collaboration among national institutions to improve the co-production, tailoring, delivery and use of science based climate predictions and services by focusing on the five GFCS pillars (WMO 2018).

relevant stakeholders as well as the current knowledge on potential climate risks for the region and the sector of concern. In *chapter V* the results of the assessment of currently available Climate Services are presented and key findings are summarized. *Chapter VI* presents the current use and demands for Climate Services from the coastal protection infrastructure sector. The results are discussed in the context of the climate-value-chain in *chapter VII*. In *chapter VIII* an evaluation of the results are formulated. In *chapter IX* a conclusion and recommendations are given as well as an outlook in c*hapter X.*

II.4. Conceptual basis

The climate vulnerability of infrastructure is a prevalent vulnerability decision-makers like planners and engineers always had to deal with in the past. In the context of climate change, however, knowledge and experiences of past climate conditions and their interrelations with society may not necessarily be valid anymore for the current or future situation. The combined effects of climate change and increase of vulnerability due to, e.g. land-use change, migration and infrastructure development provides unprecedented challenges to today's and future societies. Therefore, there is a growing need to understand climate, the interrelation of climate and socio-economic systems as well as climate predictions and how to better use this information to serve society's needs. This need is realized by many countries which attempt to develop climate service capabilities. A climate service is considered as the provision of climate information in such a way to assist decision-making by individuals or organizations in a best possible way. Although fundamental infrastructure and capabilities of climate information provision exists in many countries and regions of the world there is limited effective climate impact information for decision-making. In the context of the World Climate Conference-3 in 2009, five key challenges in climate information provision have been identified:

- Access to Climate Services needs to be established and/or improved in all countries;
- The capacity to deal with climate-related risks is lacking in many countries;
- The availability and quality of climate data are inadequate in many parts of the globe;
- Users and providers need to interact better;
- The quality of Climate Services needs improvement to match user requirements better.

A Global Framework of Climate Services was established during the World Climate Conference-3 in order to meet these challenges and strengthen and coordinate existing initiatives and to develop new infrastructures where needed (WMO 2014a).

This chapter provides basic background information on the matter of Climate Services. This comprises definitions of Climate Services as well as the organizational framework for producing, disseminating and applying Climate Services on a national level. The

content of this chapter provides a conceptual framing for the baseline assessment as well as for the provided recommendations.

II.4.1. *Definition and scope of Climate Services*

Since the concept of Climate Services is relatively new, various definitions and interpretations exist. The CSI project agreed on the definition provided by the World Meteorological Organization (WMO) in the context of the Global Framework of Climate Services (GFCS). The WMO defines Climate Services as follows:

"Providing climate information in a way that assists decision making by individuals and organizations. A service requires appropriate engagement along with an effective access mechanism and must respond to user needs" (WMO 2014a).

The general WMO definition provides a rather loose delineation of the scope of Climate Services and gives thus room for interpretation. To get a better idea about the scope of Climate Services, the definition of the European Commission provides a more detailed characterization, which can be considered as supplement:

"Transformation of climate-related data — together with other relevant information — into customized products such as projections, forecasts, information, trends, economic analysis, assessments (including technology assessment), counselling on best practices, development and evaluation of solutions and any other service in relation to climate that may be of use for the society at large. As such, these services include data, information and knowledge that support adaptation, mitigation and disaster risk management" (EU 2015).

***Box1**: basic definitions, as used in GFCS Implementation Plan (WMO 2014a)*

Climate data: Historical and real-time climate observations along with direct model outputs covering historical and future periods. Information about how these observations and model outputs were generated ("metadata") should accompany all climate data.

Climate product: A derived synthesis of climate data. A product combines climate data with climate knowledge to add value.

Climate information: Climate data, climate products and/or climate knowledge.

Climate Service: Providing climate information in a way that assists decision making by individuals and organizations. A service requires appropriate engagement along with an effective access mechanism and must respond to user needs

The definitions above imply three fundamental characteristics of Climate Services which also distinguish Climate Services from climate data and climate information (Box 1). These characteristics are here defined as the three dimensions of Climate Services

and refer to and merge the Climate Service elements defined by WMO (2014a) *[products; support; feedback]* and International Research Institute for Climate and Society (2012) *[information; collaboration; policy & practice]*. The Climate Service dimensions are defined as follows:

- **The *technical dimension* defines the usefulness of a climate information product.** It refers to the content of climate information and its relevance for a specific user, user-group or sector (e.g. parameters, indices, etc.). It also refers to the contextualization of climate information with respect to scale and resolution (temporal and spatial) but also format and style of presentation of climate information (e.g. maps, graphs, diagrams, etc.). And furthermore it comprises the quality of climate information and the provision and communication of meta-data and information on uncertainty along with the climate information.
- **The s*ervice dimension* defines the usability of a climate information product.** It refers to dissemination and utilization of climate information. Dissemination comprises the provision of physical access to climate information (e.g. data platforms, filter systems, etc.) but also promotion of climate information to enhance visibility and perception of the added value for the user. A critical aspect of dissemination is the timing of delivery and update frequency of climate information. Utilization refers to the support of the user in using climate information for his decision-context. This may comprise assistance for data interpretation, decision-support tools and advice for the implementation in decision-making processes as well as training and educational material on these issues.
- **The *institutional dimension* constitutes a framework for the formation of technical and service dimension**. It refers the cooperation of relevant stakeholders which are involved in the production of a Climate Service. This implies the cooperation between various (climate) data and information providers as well as the relationship to users to guarantee usefulness and usability of climate information. But also cooperation to political stakeholders to ensure appropriate data policies (data access and availability) mandates and guidelines for the use of climate information.

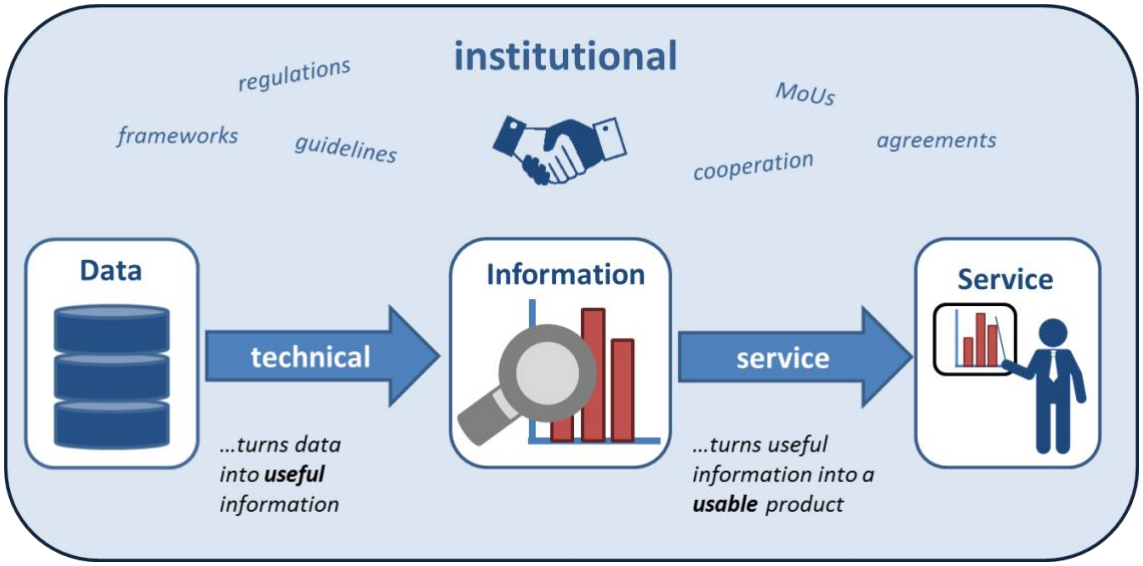

Figure 1: The three dimensions of Climate Services. The technical dimension turns data into useful information by tailoring of the data. The service dimension turns useful information into a usable climate information product by tailoring the presentation and format of the information as well as providing user-specific support and advice. The institutional dimension provides the institutional framework within a co-production of Climate Services can be realized by the cooperation of climate information providers and users.

The Climate Service dimensions suggest that a Climate Service product goes beyond the purely technical level but also includes the provision, communication and advice on climate information, the interaction with users and other stakeholders as well as the governance of climate information production and provision. Furthermore, a Climate Service product often has to be considered as a joint product, which involves the cooperation of several stakeholders. Such a cooperation may be characterized either by a concurrent and/or subsequent coproduction of a Climate Service product. In any way, coproduction in the context of Climate Services comprises a circular (iterative and continuous) process of interaction which implies an exchange of information in both directions: from provider via intermediates to users and back. A Climate Service product cycle is an end-to-end process which comprises the consideration of all required processing steps from data to decision-making as well as all involved stakeholders. Such an end-to-end production cycle is characterized by one or several steps of value-adding which might be tailoring of data or provision of information and services, etc. to make climate information usable. This process is here described as **climate value-chain,** which is required to produce and provide a Climate Service (Figure 2). The basic stakeholders of a Climate Service value chain can be classified as follows:

- *Providers*: providers of climate information collect, manage, archive and provide climate data and also basic climate diagnostic- and monitoring products as well as climate predictions and projections. Key providers on the national level are mainly National Meteorological and Hydrological Services (NMHS). Also important are academia (e.g. universities, research institutes) for model and product development as well as external data providers which provide data from the regional or global level. In many contexts the private sector may also collect relevant climate data for

own interests which is, however, not systematically provided to a central database of a NCS.

- *Intermediates*: intermediates have the function of value-adding and can be differentiated in two types: (1) technical intermediates refine basic climate data or information by tailoring and/or adding external data. Important stakeholders may be impact modelers, risk managers or authorities (line ministries) who can often be found at the sectoral level; (2) institutional intermediates or boundary organizations have the function as communicators of climate information as well as advisors for decision-making. Private companies, None Governmental Organizations (NGOs), Community-based Organizations (CBOs) and media are important stakeholders. Another group of intermediates are "enablers" who provide basic resources like global and regional data, knowledge and capabilities (e.g. UN organizations) and funding (e.g. development banks). Intermediates are also users of climate information but with the main function as a value-adder, communicator or purveyor of climate information.
- *End-Users*: the term end-user predominantly targets stakeholders who use climate information for decision-making in a practical context from the national to the community level. In this concern they can be distinguished from intermediates. Important stakeholders for infrastructure sectors are managers, planners, engineers or politicians.

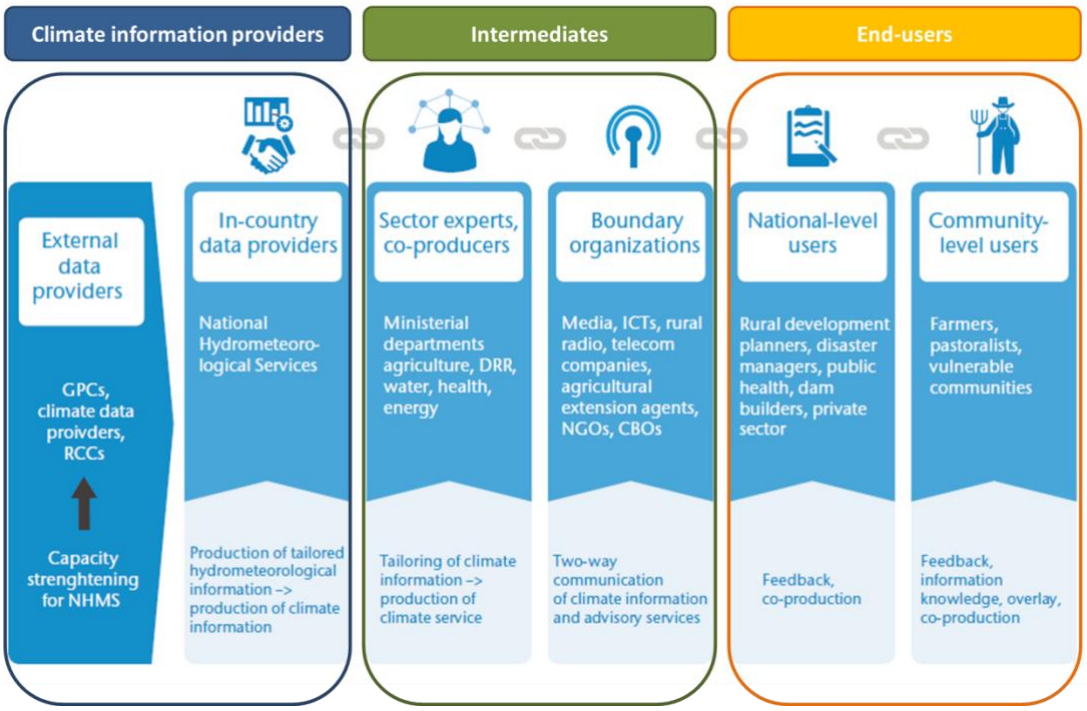

Figure 2: Concept of the climate value chain including the three major stakeholder types: climate information providers (blue box), intermediates (green box) and end-users (yellow box). The stakeholder types are subdivided by sub-types. For each sub-type examples for specific stakeholders are given (blue area) as well as their functions regarding Climate Service development and provision (grey area) (modified from WMO 2018)

Climate value chain characteristics are in general context specific which often refers to individual sectors or even users or user-groups. A climate value chain is always defined by at least one provider and one user. However, the number of intermediates may vary significantly depending on the complexity of purpose and context of a Climate Service application, and furthermore, on the type of end-user and his demands for Climate Services which reflects his capabilities and capacities to process, interpret and digest climate data and information. Besides the amount of stakeholders, the type of stakeholders may also vary or change regarding the context of the Climate Service application. Intermediates and the users often also appear in a very sector-specific context, whereas providers take a rather consistent role for Climate Service provision.

II.4.2. *Global Framework for Climate Services (GFCS)*

Decision-makers in many socio-economic sectors including water, agriculture, fisheries, health, forestry, transport, tourism and energy are increasingly concerned by the adverse impacts and consequences of climate variability and change. Thus, there is a growing need for climate information in infrastructure planning and operational decision-making processes. However, the impact of climate information on decision-making is inhibited for various reasons, like limited access to adequate and qualitative climate information, limited capabilities of users to implement climate information in decision-making processes as well as limited capacities of users to deal with climate-related risks and existing climate information.

The World Climate Conference-3 in 2009 in Geneva agreed that in the past 30 years considerable progress was achieved in increasing the quality, coverage and accessibility of climate-related data and the research, modelling and prediction of climate and its impacts. This information enabled the IPCC to provide comprehensive and user-friendly assessments on the current state of knowledge on climate change and its impacts and consequences for society. However, the conference also agreed that less progress has been made in transferring this information into useful and usable Climate Services which help decision-makers to incorporate current knowledge into decision-making processes in order to effectively adapt to climate variability and change. It was realized that *"present capabilities to provide effective Climate Services fall far short of meeting present and future needs and of delivering the full potential benefits, particularly in developing countries"* (WCC-3 2009, p.2). Based on these findings the Global Framework of Climate Services (GFCS) was established. The GFCS bridges the gap between Climate Service providers and users so that outputs become better assimilated by decision-makers. Thus, the vision of the GFCS is *"to enable society to manage better the risks and opportunities arising from climate variability and change, especially as they concern those who are most vulnerable to climate-related hazards"* (WMO 2014a, p.4).

The goals of GFCS in support of this vision are:

I. Reducing the vulnerability of society to climate-related hazards through better provision of climate information;
II. Advancing the key global development goals through better provision of climate information;
III. Mainstreaming the use of climate information in decision-making;
IV. Strengthening the engagement of providers and users of Climate Services;
V. Maximizing the utility of existing climate service infrastructure.

The structure of GFCS is based on five essential components, which are required to enable the production and dissemination of effective Climate Services (Figure 3). The characteristics of the five components of GFCS are briefly described:

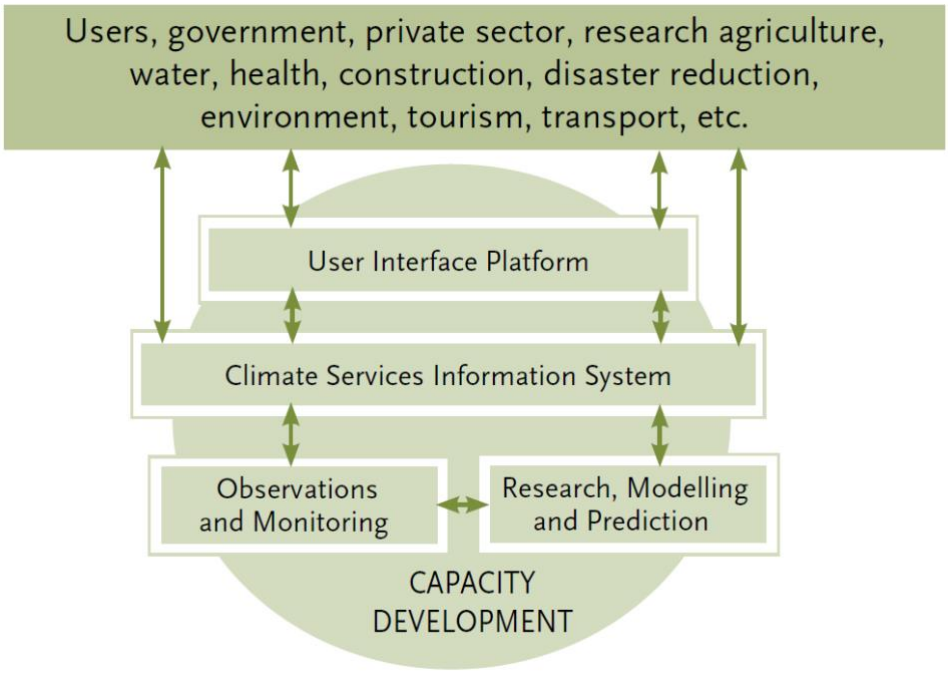

Figure 3: The five functional components of GFCS (WMO 2018)

- *Observations and Monitoring (OM):* the observation and monitoring of the Essential Climate Variables (ECV's[2]) as well as relevant climate phenomena and weather events are the basis for climate analysis and predictions. "High-quality historical and real-time observations and data are required not only across the entire climate system but also relevant biological, environmental, and socio-economic variables so that the impacts of climate variability and change can be evaluated and addressed. Monitoring products such as extreme value statistics derived from high-quality climate observations are of prime importance to planning decisions, for instance regarding reducing disaster risk by developing appropriately resilient infrastructure" (WMO 2014a, p. 9).

[2] ECV - Essential Climate Variable. An ECV is a physical, chemical or biological variable or a group of linked variables that critically contributes to the characterization of Earth' s climate.

- *Research, Modelling and Prediction (RMP): "*RMP fosters research towards continually improving the scientific quality of climate information, providing an evidence base for determining the impacts of climate change and variability and for evaluating the cost-effectiveness of using climate information. It supports the development and improvement of tools and methods that will facilitate the transition of research to operational climate service provision and engender practical applications of climate information. High-quality, reliable observation data and targeted dynamical model outputs will be developed to support the activities of the other pillars" (WMO 2014a, p. 10).
- *Climate Services Information System (CSIS): "*the CSIS is the principal mechanism through which information about climate (past, present and future) is routinely archived, analysed, modelled, exchanged and processed. The CSIS is the 'operational core' of the GFCS; it comprises a physical infrastructure of institutes, centres and computer capabilities that, together with professional human resources, develops, generates and distributes a wide range of climate information products and services to inform complex decision-making processes across a wide range of climate-sensitive activities and enterprises. Its functions include climate analysis and monitoring, assessment and attribution, prediction (monthly, seasonal, decadal) and projection (centennial scale). These functions comprise processes of data retrieval, analysis and assessment, re-analysis, diagnostics, interpretation, assessment, attribution, generation and verification of predictions and projections and communication (including exchange and dissemination of data and products). Knowing user requirements and understanding how users apply climate information will be essential for designing, disseminating and encouraging the uptake of CSIS products and services" (WMO 2014c, p. iii-iv). An essential feature of disseminating and communicating climate information is the pro-active support, training and advice on climate information. This comprises the understanding of climate information content, the application of climate information for the specific user or sectoral contexts and the integration in decision-making processes.
- *User Interface Platform (UIP): "*the UIP provides a structured means for users, climate researchers and climate data and information providers to interact at all levels. The objective of the UIP is to promote effective decision-making with respect to climate considerations by making sure that the right information, at the right time and in the right amount, is delivered, understood, and used. It can be defined further as a managed methodology, or a collection of methods, means, approaches, and processes of systematic and mutually beneficial collaboration. It enables interactions that help define user needs and provider capabilities, tries to reconcile the needs with those capabilities, and eventually promotes effective decisions based on climate information. To achieve its objective, the UIP is aiming for four outcomes: feedback, dialogue, outreach and evaluation. In considering the scope of the UIP it must be borne in mind that the Framework is not a centrally managed system. The methods for developing interactions between climate service users and providers will be determined on a case-by-case basis using available technologies and capabilities" (WMO 2014d, p.1-2).

- *Capacity Development (CD): "*CD tackles two separate but related activity areas: (i) the particular capacity development requirements identified in the other four pillars; and (ii) more broadly the basic requirements (national policies/legislation, institutions, infrastructure and personnel) to enable any GFCS related activities to occur. In the context of both activity areas capacity development actions under the Framework will facilitate and strengthen, not duplicate existing activities. They will also address needs from both the demand side and the supply side of Climate Services" (WMO 2014b, p. iv-1). The CD component is key for the enhancement of developing and using Climate Services. A well developed and implemented CD component enables an effective and efficient development of useful and usable climate information products as well as a sustainable strengthening of users in the formulation of their demands of Climate Services, their application as well as integration in decision-making processes.

The five components do not function as stand-alone entities but they need to interact to in order to make the production, delivery and application of Climate Services effective. Furthermore, they need to be considered as conceptual models which cannot be delineated clearly in practice and will cause some overlapping of functions and responsibilities. The functions and responsibilities of each element do not necessarily need to be covered by one institution (e.g. NMHS) but are rather distributed among various stakeholders within a National Climate Service.

The implementation of the GFCS needs to be happening on three different geographic scales in order to achieve its objectives: global scale, regional scale, national scale. At the global and regional scale key stakeholders are preliminary UN institutions (e.g. WMO, FAO, UNDP, WFP, WHO, UNISDR, etc.) and other international active organizations like development agencies and development banks (e.g. GIZ, USAID, World Bank, etc.). These international stakeholders pool their knowhow, capacities and resources in order to enable and provide knowledge, information and services that support effective decision-making in the context of climate issues.

II.5. National Climate Service

For the implementation of the GFCS at the national level each country requires a respective National Framework for Climate Services (NFCS). *"An NFCS is an institutional mechanism to coordinate, facilitate and strengthen collaboration among national institutions to improve the co-production, tailoring, delivery and use of science based climate predictions and services by focusing on the five GFCS pillars*" (WMO 2018, p. 8). The implementation of a NFCS can be respectively called **National Climate Service**. A well-organized National Climate Service has the capacities and capabilities to provide core climate products for all relevant sectors and for various demands. Furthermore, it is able to facilitate end-to-end Climate Service provision due to a well-developed User Interface Platform with a wide interlinked network of stakeholders from various sectors and close continuous relationships to a wide range of users, user-groups and other relevant sectoral stakeholders.

The term National Climate Service (NCS) will be used throughout the entire report referring to the collaborative network of stakeholders which are involved in the development production and dissemination of Climate Services on a national level.

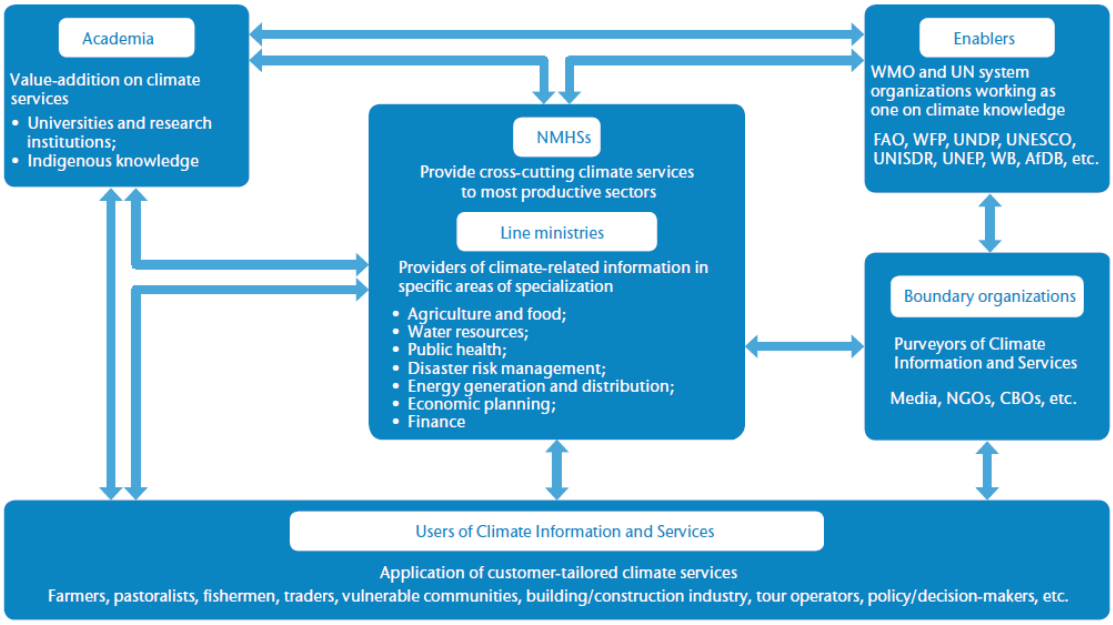

Figure 4: Example for an institutional arrangement of an NCS with key partner institutions and their interlinkages (WMO 2018). *(AfDB = African Development Bank; CBO = community-based organization; FAO = Food and Agriculture Organization of the United Nations; NGO = non-governmental organization; UN = United Nations; UNDP = United Nations Development Programme; UNEP = United Nations Environment Programme; UNESCO = United Nations Educational, Scientific and Cultural Organization; UNISDR = United Nations International Strategy for Disaster Reduction; WB = World Bank; WFP = World Food Programme)*

The institutional arrangement of a National Climate Service comprises all stakeholder groups that are relevant for the production and dissemination of Climate Services (climate-value-chain) (II.4.1). Figure 4 provides an overview on a sample institutional arrangement for an NCS. The role of NMHS within a NCS is envisaged as key since the fundamental components of the GFCS (i.e. OM, CSIS) are usually adopted by the NMHS as mandated and thus established and enduring institution. Furthermore, NMHS are a point of contact to WMO institutions as well as users of various sectors and thus constitute an important interlinkage of various stakeholders within a NCS. Therefore, NMHSs are considered to be more than just a climate data provider: NMHS are envisaged to take a coordinating role of climate data and climate information as well as their dissemination and communication. And furthermore, the NMHS is expected to coordinate the tasks transferred to the NCS-partners, which refer to value-adding, support, training and advice, in order to guarantee the adherence of standards and thus quality and reliability of climate information.

III Methodology

III.1. Assessment concept

The objective of the assessment is to provide an abstract of the current state of the National Climate Service (NCS) in the context of the coastal protection infrastructure sector in Vietnam. The NCS will be characterized and described in this study by basically two products: (1) the ***climate value chain*** identifies and depicts all relevant stakeholders for climate information provision in the context of the road infrastructure sector and elaborates the state of their tasks as well as their relationships; and (2) the ***baseline*** which comprises a ***Climate Service inventory*** of currently available Climate Service products which are actually or potentially useful for the road infrastructure sector as well as a synopsis of ***Climate Service needs*** which list all Climate Services which are currently being used by users of the road infrastructure sector. The ***output*** will be an analysis of the completeness of the climate value chain in terms of lacking interlinkages of stakeholders as well as the identification of discrepancies between climate service offer and demand. According to this analysis, entry points for specific measures to enhance the provision of Climate Services for infrastructure investments will be identified.

(1) Climate value chain: the climate value chain will be analysed with focus on the case-study which is selected for the climate risk assessment in the context of the CSI project. The entry points for the stakeholder analysis of the climate value chain will be the CSI project partners and stakeholders affiliated to the CSI project. For the provider group this will be the National Meteorological and Hydrological Service of Vietnam (NMHS) which is the main responsible institution for climate information provision. The user-group will be represented by key stakeholders of the coastal protection infrastructure sector. By interviewing these stakeholders the climate value chain will be (re-) constructed starting simultaneously at different positions within the value chain and in different directions along the value chain. Additional stakeholders might be identified successively as a result of the interviews conducted in the context of the baseline assessment. The benefit of this approach is a potential double-check of interlinkages of stakeholders and how climate information is provided or used. Furthermore, a more comprehensive picture of the Climate Service inventory can be achieved since stakeholders are identified throughout the entire spectrum of the value chain, including data providers, intermediates and applied users from different sectors.

(2) Climate Service inventory: the inventory of Climate Services within a NCS is assessed on the basis of the GFCS components. The state of each component within the NCS is analyzed by considering the fulfilment of the required functions regarding the definitions of the GFCS (II.4.2) and the involved stakeholders which feed back into the climate value chain. Fundamental shortcomings and development needs are identified. The currently available Climate Service products relevant for the coastal protection infrastructure sector are assessed considering all three dimensions of Climate Services. This means that besides the listing of products a special emphasis is

put on the tailoring and dissemination characteristics for each product type as well as provided services which come along to make it usable for the specific user of the coastal protection infrastructure sector. Furthermore, stakeholders are identified which are involved for the production and provision of each product type. A preliminary classification of the availability of climate information products and services is evaluated according the categories of WMO (2012) (Appendix 2). Concurrently, Climate Service products which are currently used by stakeholders of the coastal protection infrastructure sector as well as their needs for not yet available Climate Services are assessed, again considering all three dimensions of Climate Services.

Main findings from the baseline will be summarized within a graphical visualization of the climate value chain for the specific sectoral context as well as in a SCOT differentiating strengths, challenges, opportunities and threats of the current state of a National Climate Service from both perspectives: providers and users.

III.2. Assessment methods and tools

The basic methods for data collection are questionnaires. Altogether two questionnaires were developed: one for providers and one for the users. There is no extra questionnaire for intermediates, since the classification to a stakeholder type is often not that clear and causes discussion and confusion. The user-questionnaire is also suitable for intermediates since it asks for the purpose and output of the use of climate information, which can refer to a decision-making process as well as to a product or service which will be used by another stakeholder. Although, the catalogue of questions is provided in the format of a questionnaire, the required information could also be collected via other methods like interviews or workshop notes and minutes depending on the local situation.

Provider questionnaire: the structure and content of the provider questionnaire mainly addresses NMHSs since these are normally key stakeholder of the Climate Service provider group covering fundamental tasks of a National Climate Service. However, the questionnaire is also suitable for other Climate Service providers when skipping some of the questions. The provider questionnaire is compiled from several WMO questionnaires. This comprises a standard questionnaire from WMO which is used to observe the development of its members as well as three draft versions which also address the current status of Climate Services provided by NMHSs in the context of the NFCS implementation.

User questionnaire: the user questionnaire was developed within the CSI project. However, ideas and experiences from other projects and programs addressing users and their need for Climate Services were considered (e.g. Bessembinder et al. 2012; Daly et al. 2016; BELSPO 2014). The scope and structure of the user questionnaire addresses a range of user types. This comprises experienced users who regularly use climate data and are able to process climate data for their context as well as users who have no experience with climate data. Less experienced users often require tailored products and help with interpretation of climate information as well as decision support. They are often not able to formulate their needs for specific climate information

products. The questionnaire is structured in a way that a user is guided to identify his needs for climate information for his specific context.

Product matrix: the product matrix is a tool which is attached to or integrated in the questionnaires. The product matrix reflects the three dimensions of Climate Services on the level of product types. This is because Climate Service dimensions (i.e. the tailoring of products for a specific sector, the services provided along with products, user-interaction as well as cooperation with other stakeholders to develop Climate Service products) may vary between product types (for the product matrix see Appendix 4). The matrix was completed by providers and users and can be directly compared. Discrepancies in offer and demand can directly be identified and also the reason for this discrepancy which might be found within any of the three dimensions of Climate Services (II.4). This approach potentially provides concrete entry points for measures to enhance the use of Climate Services.

IV National Background

IV.1. Climate change risks in the Mekong Delta

The Mekong Delta's economic attractiveness and success basically stems from productivity of the Mekong River which annually transforms the Delta region by providing fresh-water and nutrient-laden sediments (50-160 million t/a) as basis for agricultural production. This potential has been extensively exploited by the government since the 1960s with ambitious planning efforts to control the delta's freshwater hydrology in order to optimize the rice crop production. However, rapid population growth and intensive agricultural and aquaculture development during the past decades put pressure on the natural values of the Delta region with significant economic consequences: (1) intensively operated and highly controlled farming systems have depleted soil fertility and cut off cropping areas from the natural freshwater and nutrient source of the Mekong River; (2) the shrinking of floodplains due to land reclamation increase the risk of flooding in unprotected regions; (3) draining of wetlands causing water quality issues due to acidification with consequences for water supply and ecosystems; (4) over-exploitation of fresh-water in the context of dry-season agriculture cause land subsidence and causing salinization of remaining fresh-water sources. Furthermore, recent rapid hydro-power development in the Mekong Basin provides additional uncertainty on the planning of natural assets: (1) the regulating effects of reservoir dams dampen the natural flood-pulse of the Mekong which has been identified as main factor for the productivity of the floodplain and delta environment; (2) the reservoirs have a barrier effect for sediments, nutrients and biological organisms. Thus, this already vulnerable natural and socio-economic environment of the Mekong Delta region struggles with three drivers of change: (1) land-use change, hydropower development and climate change (MARD 2016).

Projected climate change will enhance prevalent risks especially with respect to changes in temperature and rainfall as well as sea level rise: (1) climate change will increase the seasonal variability of rainfall in the direction of more extremes which implies the risk of more severe and frequent floods and an increase in drought events. The flood season will be extended and the transition from the dry season to the flood season will be shortened. The dry season, however, will supposedly be wetter on average in the future. According to the worst case scenario, by 2050 flow volumes in the dry season will be reduced by 18% and average annual flood flow volumes will decrease by 22%. However, peak daily flood flows will increase significantly: a historic 100-year event will become a 20-year event and the 20-year and 10-year events will become 5-year events. Related sediment inflows to the delta will be reduced by 94%. Rising sea level will increase the problem of land subsidence and salt water intrusion (MARD 2016).

As a consequence, risk management strategies for the various parts of the Delta will become more critical in the context of the multiple pressures in the near future and

decision-makers need to carefully consider existing trends and challenges and the various drivers of change for the different hydro-ecological zones (MARD 2016).

IV.2. Context of CSI-project

Political background

In response to the emerging challenges of climate change for Vietnam, the government of Vietnam has ratified the UNFCCC and the Kyoto protocol. Furthermore, the government established a national framework for the prevention and mitigation of disasters originating from natural hazards. In December 2008, the National Target Program to Respond to Climate Change (NTPRCC) was approved and exactly three years later, in 2011, the National Strategy on Climate Change as well as the the Action Plan to Respond to Climate Change and Sea Level Rise (MARD 2016). Further laws on Disaster Risk Reduction or Environmental Protection are in line with the overarching national strategies. For most provinces, especially with regard to adaptation, the above-mentioned Action Plan to Respond to Climate Change has also been disseminated to the local level. The 63 provinces in Vietnam function as the second administrative tier with far reaching responsibilities and execute about 70% of the country's total public budget (MPI, 2015:36). A translation and applicability of national policies into action for coastal protection, has thus gained high priority.

All existing response approaches on national and provincial level in Vietnam have also paved the way to advancing Vietnam's aspiration for a successful contribution to the Paris Agreement through the formulation of the Nationally Determined Contributions (NDC). Probably the most important outlook for Vietnam's actions for the future, the NDC and its annex, the "Plan for Implementation of the Paris Agreement" (2016), contain a list of compulsory, priority and encouraged tasks to be implemented until 2020 and 2030 respectively. Further laws on Disaster Risk Reduction or Environmental Protection are in line with the overarching national strategies. The right column of

Table 1 displays 14 NDC tasks that are in line with the principals of enhancing the utilization of Climate Services in coastal protection. The tasks are also reflected in existing Vietnamese plans and strategies and are related to Integrated Coastal Protection (e.g. #29, 30, 31, 35, 36, 37, 38) and adaptation and climate proofing of infrastructure (#19, 27, 37). In addition, tasks #28, 65, 66 and 67 also highlight the commitment to new and necessary planning procedures. This includes the integration of climate change in medium-term socio-economic planning as well as principals for cross-sectoral and cross-provincial planning.

Table 1: Connection between Vietnam's already existing climate change approaches and NDC tasks

Vietnamese strategy	NDC tasks
National Climate Change Strategy (NCCS)	#26 meteorological data modernization; #27 guidelines for public infrastructure; #28 SEDP climate change planning #29 prevention of natural disasters (floods, etc.) #38 complete coastal dykes, control of salinity intrusion #65 integrate cc into policies and plans of ministries and provinces
Action Plan to Respond to Climate Change	#30 integrated water management #31 sustainable forest development/ coastal forest #35 ecosystems based adaptation #36 …integrated coastal management #37 resilient infrastructure, water supply, prevent flooding #66 revision of admin. functions
Law on Natural Disaster Prevention	#19 risk and vulnerability assessment
PM Decision 593 on regional steering	#67 enhance coordination in handling regional response to climate change

National Climate Service for the coastal protection infrastructure sector

In the context of the baseline assessment relevant stakeholders for the provision and use of Climate Services for the coastal protection sector was identified. Regarding the tasks and functions of the individual stakeholders, a preliminary institutional arrangement (stakeholder map) of a NCS for the coastal protection sector in Costa Rica can be drafted. Such an arrangement is provided in Figure 5. It is important to note that this NCS is hypothetical. The stakeholders do exist and may be allocated to the respective roles within the NCS due to their current tasks and mandates. However, actual roles and interrelations may not (yet) be existent. This stakeholder map shall provide a starting point for the baseline assessment and basis for the discussion of the results.

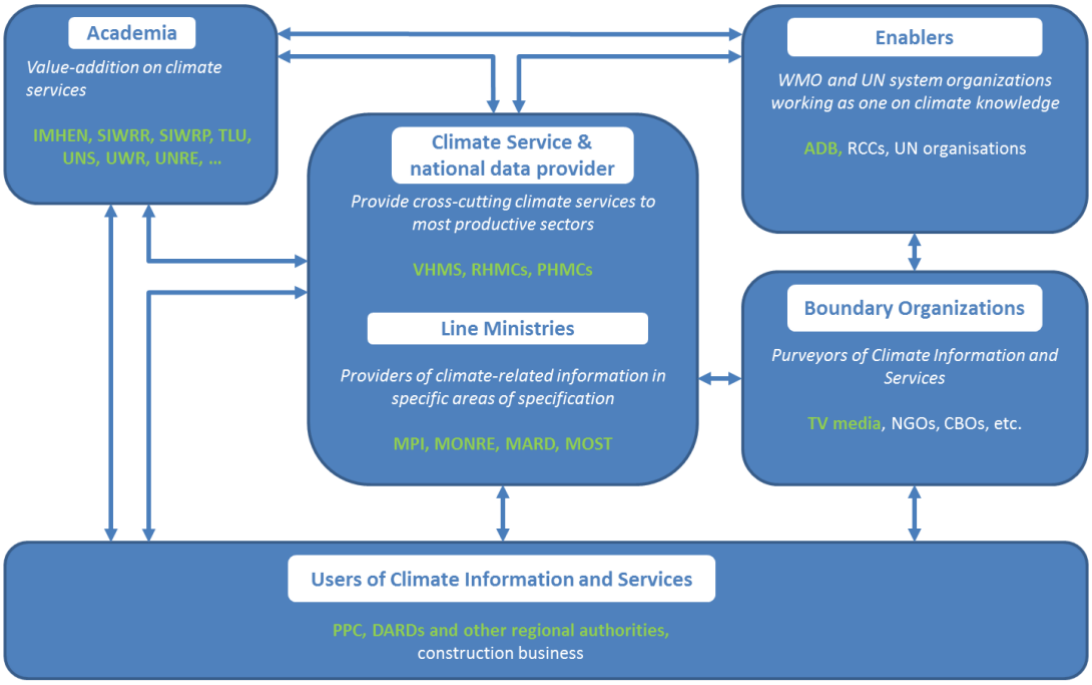

Figure 5: Preliminary institutional arrangement for an NCS of the coastal protection sector in Vietnam. Stakeholders in green color are identified organizations and institutions in Vietnam which already do or potentially might take the allocated role within a NCS for the coastal protection sector (based on WMO 2018). For abbreviations please refer to abbreviations list.

IV.3. Data collection

For the assessment of the Climate Service inventory a workshop was conducted at NMHS in order to introduce clarify the scope of the questionnaire and to become a common understanding of concepts and definitions. In a second step NMHS staff was interviewed exclusively. In order to get best possible information for different topics of the questionnaire, NMHS staff from seven different departments was interviewed, both from the national central office and the regional office in the area of the pilot study (Southern RHMC (Nam Bo)) (

Table 2). Besides the interviews, further sources of information have been used which comprises presentations on the NMHS which were kindly provided by NMHS as supplement to the questionnaires. One central document used for this analysis is an already existing baseline report of the NMHS from 2013, which was produced by World Bank and UNISDR (World Bank & UNISDR 2013).

Table 2: interviewed departments of the NMHS as key provider of Climate Service in Vietnam for the Climate Service baseline assessment

#	Department	Topic
1	NMHS: Centre for Hydrological Data Network and Information	Data sources and observation systems; Data management and exchange; Research; User interaction, interface and use-specific climate services
2	NMHS: Technology Application and Training Centre for Hydro-Meteorology and Environment (HYMETEC)	Climate product portfolio; Dissemination; Research; User interaction, interface and use-specific climate services; Monitoring and Evaluation
3	NMHS: Centre for Hydrological Network and Environment	Climate product portfolio; Research
4	NMHS: Centre for hydrological forecast	Dissemination; Research; User interaction, interface and use-specific climate services; Monitoring and Evaluation
5	RHMC: Laboratory for Environmental Analysis	All
6	RHMC: Department of Forecast	All
7	RHMC: Department of Information & Data	All

For the assessment of the sectoral users, questionnaires were sent to various stakeholders relevant for the planning of coastal protection infrastructures (Table 3). Furthermore, chapter 3 (User Assessment of Services and Hydrometeorological Information) from the World Bank study (World Bank & UNISDR, 2013) was considered and actively integrated in chapter VI.2.4 of this assessment report (Table 4 & Figure 13). Additional information about organizational structures of sectoral stakeholders was taken from ADB (2013) and MARD (2016) as well as communicated within the CSI project.

Table 3: Key users from the coastal protection infrastructure sector in Vietnam interviewed for the Climate Service baseline assessment.

#	Entity	Department / Unit
1	Ministry of Agriculture and Rural Development (MARD)	nn
2	Southern Institute for Water Resources Research (SIWRR)	• Financial Planning- & Accounting • International Cooperation • Vice Director
3	Southern Institute for Water Resource Planning (SIWRP)	nn

4	Kien GiangDepartment for Planning and Investments (KG-DPI)	nn
5	Kien Giang Sub-Department for Water Resources (KG-DWR)	nn
6	Thuy Loi University (TLU)	nn

V Climate Service inventory

The climate service inventory is supposed to be assessed for the National Climate Service (NCS) of Vietnam for the context of the sector of coastal protection infrastructure. This comprises Climate Services which are provided by all partners of the NCS in Vietnam (see II.5). However, the NMHS as National Hydro-Meteorological Service takes a central position within the NCS since it has a mandate from the government as official provider of Climate Services in Vietnam and is also funded via national budget. There are officially no other entities in Vietnam that provide Climate Services, and thus the NMHS also appears as central Climate Service provider in Vietnam. For that reason, the focus of the inventory assessment is put on the NMHS. Nevertheless, cooperation partners who support the NMHS in the production and provision of Climate Services are also assessed.

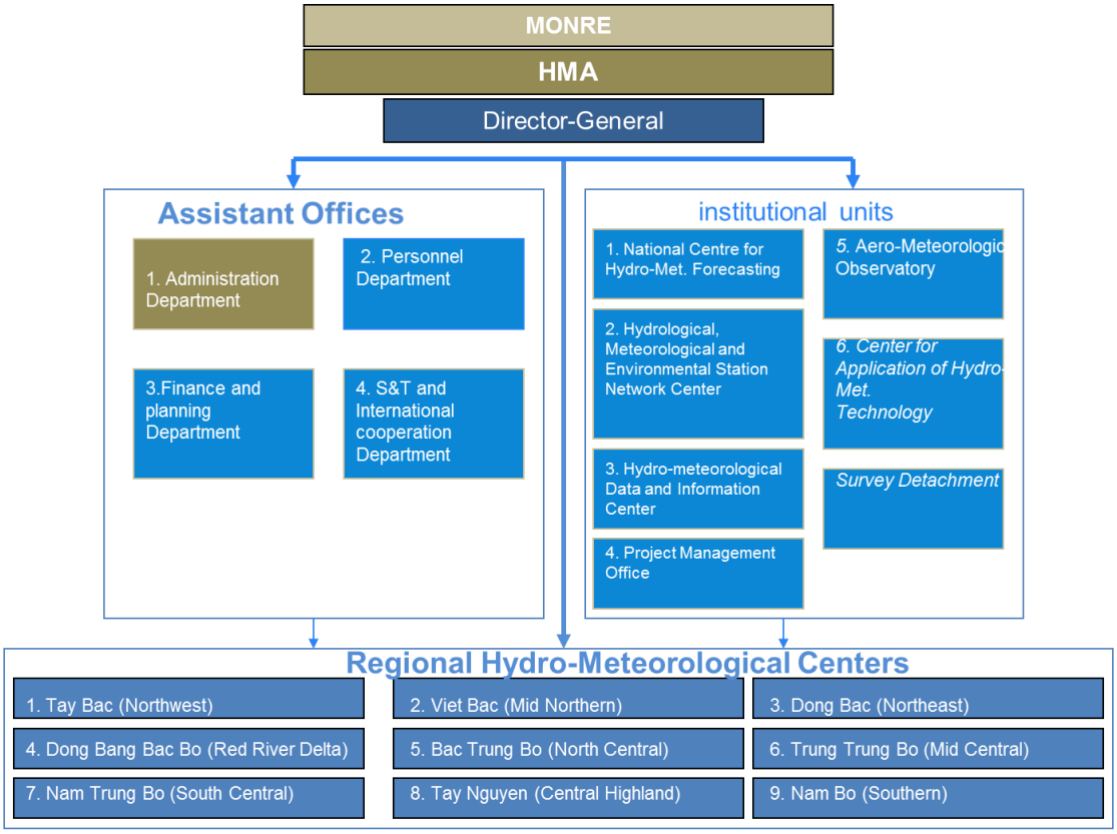

Figure 6: organizational structure of the NMHS.

Vietnam National Hydro-Meteorological Service (NMHS)

The National Meteorological-Hydrological Service of Vietnam (NMHS) is a state organization under the Ministry of Natural Resources and Environment (MONRE). In March 2018, it was upgraded to the Hydro-Meteorological Administration (HMA). Since then, its mandates and functions have been realized in accordance with abiding to the legal and policy framework under the Hydro-Meteorological Law in 2015. It is mandated to assist the Minister to manage and exploit national meteorological and

hydrological observation networks, to monitor air, water and environment in support of natural disaster prevention and preparedness, socio-economic development, national security and defence of the country. The NMHS is organized in four support departments (assistant offices) and seven operational and technical departments (institutional units) which are overseen by one Director General and three Deputy Director Generals (Figure 6). On the regional level there are nine Regional Hydro-Meteorological Centres (RHMCs) and on the local level there are 54 Provincial Hydro-Meteorological Centres (PHMCs) which are subordinated to the respective RHMCs (not illustrated in Figure 6). The operational forecasting activities of the NMHS are carried out by the National Centre for Hydro-Meteorological Forecasting (NCHMF). The NMHS has a total of around 3200 staff at the head-quarter and field offices and the NCHMF has a total of 140 staff plus a varying number of students at various levels. The main responsibilities of the NMHS are:

- the hydro-meteorological monitoring in Vietnam;
- to generate and disseminate operational forecasts, warnings and related information;
- the provision of hydro-meteorological services to various national and international organizations;
- the provision of research, training and support in order to enhance monitoring and forecast operations.

Whereas originally the focus was rather on forecasts and meteorological services mainly in the context of disaster risk prevention, a decree (No 36/2017/NĐ-CP) was issued by the Vietnamese Government on 4th April 2017 which redefines the functions, tasks, powers and organizational structure of MONRE. According to this decree, the NMHS was transferred into the Hydro-Meteorological Administration, along with the adoption of the new task of climate monitoring and the provision of climate service products.

The NMHS contributes and exchanges science and technology expertise at the regional and international level especially in the context of disaster prevention. Examples are the Asia Disaster Preparedness Centre (ADPC), the active participation at the Southeast Asia Flash Flood Guidance (SEAFFG), the Second Steering Committee (SCM2) and the ASEAN Regional Climate Outlook Forum (ASEANCOF-9).

V.1. Observations and monitoring

The observation and monitoring network of Vietnam is completely operated and managed by NMHS and is subject of comprehensive optimization programs.

The NMHS has an official mandate for the observation and monitoring of climate variables in Vietnam. By 2018, the density of observation stations in the national network has reached only 20-30% total area, of which about 50% are automatic stations. NMHS operates and maintains all meteorological and hydrological stations in Vietnam. One exception is the Institute for Transportation which operates its own

observation stations at airports in order to make forecasts for aviation. The NMHS collaborates with this institute for data sharing.

The surface observation network comprises more than 186 synoptic stations all over Vietnam (Figure 7) operated and managed by the NMHS and thus facilitates the observation and archiving of the most relevant Essential Climate Variables [ECV's] for the near surface atmospheric domain (*Precipitation, Temperature, Relative Humidity, Wind, Atmospheric Pressure*) by 4 to 8 observations per day. For the measurement of radiation, 14 stations are available. Additionally, there is an extensive network of rain gauge stations available which comprises more than 1300 reading points for precipitation measurements (Figure 8). Around half of the rain gauge stations are external measurement points which do not belong to observation the network managed by NMHS. Details on the operation responsibility of these "private" rain gauge stations as well as procedures of data integration are not given. For standard WMO parameters (temperature, rain, wind) there are time lines for periods of more than 30 years available.

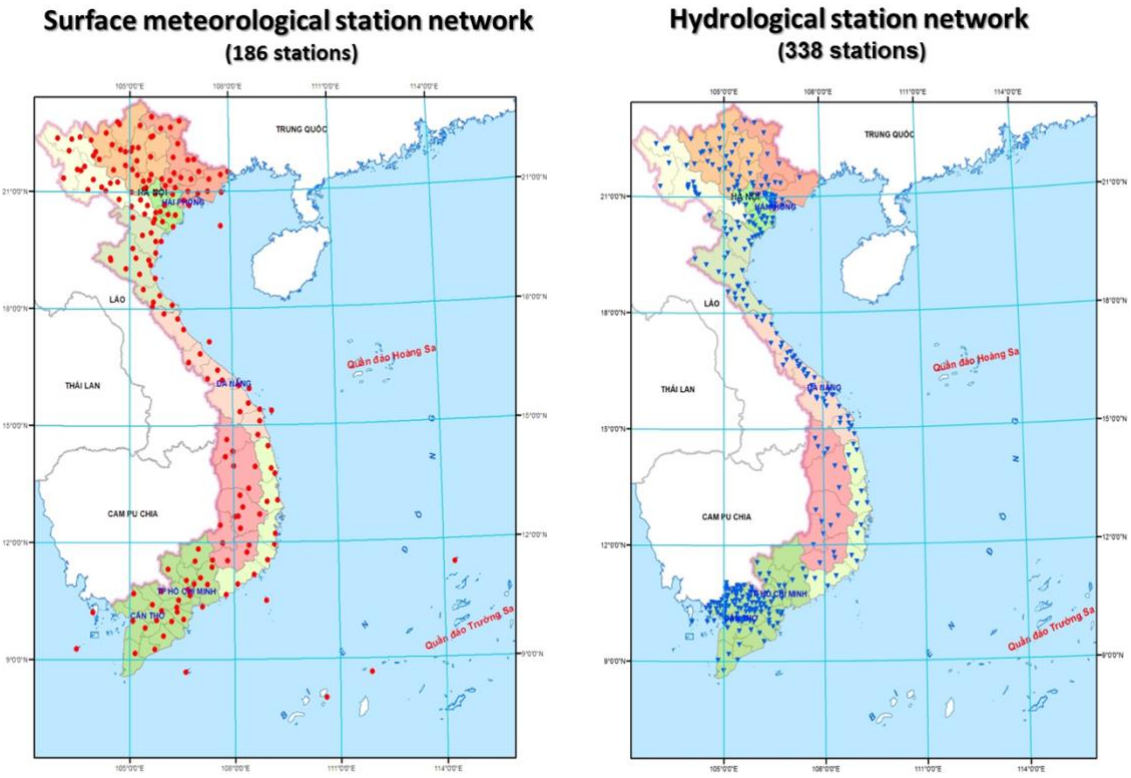

Figure 7: NMHS observation network. Left: surface meteorological station network. Right: hydrological station network.

Remote sensing systems comprise upper air observation tools with 6 radiosonde stations (2 observations per day), 8 wind-gauge stations (by theodolite) and 3 ozone and UV measurement stations as well as 7 weather radars (on 24h operation) (Figure 8) and a satellite receiving system which receives data from geostationary satellites (MTSAT-1R, CMACAST) and polar-orbiting satellites (NOAA, FY-1D, Himawari 8). These systems enable the observation of ECVs from the upper atmosphere (*e.g. global*

radiation, lightning, upper air temperature, water vapour, wind (speed and direction) and others) and atmospheric composition (*e.g. ozone, CO_2, CH4, SO_2, NO_2 and others*) as well as weather phenomena. In addition, 17 marine hydro-meteorological stations are located along coastal areas (5) and on island in front of the coastline (11). These stations observe tides, sea level height, currents and waves as well as hydro-meteorological variables. Additionally, there is a marine research ship for research activities and expeditions.

Regarding the monitoring of extreme weather events, especially storm and storm surge parameters are being measured, like wind, wave height etc. In total, 19 types of extreme weather related parameters, are monitored and stored, including tsunami parameters. This information is stored in a storm and hazard database in the Hanoi Centre which provides information on intensity, frequency and time of occurrence of individual storm events.

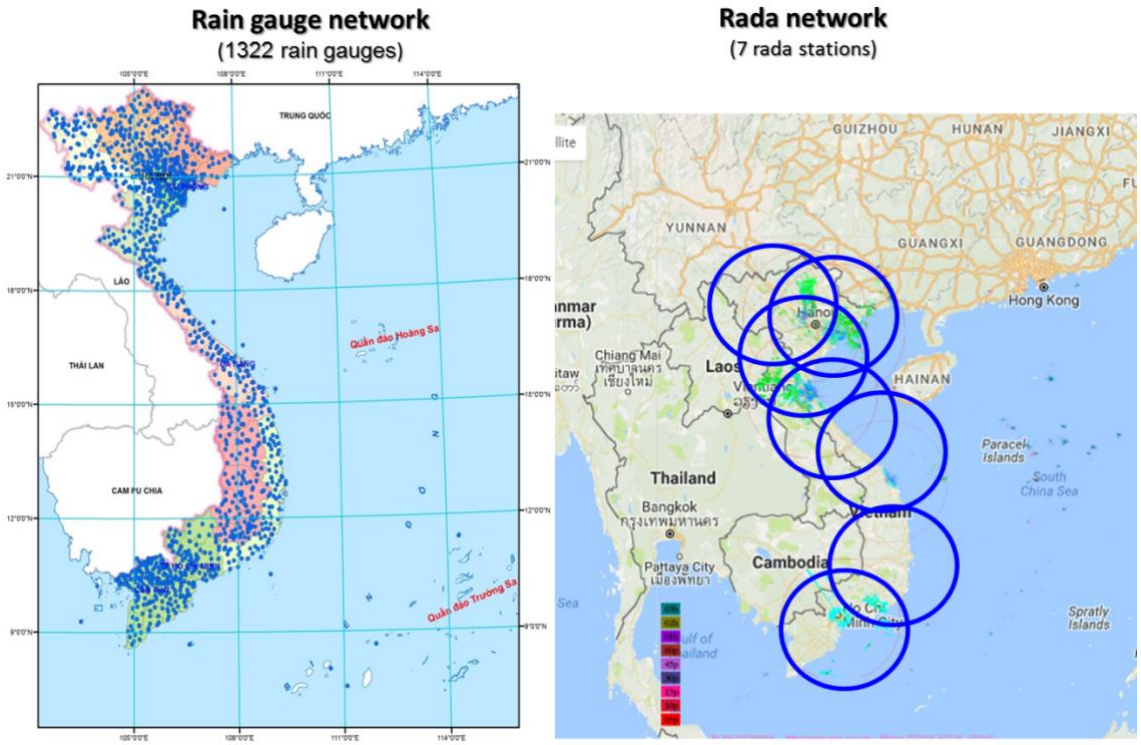

Figure 8: NMHS observation network. Left: rain gauge network. Right: radar network.

The observation system is completed by a hydrological observation network with about 238 hydrological stations (Figure 7) on category 1 to 3 rivers as well as in tidal areas providing information on river runoff, water level and sea level. Furthermore, about 174 mainly manually operated environmental stations, which provide information on air-, water- and sediment-quality of rivers and near costal ocean waters.

International cooperation regarding data access and exchange exists with WMO. Vietnam is official and active member of the WMO since 1955. It actively contributes to the global WMO data exchange system as part of the Regional Association II (Asia) of WMO and is member of the UNESCAP/WMO Typhoon Committee. Vietnam furthermore has several regional and bi-lateral agreements with NMHS from other

countries on data and product exchange, technological transfer, research and training. Among others, such cooperation comprises Japan and China in the field of satellite meteorology and the US for radar observations besides many others (e.g. ASEAN, Korea, Lao, France, Australia, Russia, Norway, Finland, and Italy in the fields of meteorology and hydrology). Nevertheless, there is a strong need formulated by the NMHS for access to internationally available data and for strengthening the cooperation with partners in order to enhance the provision of Climate Services.

Regarding observation and monitoring practices and processes the NMHS does not adhere to the WMO climate monitoring principles (see appendix 1). However, a non-real time quality control system is implemented nationwide. Observed data is collected and stored in databases along with meta-data. They are archived in homogeneity tested time series and, in large parts, also in the appropriate length, temporal resolution and units. Data rescue programs are in place since 2002, especially for rainfall data. Major challenges are required real-time transmission of station data and from neighboring countries to a central database. This also affects the data quality control system, which is not real-time yet. Furthermore, station sensors are from different manufactures. In order to guarantee quality and comparability, a standardization of measured data is required as well as a suitable interface which is capable in integrating and unifying inputs from different sensor types and models. Finally, one exclusive central database is required which integrates and archives all data from the entire observation and monitoring system. Currently, observation data is archived in at least three different databases, on national and regional level, which restricts a central query of climate data. However, the NMHS adopts a long-term strategy for renewing and modernizing the observation system. Prevailing ongoing enhancement measures mainly refer to the automatization of the ground observation system.

V.2. Research, modelling and predictions

NMHS research concentrates on the enhancement of tools and knowledge to support everyday tasks and processes. Research related to climate change and the development of sector-specific climate services is done by IMHEN and national universities.

The NMHS has an official mandate to carry out research activities. However, there is no exclusive research department at NMHS. Research activities are mainly tackled by the department of Hydro-Meteorology but other departments may get involved if their field of responsibility is affected. Main fields of research support the everyday work of the NMHS of general meteorological and climatological studies as well as numerical studies to enhance the skill of weather forecast models and early warning tools for disaster prevention. Further research is done in order to improve the quality of measurement techniques and procedures as well as data archiving, management and services but also on the improvement of sector-specific hydro-meteorological services to serve community, economic and social development. Research results from the NMHS are documented and published in monthly publications. NMHS' research activities are supported and interlinked with the research from universities (on the basis

of MoUs) which comprises the University of Natural Sciences, University of Water Resources, University of Natural Resources and Environment and especially the Vietnam Institute of Meteorology, Hydrology and Climate Change (IMHEN) but also with universities on an international level in the Asian Pacific Region.

The leading center for scientific research on meteorology and hydrology in Vietnam is, however, IMHEN. The institute hosts five centers and does research on topics like climate and meteorological application, agro-meteorology, hydrology, tropical meteorology and typhoon, and environment. IMHEN already participated in research programs on the national and international level especially on applied themes like climate change, water resources and natural disasters. Regarding climate services, IMHEN works closely with the NMHS and especially contributes to research on the development of climate projections and impact modelling. More details on research themes and specific projects can be found in World Bank & UNISDR (2013).

V.3. Climate Services Information System

The Vietnamese Climate Service product portfolio and the dissemination-structure focuses on the provision of forecasts and warning of climate related hazards and is mainly aligned to the needs of the disaster risk and agriculture sectors. The provision of data and analyses products are, as of yet, of minor importance.

The NMHS is the official Climate Service provider in Vietnam. The National Centre for Hydro-Meteorological Forecasts (NCHMF) operates as climate information hub of the prevalent NCS: available forecasts and warnings, which are partly generated by other institutions like IMHEN, are collected, coordinated and disseminated and provided to authorities and the public at various spatial scales.

Climate Service Inventory

A product inventory provided and disseminated by NMHS and IMHEN is presented below. Products and services are categorized according to climate product types (Appendix 3). All products mentioned in the following sub-chapters are recapitulated in Table 5.

Climate data sets

The comprehensive observation network of NMHS comprises meteorological and hydrological data as well as environmental data. All measured parameters, which comprise most relevant atmospheric, terrestrial and oceanic ECVs, are in general available in form of station-based time series (Appendix 5). The length of time series varies and is dependent on the individual synoptic station. However, for most stations it is long enough for climatological analyses which require an ideal minimum length of 30 years. The resolution of meteorological time series is at least 3-6 hours (according to the observation interval). Higher resolutions are partly provided for rainfall data (1h) as a consequence of a data rescue program. Potentially higher resolutions are possible (up to 5 min) but this rainfall data is not yet available in digitized form. The temporal resolution for hydrological and environmental time series is not known. Data sets are not generated and provided standardly e.g. on the website. Specific data sets (e.g. for

a specific station and for specific parameters) are only compiled and provided on request.

Climate diagnostics, climate monitoring products & climate hazards and events

According to the NMHS climate diagnostic and climate monitoring products are being produced and provided to the users. Such products comprise advanced climate statistics and graphical products (e.g. regular spatial analysis of climate parameters and phenomena and their anomalies), sophisticated climate statistics and specialized products (e.g. indices for specific users, application products) as well as a review reporting in form of regular bulletins and summaries, reports on the state of climate (WMO) and climate statements for the public and specific sectors. Production and dissemination structures are not known. Such products are at least not disseminated to the public via the website and are thus not visible. They are probably not generated as standard products on a regular basis but only on request or in the context of specific projects and requests. One exception is a climatological review on the preceding seasonal period which is provided by IMHEN the context of seasonal forecasts.

The focus of the NMHS is the provision of meteorological and hydrological forecasts on various scales often in the context of early warning systems with respect to disaster prevention. Marine and inland weather forecasts with lead times between 24h and 10 days (up-dated twice a day) are provided for different regions of Vietnam (9 inland regions and coastal areas). Warnings are provided for tropical cyclones, monsoon, hot and cold spells as well as severe marine weather events 1-3 days in advance. Hydrological forecasts are provided as short- and long-term forecasts (for floods and droughts respectively). A daily hydrological bulletin provides the warning level status on observed and forecasted water levels. Hydrological warnings are provided regarding floods and droughts for the Northern River System and the Central and Southern River System. During flood-season, warnings are provided for major river systems as well as for big cities like Hanoi and Ho Chi Min City. Beyond that, a bulletin provides advice on water release rates for water managers in the case of droughts. Moreover, marine forecasts on wave heights and tides are provided along with warnings for storm surges and other hazards like saltwater intrusion. Data and information on hazards (19 types) are collected and archived in a hazard data base which provides information on intensity, frequency and time of occurrence and is also the basis for statistical evaluation. Apparently, information about individual hazards can be accessed at the website. At the time this report was elaborated no content was provided. Transboundary hazard alerts, outlooks and other information is also provided by the Asean Specialised Meteorological Centre (ASMC[3]) which closely cooperates with NMHS. However, there is no detailed information available which kind of information and data is exchanged based on which conditions. In the context of climate hazards and disaster prevention, similar regional cooperation exists with the Asia Disaster Preparedness Centre (ADPC) and the Southeast Asia Flash Flood Guidance

[3] http://asmc.asean.org/home/

(SEAFFG). Again, there is no information on the extend of the exchange of data and information and on what agreements exist specifically.

Long-term predictions (monthly, seasonal) and climate projections

Long-term predictions (monthly and seasonal scale) for standard meteorology parameters (temperature, rainfall) and hydrology (water level) as well as forecasts and outlooks on climate phenomena (e.g. typhoons, monsoon and ENSO) are provided by IMHEN but are also published on the website of NCHMF. In order to provide these services, IMHEN refers to data and model runs provided by the United States Climate Change Centre (CPC), the International Institute for Social and Climate Research (IRI), the Australian Bureau of Meteorology (BOM) and the European Centre for Medium-Range Weather Forecasts (ECMWF). Since IMHEN has not been interviewed, no further information on the development and production of seasonal forecasts (sources, capacities, partners, etc.) can be provided at this point. ASMC is also a regional stakeholder who provides seasonal forecasts and organizes regional outlook fora for the ASEAN region (ASEANCOF[4]). However, to what extend ASMC contributes to the seasonal forecasts and outlooks provided on the website of NCHMF and IMHEN is not known. The role of regional WMO institutions for the provision of seasonal climate data and model runs, for example, is not clear. Officially, the NMHS is part of the WMO Regional Association #2 (RCC RAII[5]). However, NMHS is not involved the provision of seasonal forecasts. Furthermore, answers from the NMHS interviewees indicate neither any activity of the NMHS within the RCC RAII nor the use of climate data and other services provided by the RCCs from RAII. The climate product and service portfolio of the RCCs from RAII has not been analyzed for this report. So, no statement can be made about potentially useful products. Furthermore, the RCC in Pune, India, which might potentially be responsible for the area of South Asia (i.e. Vietnam), is still about to be established and might provide usable information in the future.

Climate projections as well as impact projections are being developed by IMHEN in the context of the project “High resolution Climate Projections for Vietnam”. The project is based on a partnership between Australia’s Commonwealth Scientific and Industrial Research Organisation (CSIRO), Vietnam’s Institute of Meteorology, Hydrology and Environment (IMHEN) and the University of Science - Vietnam National University and is funded by the CSIRO - AusAID *Research for Development Alliance.* The climate projections for Vietnam comprise four scenarios (RCP2.6; RCP4.5; RCP6.0; RCP8.5[6]) and are based on a Global Climate Model ensemble (GCM) from the CMIP5[7] initiative (up to 47 dependent on parameter; mean resolution: 200 km) and 4 Regional Climate Models (resolution mean: 20 km). Climate projections are available for 20 years sub-periods from 2016 until 2099 for the following parameters: temperature (annual and seasonal means and extremes), rainfall (annual means, daily extremes), monsoon and

4 http://asmc.asean.org/asmc_asean_cof_about/
5 http://www.wmo.int/pages/prog/wcp/wcasp/RCC-Asia.html;
6 RCP (Representative Concentration Pathways) refer to “time-dependent projections of atmospheric greenhouse gas (GHG) concentrations”. More details in Moss et al. (2008).
7 https://cmip.llnl.gov/

climate extremes (number typhoons & tropical depressions; number cold days; number hot days). Climate impact projections are available for sea level rise means and extremes (storm surges; tidal regimes; inundation caused by sea level rise). The report describing the results of the project is freely available on the website of the project[8].

Climate Services for coastal protection infrastructure

Official statements are made by NMHS on sectoral requests for climate data and information: they identify the sectors energy (30%), water resources (20%) and transportation (15%) as the top 3 sectors, closely followed by agriculture (13%), construction (12%) and civil protection and others (10%). In contrast, the evaluation of the NMHS questionnaires provides no clear picture of a sectoral priority regarding the provision of Climate Services. The answers from individual interviewees are sometimes even contradicting each other as well as the official numbers. However, this may well be explained by different ways of interpreting the questions. Independently of differences, sectors which are directly related to coastal protection infrastructures due to their vulnerability to storm, saltwater intrusion and coastal erosion (e.g. water resources, agriculture, fishery, forestry) are generally rated as important or very important by at least the half of the respondents. Sectors which are rated as similarly important comprise the sectors of energy, tourism, health and finance as well as inter-sectoral user groups like the government and local authorities. Interestingly, the construction sector, the science community as well as emergency planning and response sector are rated as of rather average importance regarding the provision of Climate Services. The role of the construction sector is noteworthy, since this directly affects coastal protection infrastructure itself in order to develop climate proof designs of dams or sluice gates. The emergency planning and response sector is noteworthy since the focus of the product portfolio of the NMHS refers to climate related hazards and their prediction. The science community is plays a major role in the development of sector specific Climate Services also in the context of coastal protection infrastructure.

Considering the product portfolio of NMHS and IMHEN, available products focus on the context of coastal protection. This refers especially to the forecast and warning products which are related to droughts, fluvial water levels, storm surges, typhoons and also salt water intrusion (among others). It is also noteworthy, that the only climate impact projection is on sealevel-rise means and extremes which perfectly addresses the issue of coastal protection. In contrast, for climate data, diagnostic and monitoring products, no sector-specific products are highlighted besides the exclusive monitoring of sector relevant variables. However, such products are only produced on request anyways. Thus, sector-specific demands can directly be considered which enables the possibility of co-production of tailored data, diagnostic and monitoring products for the sector specific context.

Dissemination, communication and outreach of climate information by NMHS

Hydro-meteorological information in Vietnam is in general not freely available with some specific exceptions. According to the Ministry of Finance's Circular No. 23/2009 /

8 http://vnclimate.vn/

TT-BTC, no charge is taken for the exploitation and use of hydro-meteorological, hydrological and environmental data following purposes:

- Announcing on the mass media of the State serving the general needs of the whole society;
- Serving the needs of national defense and security;
- To exchange information with foreign countries or international organizations under international treaties which the Socialist Republic of Vietnam has signed or acceded to.

For all other purposes users have to pay for climate data, information and services. However, there is no information provided on the criteria and responsibilities to decide on the validity of these exceptions for specific inquiries. However, climate information products can be roughly distinguished by their availability: publicly available products are in general free of charge like for example forecasts and warnings.

All forecasts and warnings of relevant meteorological, hydrological and maritime events are disseminated via the NCHMF website. The NCHMF website also provides products produced by IMHEN or other departments of the NMHS. Additionally, IMHEN does have its own website at which similar products can be found. Yet, at this point it cannot be clarified to which extend the published climate information on the different websites do agree. It is furthermore not clear how well maintained the content of the NCHMF website is. At the point of research, the website did not provide content for all products with all intended features (last date of visit: 30th September, 2018). However, the NCHMF, as part of NMHS, has an official mandate for the provision of hydro-meteorological and climate information. Forecasts and warnings from the NCHMF are directly disseminated to governmental authorities, the Central Committee on Flood and Storm Control and the National Committee for Search and Rescue as well as to the public via TV, social media and SMS. At the same time, forecasts and warnings are forwarded to the regional and provincial hydro-meteorological centers that in turn disseminate this information to local authorities and to the public via media. For acute hazardous events, like tropical storms and flash-floods, forecasts and warnings are updated several times a day. In order to provide a clear communication of warnings, the national center of NMHS has the power of information in case of a disagreement of forecasts between centers. Marine hydro-meteorological forecasts as well as seasonal forecasts are often communicated directly to special user groups (e.g. fishers) as well as via common media channels (TV, radio, social media).

For the provision of climate data products as well as for climate diagnostics and monitoring products no such interface and dissemination system exist. These products are not covered by the Ministry of Finance's Circular No. 23/2009 / TT-BTC and have to be purchased. Ordering of this information happens via the NMHS press office by the formulation of a letter of request. However, there is no information about any standardized procedure for handling data requests within the NMHS regarding communication with the customer, determination of the expected timeframe and transparency of costs for the specific inquiry.

The current long-term development strategy of the NMHS envisages a commercialization of the service. Several initiatives and programs are already in place

to implement this strategy which comprises market surveys in order to identify new areas for engagement and thus potential customers as well as respective capacity building measures for staff. Accordingly, NMHS's staff is continuously trained to enhance knowledge and skills for data processing, projection, modelling, hazard warning and weather forecast news, and service development. The exchange in international bodies, such as for example in the context of the work in the International Typhoon Committee under UN Economic and Social Commission for Asia and the Pacific (UNESCAP) and the World Meteorological Organization (WMO), is also used to exchange experiences on developing and providing hydrometeorological and climate services in order to identify potentials for joint efforts to enhance these capacities in the member countries.

In general, Vietnam's strategic development orientation for the hydrometeorological sector for the time up to 2020 has the target to further investments in the enhancement of capacity for providing prompt and accurate climate information and its interpretation for socio-economic development in the context of climate change. It envisions a modernization of hydrometeorological sector, also introducing globally available technical innovations for the sector. The overall objective is to better serve the public need for Climate Services and making them usable for adding value for production and business activities. Before this background, this report may offer some recommendations for potential entry-points to achieve this, with special focus on the coastal protection sector.

However, no detailed information on the state of progress as well as the time frame is available.

V.4. User interaction and interface

A user interface exists in a basic form and is limited to single events. Activities regarding user interaction are limited to a mostly one-way communication of special forecasts and warnings to mainly political stakeholders from the disaster risk and agricultural sector.

In Vietnam there is, as of yet, no comprehensive user interaction platform available in form of an institutionalized interface or other tools, like technical platforms etc. In the past couple of years, first valuable initiatives to develop such an interface have been started. However, this user-interaction targets yet only governmental institutions and authorities on different organisational levels. There is no institutionalized interaction with stakeholders from industry.

Since 2009 onwards, the communication procedure of forecasts and warnings with the public was enhanced by the coordination with RHMFCs via online conferences. The user has now the opportunity to give feedback on these services by commenting. However, no information on this tool and feedback mechanism was provided by the interviewees from NMHS. Direct interaction channels exists between NMHS Centres and political stakeholders from the Natural Hazard and Disaster Prevention sector which comprises MARD, the Central Committee on Flood and Storm Control (CCFSC) and the National Committee for Search and Rescue (NCSR).

In 2010, the NMHS organized a workshop with mass media practitioners in Ha Noi. Since this initiative, there are exclusive collaborations of NMHS with national and regional TV Centers. The media (especially TV) takes a key role for communication of forecasts and warnings as well as for providing guidance for specific user groups like farmers and fishers by specific formats (e.g. Farmer News) or even exclusive TV Centers ("Center for disaster prevention"). Moreover, the Asia disaster preparedness center (ADPC) adopts tasks regarding the promotion of weather and climate warnings.

In 2010, four climate outlook forums at national as well as regional level were organized for all relevant agencies and end users. The scope of these forums was to assess the demand on hydro-meteorological data and information of various users in order to improve the provision of climate services.

The major current platform for direct user interaction is a regular meeting with the provinces on an annual basis. Content of these meeting is especially the presentation of new products, product improvements as well as research results with a focus on forecasts for civil protection and agriculture. Participants of these meetings are especially representatives from authorities responsible for civil protection and agriculture on the national and regional level. Yet, it is not clear if the annual meeting are an institutionalization of the climate outlook fora which were conducted in 2010. Furthermore, there is no information on the scope of such meetings and to what degree user interaction is part of them (e.g. feedback on presented products and services; co-production of tailored products; provision of support and guidance). Additionally, to what degree there is representation of other sectors beyond civil protection and agriculture via the involvement of end-users from the private sector is not known.

A regular forum is planned or already in preparation to provide continuous interaction between the NMHS and line ministries of specific sectors in order to identify sectoral needs and discuss the usefulness and usability of available products and services. However, no details are provided on the scope and objectives of such a platform.

On a day-to-day operational level, there is yet no established user interface available in order to handle user requests in a systematic and institutionalized way. The NMHS has no exclusive department or unit which is responsible for user-interaction. There is no helpdesk established to handle user-requests and feedback as well as to provide support and guidance for users. According to the interviewee, the head of each department is responsible for issues regarding user interaction. User needs are received centrally via inquiries by the press officer. However, the process of handling these inquiries is not structurally organized (as described above).

However, the need for an organized and comprehensive user interface is recognized by the NMHS. Yet, climate services are often not appreciated by many users and thus the profitability of climate information products and their impact on decision-making is regarded by the NMHS to be limited. Also, the lack of user feedback on provided climate services is regarded as obstacle to validate and enhance the quality of the products. The NMHS also admits that the lack of a training programs for users on the use of climate information may limit the use and impact of existing Climate Services.

V.5. Capacity development

Capacity development programs are, as of yet, very dependent on externally funded programs often provided by international organizations. The NMHS long-term strategy envisages a commercialization of the service and respectively aligns development activities and programs.

The capacity development component is an integral part of the GFCS. The content of this chapter refers to the existent capacity development structures of the NCS in Vietnam. Identified needs refer to the interviewees, first of all NMHS. Recommendations on specific capacity development activities are provided in chapter IX.

Capacity development is clustered into the three dimensions i) human/ individual, ii) organizational, and iii) systematic or enabling environment.

i. Individual level. The education of technical staff for the NMHS and other related institutions is conducted by the national universities, especially the Universities of Natural Resources and Environment (UNRE) in Ha Noi and Ho Chi Minh City, the Ha Noi National University as well as the Ha Noi Water Resources University. Regarding post-gradual programs and higher level training, IMHEN takes a major role along with the universities in the country. Advanced training for existing staff is mainly conducted in collaboration with international partners and the utilization of internationally provided trainings and courses (e.g. by WMO), especially on topics like seasonal climate, climate change and monsoons as well as the implementation and handling of new technologies (e.g. radar application). However, there is no indication for training programs organized and managed by Vietnamese institutions. According to NMHS interviewees, there are training programs for user communities available. However, no details were provided on type of training and the targeted sector(s). Training needs on the individual level are highlighted especially for the tailoring of climate information for specific user needs, the communication with users in order to identify their needs and also for the matter of Climate Services in general.
ii. Organizational level. Interviewees of the NMHS are aware of required organizational changes in order to enhance the provision of Climate Services. No specifications on what changes are required are being made. However, demands for more staff in order to accomplish emerging tasks in the context of Climate Service production and provision were formulated. This especially refers to the issues of user-interaction and research and development but also with respect to data management. On the technical level, especially needs for application software and funding in general were formulated.
iii. Systematic level. Regarding the enabling environment, the NMHS considers policies which define and support the role of the NMHS as central Climate Service provider in Vietnam as insufficient and thus as major structural shortcoming. According to NMHS staff, this shortcoming may refer to a lack of understanding on the political level for the use and value of Climate Services for

sectoral decision-making and furthermore to a lack of visibility of the NMHS in the public as Climate Service provider in Vietnam. In the long-term the NMHS envisages a commercialization of its organization by unlocking new markets for Climate Services in Vietnam, especially the private sector, besides its public tasks. A couple of programs are already in place in order to develop into this direction (e.g. market survey, capacity building for staff, etc.).

V.6. Evaluation of the Climate Service inventory

This chapter provides an approximate (qualitative) evaluation of the current state of the Climate Service inventory of the NCS Vietnam. This evaluation is done by using the WMO classification system for NMHSs. However, the role of other stakeholders is considered besides NMHS in order to provide specific types of products or services. The WMO classification defines 4 hierarchical categories. The categories 1-4 provide a qualitative assessment of the prevalent state of existing climate data services and information products provided by a NMHS (1= basic; 2=essential; 3=comprehensive; 4= advanced) (for details of each category please refer to Appendix 2). The focus of this system is on products and services which mainly refer to the “Climate Service Information System” component of GFCS. However, aspects from the other components are also considered since they are reflected within the product and service portfolio. This is also valid for contributions from other stakeholders from the National Climate Service. Nevertheless, an assessment of the NCS for the context of the coastal protection sector in particular as well as recommendations on the enhancement of the NCS for this sector will be done in chapter VII and chapter IX.

Category 1: Basic climate data services and information products

Functions of a Category 1 are basically fully covered exclusively by the NMHS. Current shortcomings and opportunities for optimization are clearly identified in the NMHS baseline from World Bank & UNISDR (2013) as well as specific recommendations. This refers to the *national observation system, data management (QA/QC), data archives, climate monitoring and the development of climate product standards*. The provision of basic *climate diagnostics and climate analysis* is also done by NMHS, however, only on request and not on the basis of standard products. According to the currently available information this area of operation is limited and the staff capacity for climate analysis is unknown. Furthermore, no capacity building projects are planned for this operational area according to World Bank & UNISDR (2013). The media is well incorporated in dissemination processes, however, mainly for the communication of warnings and forecasts in the context of the sectors of disaster risk and agriculture. User interaction is existent on a very basic level in the context of annual meetings.

Category 2: Essential climate data services and information products

Functions of category 2 are almost fully covered by the NCS Vietnam but only partly by NMHS and with fundamental support by IMHEN. *Monthly and longer climate predictions* as well as *climate watches* and *early warnings* can only be provided in

cooperation with IMHEN. The incorporation of similar products provided by other regional institutions like RCCs or ASMC is not known. The *interaction with users from different sectors* is done by NMHS, however, mainly with respect to forecasts and early warnings especially in the context of disaster risk management of different sectors. Main users are rather political stakeholders than classical end-users. There is no information on the *capacities and staff expertise regarding sector-specific tailoring* of climate data and climate diagnostics as well as on *competencies for advice and support for sector-specific users and to identify their needs*. For this context IMHEN seems to have more potential, since the scope of their research portfolio comprises sector-specific issues.

Category 3: Comprehensive range of climate data services and information products

Functions of category 3 are only partly covered by NCS Vietnam and IMHEN plays a dominant role. There are no indications that NMHS has adequate capacities to routinely *develop and/or provide specialised climate products* to meet the needs of major sectors. NMHS states that they produce such products but only on request and not in a regular manner. Furthermore, there are no organizational units within NMHS which may be able to cover specific sectoral needs. Sectoral foci are put on disaster risk and agriculture. The provision of long-term projections and their processing (e.g. *downscaling*) is done by IMHEN which are also being used to *build societal awareness of climate change issues* as well as *for policy development and National Action Plans*. There is no information to what extend NMHS or IMHEN also provides *advice on adaptation* measures for specific sectors. No detailed information is available to what extend all elements of Climate Risk Management activities are covered by NMHS and IMHEN and to what extend NMHS staff has *special knowledge in risk assessment and risk management*. However, disaster risk is the most developed sector regarding climate information provision in Vietnam especially regarding climate hazard monitoring, forecasting and early warning. There is no indication for any activity of the NMHS in the context of a *Regional Climate Centre Network*, although there is cooperation on the regional level (e.g. ASMC).

Category 4: Advanced Climate Services

Functions of category 4 are only sporadically covered by NCS Vietnam and only by the work of IMHEN. The ability to *run Global Climate Models* as well as the capacities for *sector-based research* also in *collaboration with sectoral stakeholders in order to develop software and product suites for customised climate products* can only be provided by IMHEN and other universities in Vietnam. There is no indication that the NMHS *could serve as a Global Producing Centre, a Regional Climate Centre or as a node in a Regional Climate Centre Network*.

VI Climate Service use and demand

The sectorial process of infrastructure planning and implementation for coastal protection in the Kien Giang province is outlined in Figure 9. This graphic displays relevant stakeholders (red bubbles) as well as their interrelation regarding mandates or other ways of initiating an activity (green boxes and lines) and products and services which are provided by mandated stakeholders (blue boxes and lines). Stakeholders are roughly classified based on their sectors (public, scientific and private). The displayed stakeholders and products and services reflect the answers from the interviewees. Thus, only stakeholders are displayed which were interviewed or mentioned within the interviews. The same is true for the characterization of the interrelationships. Furthermore, only relationships between stakeholders are displayed which are most relevant for the planning process of coastal protection infrastructure. Therefore, this figure lays no claim to being exhaustive! There may be many more cross-relationships between the stakeholders in reality.

According to the specifications given by the interviewees, the planning process of coastal protection infrastructure projects and the role of the interviewees within this process can be characterized as follows: The implementation of major inter-provincial infrastructure projects for irrigation and coastal protection is in general in the responsibility of the Ministry for Agriculture and Rural Development (MARD) and initiated by the Ministry for Planning and Investments (MPI). On the provincial level of Kien Giang, the Department of Agriculture and Rural Development of Kien Giang (KG-DARD) is in charge for the implementation of such infrastructure projects depending on the scope and funding source of the project. Here, the initiation is started by the Provincial Peoples Committee (PPC). The Kien Giang Department of Planning and Investment (KG-DPI) review and adjust the socio-economic development plan of the province in cooperation with the Kien Giang Department of Natural Resources and Environment (DONRE)) and DARD in order to identify the needs for coastal protection and production infrastructure needs. KG-DARD, then mandates the Kien Giang Water Resources Sub-Department (KG-DWR) to manage and implement water resource related infrastructure and disaster risk reduction projects. Scientific studies, which are, among others, generated by the Thuy Loi University (TLU) and the Southern Institute for Water Resources Research (SIWRR), provide the necessary scientific knowledge for considering climate change. For the technical implementation of the infrastructure project, the PMU of the project is in charge of elaborating and implementing the technical designs and Environmental Impact Assessments (EIA). In many cases they tender these tasks or specific elements of them. For the Mekong Delta, the Southern Institute for Water Resource Planning (SIWRP), SIWRR and Hydraulic Engineering Consultants Corporation No.2 (HEC-2 are normally contracted by the project implementers to make the necessary environmental and hydrological analysis and to develop technical designs. The results of the work are reviewed by the relevant authorities, i.e. MARD, PPC, DONRE/MONRE etc..

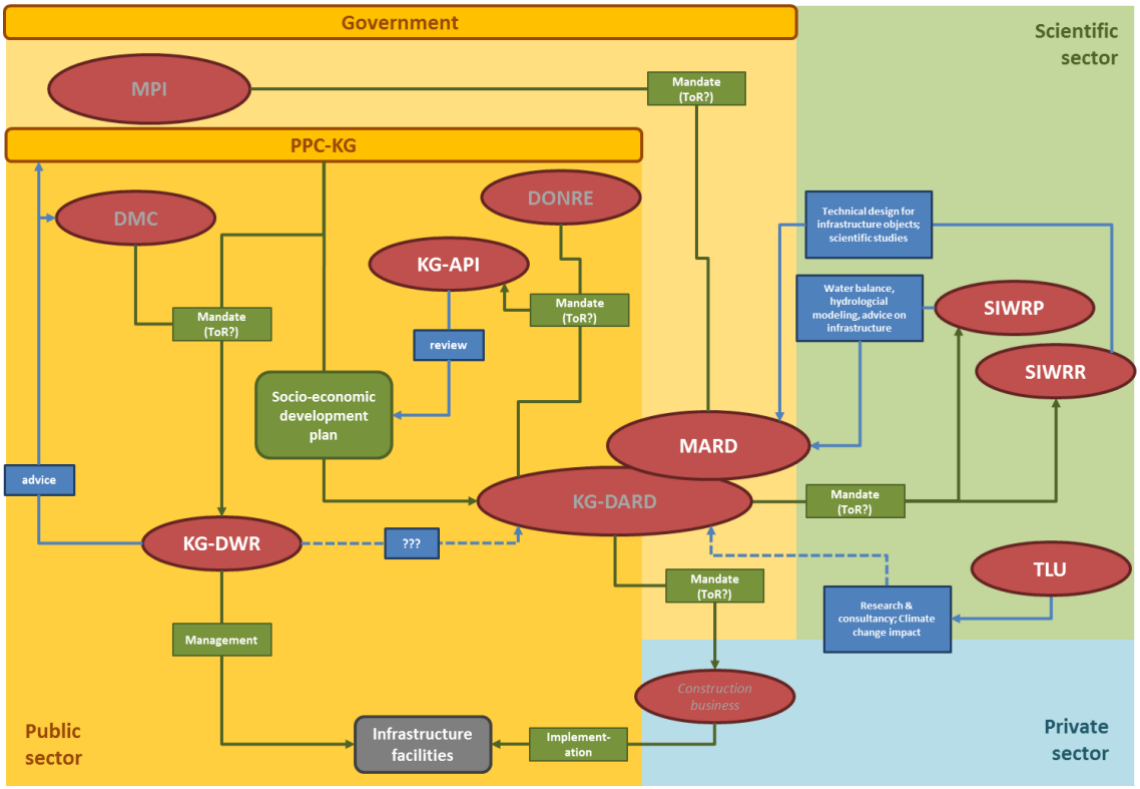

Figure 9: sectorial process of infrastructure planning and implementation for coastal protection in the Kien Giang province. Red bubbles represent relevant stakeholders which either have been interviewed (white writing) or been mentioned in the interviews (grey writing). Green lines and boxes indicate the initiation of activities (e.g. mandates). Blue lines and boxes indicate products and services which are the result of the initiation process. Dashed lines indicate unclear relationships. The colored shadings in the background indicate the sector at which processes are happening: the public sector is marked yellow (dark yellow=provincial scale; light yellow= national scale), the scientific sector is marked green and the private sector is marked light blue.

VI.1. Interviewed stakeholders of the coastal protection infrastructure sector

The Ministry for Agriculture and Rural Development (**MARD**) is responsible for rural development, governance, and the promotion of agriculture, fisheries, forestry, and irrigation in Viet Nam. With respect to infrastructure, MARD is in charge of the development of water resource systems (e.g. irrigation systems) and specific infrastructure constructions (e.g. sluice gates) as well as their management. As ministry, MARD has its own functions and is equal to and thus independent of other ministries. However, especially in the context of climate change adaptation measures, it works closely together with other ministries (e.g. MPI, MONRE, MOST) and gets requests from MPI for specific infrastructure projects in order to implement climate change strategies (IV.2). MARD is furthermore member of the Central Steering Committee for flood and storm control and is in charge for the organization of responses to natural disasters in the agricultural sector. In order to do so, MARD provides supervision, guidance, and facilitation to agencies in order to implement climate-change-responsive agriculture and rural development projects. This comprises,

among others, the areas of irrigation, water management, biodiversity management of forests and oceans as well as flood control and the related infrastructure constructions. For the implementation of specific projects, MARD has a nationwide network of 63 provincial offices (DARDs) and a relatively large cadre of field staff.

Climate information directly affects the planning and implementation processes of infrastructure objects. Studies on hazard exposures and climate vulnerabilities and risks, also in the context of climate change, directly influence the purpose, design and location of the infrastructure. The consideration of climate information in the planning process is determined by the Disaster Prevention Law, Natural Resources & Environment Law and Water Resource Law which requires a close collaboration with respective neighboring ministries for example in the context of the Central Steering Committee.

Decision-making process by MARD are based on tailored climate information specifically for the region and sector as well as on aggregated climate information products like sector-specific vulnerability and risk information. Decisions made by MARD directly refer to the climate data analysis and recommendations of technical consultants (e.g. SIWRP, SIWRR). MARD furthermore receives climate information from NMHS and IMHEN, especially regarding climate change and climate hazards. However, MARD does no own data analysis and processing capacities in order to get required information but is dependent on the provided information content. MARD specifies that they do not have to pay for the climate information they receive from SIWRP and SIWRR, which are part of MARD, neither from NMHS and IMHEN. In the context of a climate-value-chain, MARD considers itself as information broker who has a medium ability to formulate its needs for climate information. However, it is not clear how this role of a broker is characterized and who are the recipient and beneficiary of this service.

Southern Institute for Water Resource Planning **(SIWRP)** is part of the Institute for Water Resource Planning (IWRP) and responsible for the South Central and Central Highland Region. IWRP is a public non-profit organization under MARD. Its major tasks include regulating the use of water resources, as well as protecting and developing water resources and the environment in a sustainable way. IWRP provides consultancy and services in the context of water resources, which comprise water resources planning, basic survey (e.g. hydrology, topography, geology and water quality), environmental assessment, water resources planning in combination with natural disaster management, development of operational regulations of hydraulic infrastructures, etc. In the context of infrastructure-planning SIWRP makes technical analysis like hydrological and hydraulic modeling, water balances, water quality and flood forecasts as well as construction design and provides advice on infrastructure propositions and prioritizations. Climate information is directly integrated in the analysis processes. SIWRP does these services on behalf of MARD but also for other regional stakeholders like the KG-DWR and PPC.

SIWRP obtains relevant climate information from the Southern Regional Hydro-Met Centre. There is no MoU or other agreement with the SRMHC regarding the provision

of climate data and information. Data is provided on request. Although, the hydrological law[9] envisages the free provision of climate data for purposes of public interest, it is not clear if SIWRP has to pay for this data. SIWRP considers itself as end-user as well as climate broker in the context of the climate-value chain. In this context, SIWRP assess its ability to formulate needs for climate data and information as “good”.

Southern Institute for Water Resources Research **(SIWRR)** is a non-profit agency for scientific and technological research and post-graduation training for southern provinces under MARD. The general task of SIWRR is research in the area of water resources and their management especially in the context of climate change. Besides research, SIWRR also provides advisory services to MARD. This advisory, in the context of infrastructure planning, comprises planning for flood prevention (e.g. in HCM city) as well as planning and designing infrastructure facilities for water resources like dykes and sewer systems in the Mekong Delta. Purchaser of research and consulting services of SIWRR and thus users of the output are besides MARD also MOST, MONRE and the regional PPCs.

Climate data is directly used for the generation of the provided services and products. This climate data is directly obtained from the regional (SRMHC) and provincial (PMHC) hydro-met centers as well as from climate change institutes like IMHEN and universities. SIWRR has to pay for the data provided by the Hydro-Met Centres as well as for consultancies. The application of climate data is regulated in general by meteorological standards and, dependent on the specific purpose, by technical design standards as well as various laws (e.g. dykes law, water resource law, and natural disaster prevention & control law) which are supervised i.e. by MONRE and other ministries. Decisions on what specific climate information (e.g. data sets and their characterization) should be used are done by the specific project managers or by the superior agency or ministry. In the context of the climate-value chain, SIWRR considers itself as broker and value-adder. As direct user and processor of climate data SIWRR assess its abilities to formulate its needs for climate data and information as “good”.

Kien Giang Department for Planning and Investment **(KG-DPI)** is the regional office of MPI. The general task of KG-DPI is the consideration of disasters in coastal protection planning in the context climate change and respective adaptation activities (e.g. dyke construction and reforestation (implementation of circular 05/2016/TT-BDKH). In the context of infrastructure planning, KG-DPI develops and/or adjusts the Socio-Economic Development Plan for the region. In order to do so, KG-DPI develops hydro-meteorological scenarios for the deployment of dykes. KG-DPI works on behalf of DARD and DONRE, that also use the output of their work.

Climate information which is required for the development of the scenarios is obtained from SRMHC as well as from specific district reports. KG-DPI has to pay for the climate data and statistics it receives from SRMHC. The district report provides climate information as well as recommendations for action for the agricultural sector. The

[9] Law No. 90/2015/QH13 Hydrometeorology

report is provided by the Agricultural and Rural Development Committee and the Resource and Environment Committee. In the context of the climate-value chain, KG-DPI considers itself as value-adder who has “good” abilities to formulate its needs for climate information.

Kien Giang Department for Water Resource Department **(KG-DWR)** is in charge for the management of water resource infrastructures in the region. This implies tasks of dyke management and review of irrigation facilities in the context of disaster prevention. Additionally, irrigation plans for the region are being reviewed by KG-DWR in order to check their accordance with regional climate conditions and local production structures. In the context of specific infrastructure projects, KG-DWR provides advice on the project development and implementation. KG-DWR acts on behalf of the PPC and the Disaster Management Committee (DMC). The direct relationship with DARD/MARD or KG-DPI is not clear based on the available information.

KG-DWR purchases its climate information form the National, Regional and Provincial MHCs and from SIWRP. However, they have institutional relationships to the Hydro-Met Services with regular meetings and exchange. The construction law (MOC) and irrigation law (MARD) regulate the use of climate data in the context of KG-DWR’s tasks. The PPC also decides which climate information should be used in detail. KG-DWR considers itself as end-user as well as broker and value-adder in the context of a climate-value chain. It assesses its ability to formulate its needs for climate information as “good”.

The Thuy Loi University **(TLU)** is an organization for research, consultancy & technology transfer especially in the field of irrigation and environment for which they also provide vocational training. In the context of infrastructure investments, they provide research and consultancy for impact analysis of climate change on infrastructure objects in order to support adaptation activities. TLU provides its services for national authorities and management units which are not further defined by TLU. Relevant climate data and information is purchased from the NMHS by request as well as by own measurements. In the context of a climate-value chain, TLU considers itself as end-user and assess its ability to formulate needs for climate information as “good”.

VI.2. Use and demand of climate information by interviewed stakeholders

The results from the user interviews are comprehensively evaluated according to individual aspects of Climate Service application. Answers from individual users will not be discussed beyond the user characterization in chapter X.1. The objective of the presented results below is to get an idea about the general habits of using and purveying climate information within the coastal protection sector.

VI.2.1. *Legal and regulatory frameworks*

The consideration of climate and climate change for coastal protection issues is tackled by a high number of laws and regulations. However, there is little information about the regulation of the use of specific climate information and data.

There are many laws, regulations and political strategies from various sectors which are valid for planning processes of coastal protection infrastructure facilities. Overarching strategies are the implementation of the Sustainable Development Goals (MPI) and the NDC (MPI & MONRE). Most of the laws valid for coastal protection projects are of general relevance and determined by MONRE (e.g. Natural Resources and Environmental Law, Water Resources Law, Disaster Prevention Law, National Adaptation Plan). Rather infrastructure specific laws and regulations are determined by MARD (e.g. Irrigation Law, Dykes Law) and MOC (Construction Law). However, in the context of this assessment, there is no information to which detail the use and relevance of climate information is determined within the individual laws. Furthermore, there is a Hydrometeorological Law which, however, only determines which climate information products are freely available and which products and services need to be charged for (see V.3). Despite the huge number of strategies, laws and regulations which need to be considered for planning processes for coastal protection infrastructure facilities, 5 of 6 respondents still consider climate related laws and regulations as “relevant” for their organizations relative to other laws and regulations.

VI.2.2. *Motivation for the use of climate information*

The motivation to use climate data and information for decision-making is dominated by the obligation to consider laws and regulations.

All interviewed stakeholders have profound experience with climate related hazards and their consequences for the coastal area in general and for their individual contexts in particular. There is also a great awareness of climate change and the current and potential future impacts on the coastal area and the related sectors. Much of this experience on the effects of climate and climate change is not only perceived by interviewees but can also be confirmed by data. In 60% of the interviewee’s organizations there is some kind of agreement about the objectives and values related to climate-related issues in general and climate change in particular. However, only 50% of the responding organizations have an actual or potential focal point (expert or working group) on the topic of climate and climate change they can refer to if necessary. All responding organizations use some kind of climate information and all interviewees consider climate information as relevant compared to other information. The most important motivation to use climate information is laws and regulations. Internal motivation is also an important reason to use climate information. Interestingly, economic reasons like external motivation and business interests cause the lowest motivation to use climate information (Figure 10).

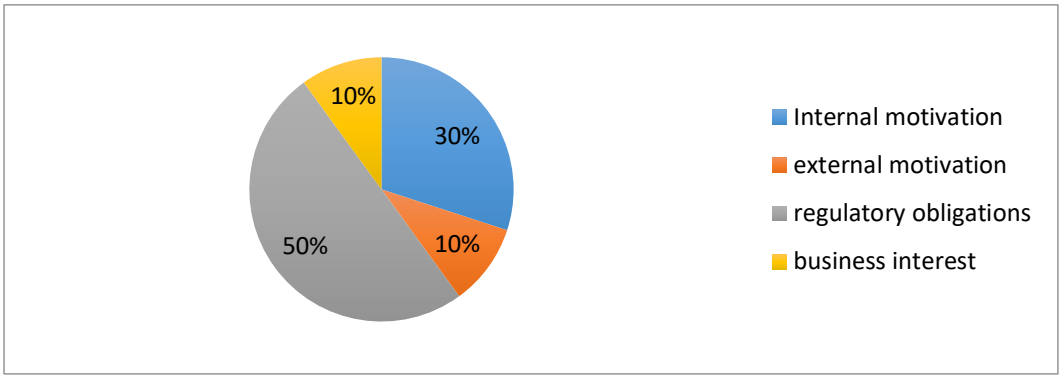

Figure 10: Motivation of stakeholders of the coastal protection sector to use climate information. Internal motivation refers to organization's vision, credo or policy etc.; External motivation refers to PR, image, etc.; Regulatory obligations refer to the consideration of laws, decrees, etc.; Business interests refer to competition benefit, economic value, etc.

VI.2.3. *Climate information and decision-making*

Climate information is predominantly used for decision-makings processes which refer to infrastructure planning and implementation as well as the development and implementation of risk management plans. Most favorable risk management strategies are risk prevention by protection and by transformation as well as awareness creation.

Within the organizational structure of most of the organizations, climate information has an impact at various levels of decision-making, which also have various temporal scopes (e.g. day-to-day operations (short-term); planning and maintenance activities (mid-term); strategic planning (long-term)). The interviewees consider that climate information has at least "some relevance" for all levels of decision-making. However, salient decision-making processes for which climate information is considered as "relevant" and "very relevant" are the "development and implementation of risk management plans" as well as "infrastructure planning and implementation". All respondents state that they already consider climate change for their decision-making processes based on available climate information. With respect to climate risk management options the responding organizations pursue two main strategies in the context of current climate hazards (4 of 5 answers): "awareness creation", "prevention-by-protection" and "prevention-by transformation". Prevention-by-protection comprises the construction of objects which protect the infrastructure object of concern (*e.g. dams or sewers*) and prevention-by-transformation the transformation of the infrastructure object in order to make it resilient to climate impacts (*e.g. adaptation of design parameters*). Other strategies like "prevention-by-retreat", "contingency planning", "early warning systems" and "recovery planning" are pursued by about 50% of the respondents. The most important risk management strategies regarding climate change, which are already implemented, planned or potentially considered, are again technical prevention solutions (prevention-by-protection and prevention-by-transformation), "recovery planning" as well as "awareness creation". These strategies are already partly applied as well as in preparation. Further planned strategies are "prevention-by-retreat" and especially "contingency planning".

Table 4: Pursued and optional risk management strategies of the 5 respondents (KG-DPI didn't provide any answer). In the first column (from left) types of risk management strategies are listed. The second column (blue shading) indicates whether the specific strategy is already implemented regarding current climate risks. Within columns 3-6 (red shading) it is indicated whether each specific strategy is an option in the context of climate change (no option, potential, planned or already applied). Given numbers indicate the number of responses for each strategy.

	Current climate conditions	**Climate change**			
Purpose	**Implemented strategy**	**No option**	**Potential option**	**Planned option**	**Applyed option**
Awareness creation	4			1	3
Prevention: Protection (*e.g. protective constructions like dams*)	4				4
Prevention: Transformation of object of concern (*e.g. change of building design, or specific components*)	4		1		3
Prevention: Retreat (*e.g. relocation of constructions*)	3				3
Contingency planning accommodating climate change risks	3				4
Business continuity management accommodating climate change risks			2		
Early warning systems	3				3
Responses to warnings (e.g. evacuation, temporal protection)	1		1		2
Recovery planning	3				3

VI.2.4. *Climate information products and services*

The entire product portfolio of climate information products is provided as well as used by stakeholders from the coastal protection infrastructure sector. Greatest needs regarding climate information provision refers to a lower extend to the need for additional products but rather to the dissemination process, access and availability of data and information as well as quality and tailoring of data and information.

The climate information product types which are predominantly used and demanded are displayed in comparison in Table 5. It is very striking that the entire portfolio of climate product types is being used by at least 50% of the respondents without exception. Product types which are being used the most are climate statistics, information on regional climate conditions, sector- or user-specific products, hydrological data and statistics, information on climate vulnerability and risk as well as climate forecasts and outlooks. The least used product types are climate change impact, vulnerability and risk information as well as educative support on climate issues and decision-support tools. These are also products which are being demanded besides climate change projections and statistics of climate impacts on terrestrial systems. However, it is interesting, that there is very little feedback from the interviewees regarding needs for additional climate information products. Existing feedback on demands basically comes from two users: SIWRP and SIWRR. These two stakeholders are also the main providers, besides TLU, from the user side. Thus, they are effectively intermediates of the climate value chain in terms of providing value-added climate information. SIWRR and SIWRP mainly provide products from the entire product portfolio with exception of climate data products (which is the responsibility of NMHS) and information on climate impacts on terrestrial systems. TLU focuses on the provision of climate change related products. Information on climate change vulnerability and risks is provided by all three stakeholders.

Concerning user needs, additional information is available based on the study of World Bank & USIDR (2013). This study should be mentioned since this contains valuable information on the required and desired climate services by the sectors associated to the coastal protection sector. Specific user needs from the agriculture sector, the water management sector, the disaster risk reduction sector as well as climate change in general where extracted from the report and integrated in Table 5, column 5.

Table 5: Overview of climate product types which are provided by the climate information provider network in Vietnam and used or required by responding users from the coastal protection sector in Vietnam. Provided products: Column 2 (yellow) lists a general portfolio of climate product types potentially provided by an advanced climate service provider (category 4) (Appendix 2). Column 1 indicates the provider of the product types in VN. Column 3 (blue) provides specific examples for a product type provided by the provider listed in column 1. The variety of blue shadings of the used product types indicate the number of providers of this product type (see legend below). Used and required products: in column 4 climate (green) product types are marked which are used by the interviewees. Specific products which were mentioned by the users are listed for each product type. The variety of green shadings of the used product types indicates the degree of usage (see legend below). The green shadings in column 5 indicate the share of used products which are being used as input for the production of follow-up products. These product types, thus, do not serve for immediate decision-making. In column 6 (red) climate product types are marked which are required by the users. Required means, that they are currently not available! The variety of red shadings of the required product types indicates the degree of requirement (see legend below). Please note: for "required products" information from the interviews as well as from World Bank & UNISDR (2013) are used and counted (each sector = one additional interviewee) which makes 10 respondents for this column. They do not reflect the entire product portfolio of provided, used or required products.

Legend: Number of respondents who provide this product type: 5 4 3 2 1 — Number of respondents who use this product type: 5 4 3 2 1 — Number of respondents who require this product type: 5 4 3 2 1

Provider	Product type	Provided products	Used products		Required products
NMHS	Climate data	Station-based time series for atmospheric ECV's & derived variables (*see attachment*)	Meoteo-hydrological data, such as rain, evaporation, stage, flow, wind, sunshine etc. (at various time scales and resolutions)		
NMHS, SIWRR	Climate statistics, diagnostics & monitoring	*No standard products - only on request* (e.g. regular spatial analysis of climate parameters and phenomena and their anomalies, indices for specific users, application products) regular bulletins and summaries, reports on the state of climate (WMO) and climate statements for the public and specific sectors.			Climate data (rainfall) from remote sensing and radar; real time monitored data (climate hydrology); climate variability information
NMHS, SIWRR, SIWRP	Regional Climate Conditions	*No standard products - only on request*			
NMHS, SIWRR, SIWRP	Statistics on climate extremes / hazards	hazard data base with information on 19 hazard types	Typhoon ,flood, low-flows, salinity intrusion; heavy rain, strong wind and drought information		Flood forecast and warning (also in ungauged catchments); drought forecast
NMHS, SIWRR	Tailored climate statistics	*No standard products - only on request*			
NMHS, SIWRR	Climate statements for sectors	*No standard products - only on request*			
NMHS, SIWRR	Hydrological data & information	Station-based time series for terrestrial and oceanic ECV's & derived variables (*see attachment*)	sea level rise		
	Impact information on terrestrial systems				national database for impacts of weather/ climate-related disasters
SIWRP	Impact information for specific sectors		salinity intrusion damage in agriculture and industry		Data base for climate impacts for specific sectors
SIWRR	Vulnerability/risk information				Vulnerability assessments to climate hazards; inundation & flood hazard maps; Risk assessment analysis (climate variability and extremes)
IMHEN, SIWRR	Long-range forecasts and outlooks (seasonal – decadal)	Long-term predictions (monthly and seasonal scale) for standard meteorology parameters (temperature, rainfall) and hydrology (water level); forecasts and outlooks on climate phenomena (e.g. typhoons, monsoon and ENSO)			Long-term climate forecasts
IMHEN, TLU, SIWRR	Climate change projections	Climate projections for temperature (annual and seasonal means and extremes), rainfall (annual means, daily extremes), monsoon and climate extremes (number typhoons & tropical depressions; number cold days; number hot days)			Local climate change projections
IMHEN, TLU, SIWRR	Climate change impacts	Sea level rise means and extremes (storm surges; tidal regimes; inundation caused by sea level rise)			
TLU, SIWRR, SIWRP	Climate change vulnerability/risk information				
TLU, SIWRR	Further education on climate (change) issues (methods & awareness)		Guidline how to selecte the proper scenarios and how to deal with a large deviation of result in CC scenarios		Enhance public awareness
SIWRR, SIWRP	Further education for decision-making support				

Beyond the technical products, additional services are being used (and provided) which help to apply available climate information products for decision-making or the production of value-added products. 5 of 6 respondents specify that they have access to external support or advice on how to integrate climate-related information into decision-making. The climate information provider is considered as important provider of such services but also external stakeholders. However, when interviewees were asked to specify the external support, often members of the climate-value chain were mentioned. In Figure 11 all used, demanded and provided services are displayed. The results show that in general all services are being used and required at the same time to a similar degree. This indicates a rather high general need for such services which make climate information usable to decision-makers and value-adders. The greatest positive discrepancy between use and demand (use > demand) refer to guidelines for the selection of relevant climate information as well as the explanation of climate information content. Results from World Bank & UNISDR (20013) also indicate a general need for a better and simpler explanation and visualization of provided products. The greatest negative discrepancy between use and demand (use < demand) refers to the support for users to query climate information which directly refers to the organization and operationalization of user interaction interfaces. SIWRR is the only intermediate who states that it provides services. These services refer to support in the application of climate information products with respect to the assessment of the value of the provided climate information for the user specific context and advice for the integration of climate information in decision-making processes.

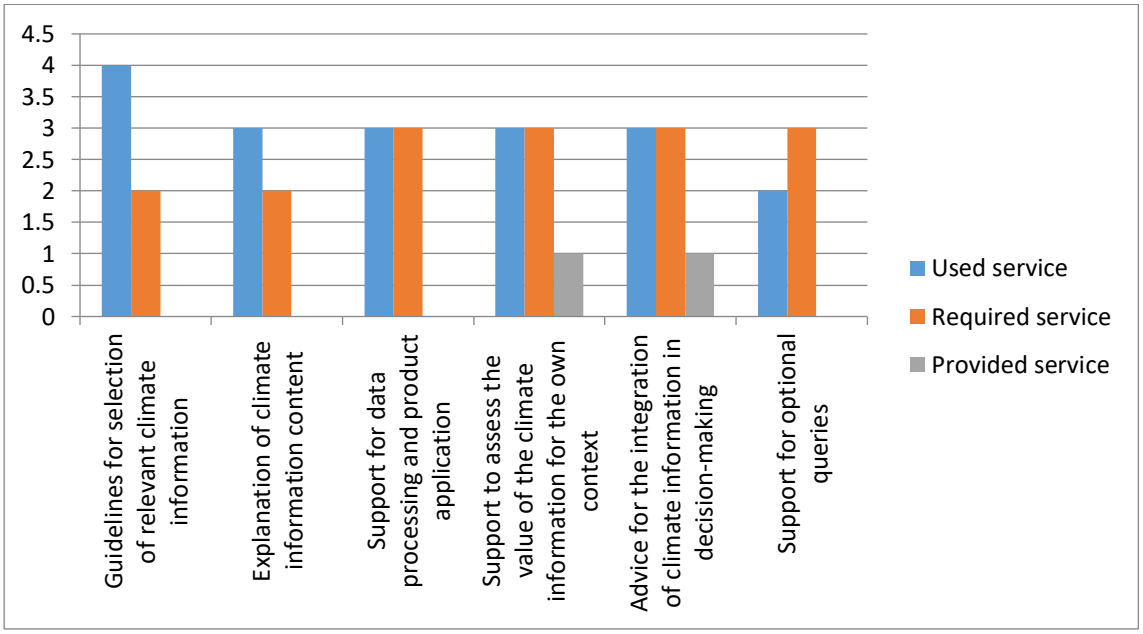

Figure 11: Services which are being used and required by stakeholders from the coastal protection sector in Vietnam. The y-axis shows the number of entries. Blue pillars indicate services which are being used by the respondents. Orange pillars indicate required services. Grey pillars indicate service which are provided by the respondents.

Stakeholders who consider themselves as value-adder or broker of climate information need to provide any additional processing-step of the climate data and information in

order to satisfy their role. The processing-steps applied by the respondents are displayed in Figure 12. The most frequently applied processing-steps are data collection, data analysis as well as modelling activities. The least applied processing steps are program coordination and applied research.

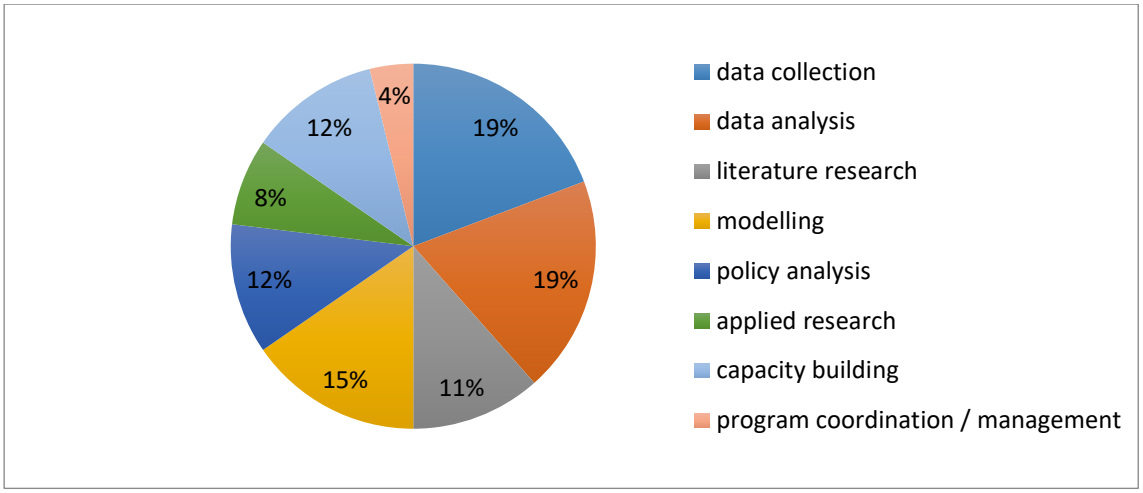

Figure 12: processing-steps applied by the respondents in order to add value to climate data and information.

Reasons why climate information products are not or only limitedly used in the coastal protection infrastructure sector refer to both, technical and institutional nature (Figure 13 & Figure 14). However, the feedback to this issue was very limited. Only 50% of the interviewees provided useful answers. For that reason, also results from World Bank & UNISDR (2013) were considered regarding technical limitations for using climate services in Figure 13. The most important technical reasons for a limited or no use of climate information products is the limited access to climate information as well as the tardy availability of climate information products. Further important reasons are: information content is not understandable and the limited quality of provided products. Reasons on the institutional level for a restricted use or no use of climate information products mainly refer to financial aspects (Figure 14). The three most frequently mentioned reasons are that products are not freely available and the non-profitable cost-benefit ratio of using climate information products, closely followed by the reason that there are no capacities available to deal with climate information appropriately.

In contrast, 4 of 6 respondents specify, that they have enough capacities to deal with climate information. However, two of them are end-users (MARD and KG-DPI) who indicate that there is no need for capacities to handle climate information. For the other stakeholders, it is especially technical equipment and skills as well as funding besides know-how and training which are required in order to better handle climate data and information.

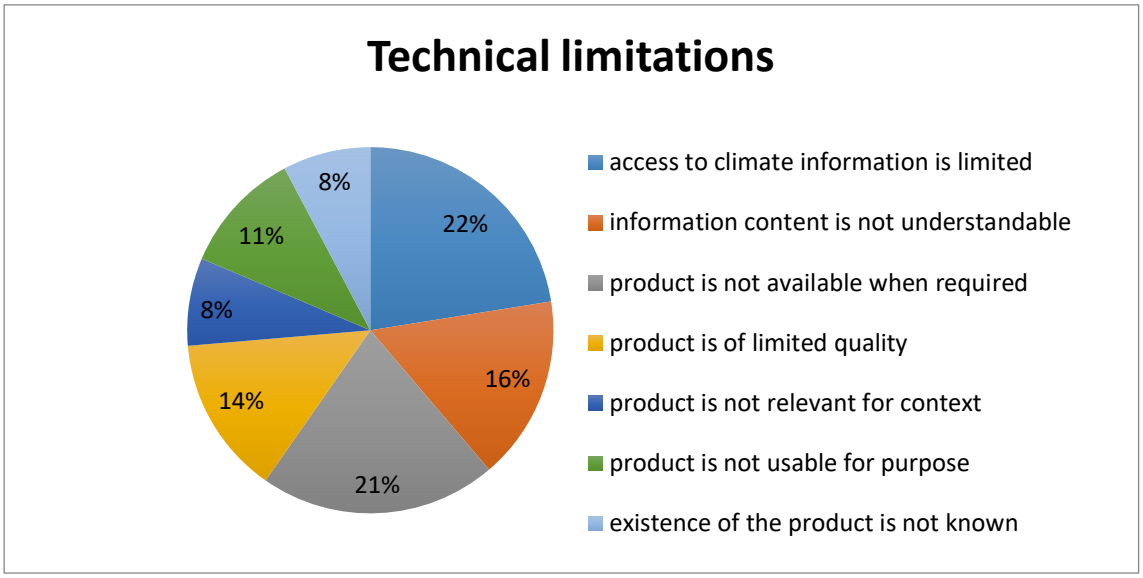

Figure 13: Technical reasons for a limited or no use of climate information products

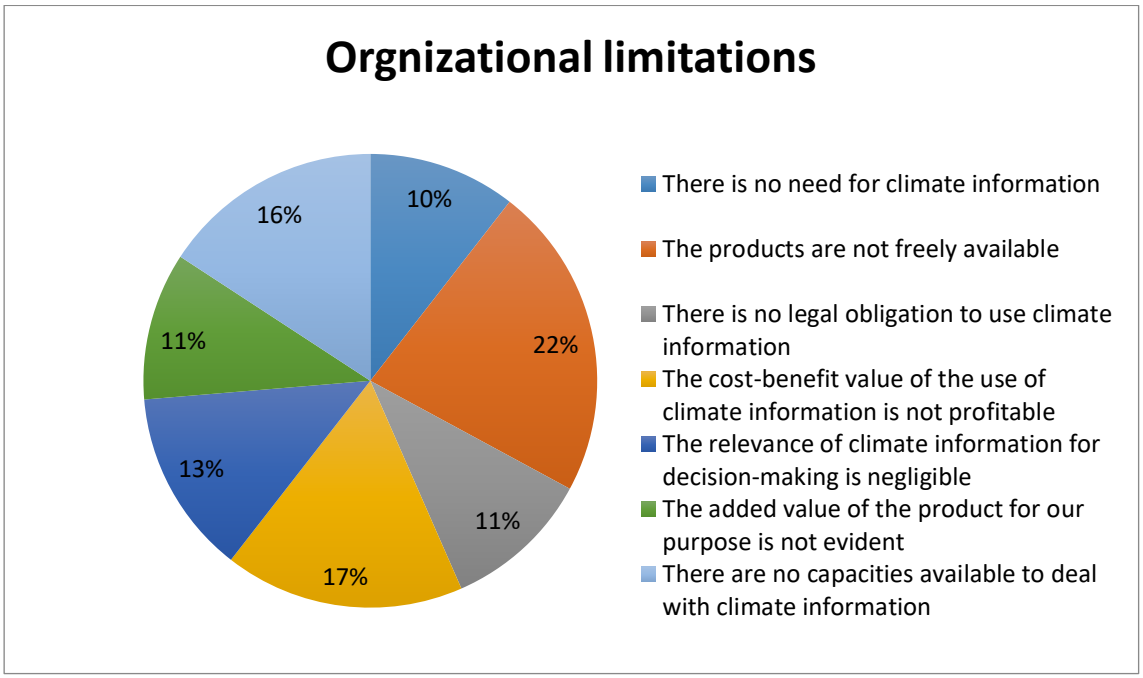

Figure 14: organizational reasons for a limited or no use of climate information product

VII Climate value chain – analysis of results

In this chapter the interrelation among climate information providers as well as with users shall be analysed and discussed. This interrelation can be described best by the climate-value-chain. The analysis is done from two perspectives: the primary purely climate information provider perspective as well as the sectoral perspective ofthe coastal protection sector.

Climate information provider network in Vietnam

The climate information provider network of Vietnam is visualized in Figure 15. The result of this stakeholder map is based on the findings from the interviews with NMHS employees and the report of World Bank & UNISDR (2013). There is no pretension to completeness.

The NCS is able to cover nearly all functions of WMO category 2 and some functions of category 3 and 4. However, in order to do so, NMHS is dependent on the contribution of IMHEN and regional climate information providers. Thus, both institutions together are the hub of the Climate Service provider network within the NCS Vietnam. Furthermore, many functions, especially beyond category 2, can only be covered due to the strong and well-developed disaster risk sector. Most products and services provided by the NCS are related to this sector. This comprises various forecasts and early warning products for a broad range of climate related hazards as well as a well-organized dissemination of these products via the media. At this point, it seems that a great deal of dissemination functions are outsourced to the media (at least for forecasts and warnings) which makes them an important stakeholder in the value-chain. The focus on disaster risk sector also partly covers the needs of other sectors and furthermore compensates for a lack of sector-specific products in category 2 and 3. The NMHS seems to take a rather basic role within the NCS, mostly limited to climate observation and monitoring as well as short-term forecasting (weather forecasts and warnings). In order to fulfil this role they make use of international support and collaborations. The NMHS also has the responsibility and ambition for the provision of climate diagnostics and monitoring products. However, this is, as of yet, not very distinct and/or visible regarding a systematic and comprehensive provision of such services. The role of providing sector-specific products is potentially rather fulfilled by IMHEN since they have the sectoral foci. Besides the sectoral focus, IMHEN has an essential role for the development and provision of long-term climate predictions and climate projections. In order to fulfil these tasks they make use of many international resources. In contrast, the collaboration with regional stakeholders that (potentially) provide similar information is not clear (e.g. RCC, ASMC). However, IMHEN is only a research institute with no or only little basic funding, making it difficult for IMHEN to adopt essential functions as Climate Service provider for the regular provision of such services. Nevertheless, a very close collaboration of NMHS and IMHEN is required in order to perpetuate the current portfolio of provided Climate Services and in order to enhance and extend the provision of Climate Services. The interlinkage with the coastal protection sector occurs mainly via political stakeholders, like the responsible

ministry (MARD) and other regional and provincial authorities (e.g. PPCs). Furthermore, especially warnings are disseminated via the media and respective committees responsible for disaster prevention (e.g. DDF, NCSR).

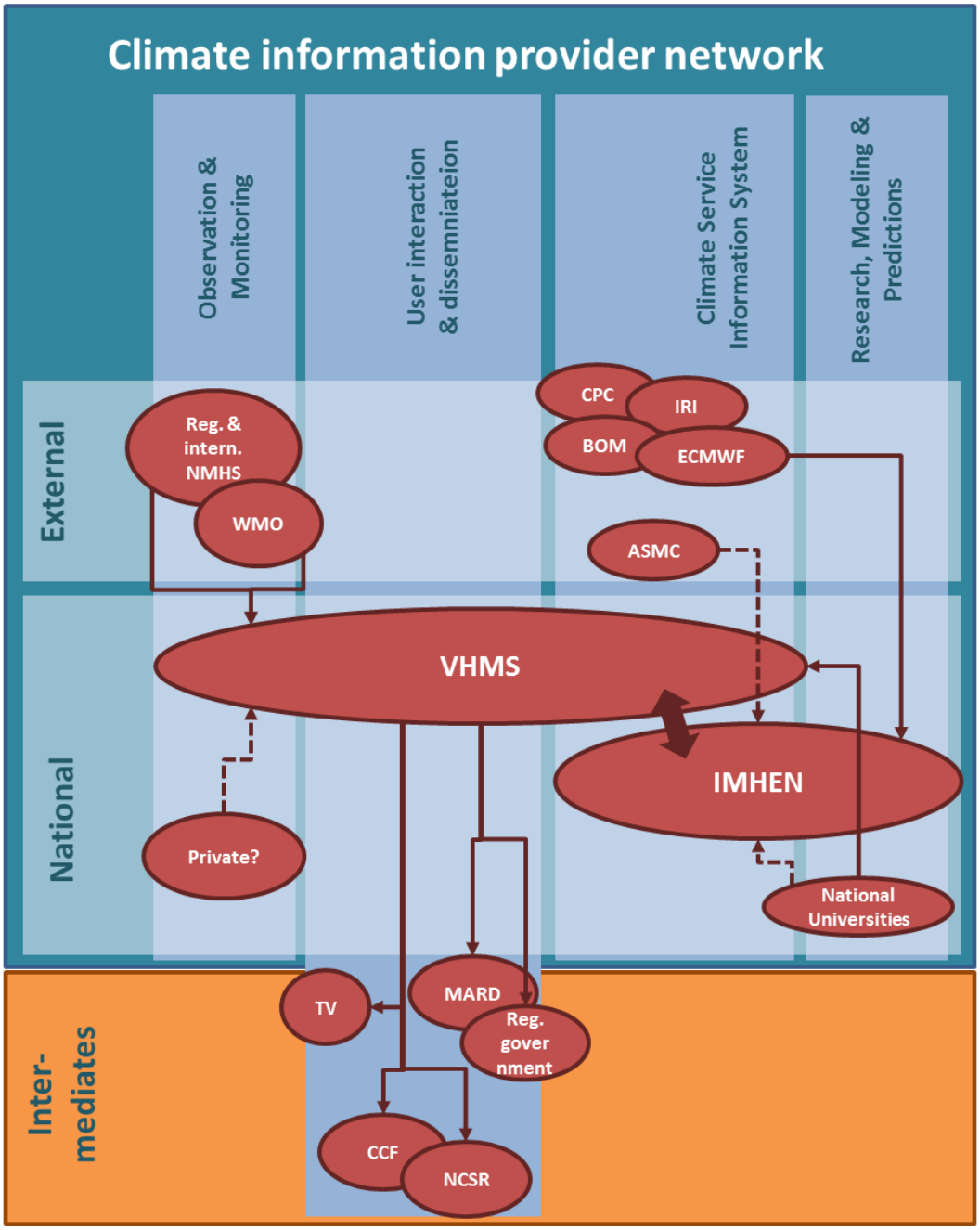

Figure 15: Overview of the climate information provider network. Stakeholders are located within the underlying matrix according to their contribution to specific products and services (columns) and their administrative level (rows). The bottom row (orange) indicates the transition to the user side. Stakeholders enlisted in this row support the NCS in disseminating and mainstreaming climate information to the public and specific sectors (here especially the coastal protection sector). Solid lines indicate the flow of data, information or support. Dashed lines indicate an unknown information exchange of the stakeholders.

Climate-value chain of the coastal protection sector

The pathways of climate information flow within the coastal protection sector are reconstructed in Figure 16 based on the specifications made by the respondents.

The suggested coastal protection value-chain for Vietnam is very compact: from the primary information providers (NMHS and IMHEN) to the end-users (MARD/DARD) there is primarily one intermediate chain link. Primary in-country data providers are NMHS and IMHEN. Stakeholders consult no external data sources. The only real end-user is MARD (KG-DARD) which can be identified as key stakeholder of the value chain: sectoral planning processes are organized and coordinated by DARD which is in charge to obtain all relevant information from various stakeholders. This is also valid for climate information: at DARD, all relevant climate information converges. This information comes from sectoral experts from two different branches: from a strategical administrative branch and from a technical branch. The technical branch comprises environmental surveys, technical designs of infrastructure facilities and risk assessments which are provided by stakeholders like SIWRR, SIWRP and universities like TLU which in turn use primary climate data and projections provided by NMHS and IMHEN. The administrative branch comprises consultancies of KG-DWR and KG-DPI regarding the integration of climate aspects (e.g. climate hazards and climate change) into planning processes like the regional socio-economic development plan, irrigation plan or others. Demanded climate information, however, has to be actively obtained by DARD from all stakeholders, which requires the formulation of ToRs in order to get the required climate information in an appropriate quality. Furthermore, DARD (or its national equivalent MARD as well as other ministries) are also in charge of contributing to the decrees of laws and regulations on the use of climate information for sectoral applications. According to the respondents, such laws and regulations are dominant factors for the motivation to use climate information. Information provided by MARD and other governmental authorities is furthermore considered as benchmark for valid and topical climate information for Vietnam (e.g. climate projections) as well as guideline for the choice and use of climate data and information. This observation is also supported by PPC, which is specified as guiding source of climate information by two stakeholders which are both from the administrative branch. However, it is not clear to what extend such laws and regulations provided by governmental authorities define the use of climate data and how provided reports on climate change and climate risks are characterized in order to guide on the use of climate information. Such binding guidelines would thus affect the scope and quality of the provided climate information for planning processes.

In order to fulfil these various tasks as central sectoral stakeholder, MARD/DARD requires a comprehensive overview of the sectoral stakeholder landscape and processes and additionally a profound knowledge and understanding of existing and required climate information products relevant for their sector. Furthermore, DARD is also a kind of information pool since all information, from both branches, the administrative branch and technical branch, end up at DARD. The responsibility of DARD for this potential treasure of information should be highlighted in the context of a NCS and should be reflected in the definition of roles and tasks of individual members.

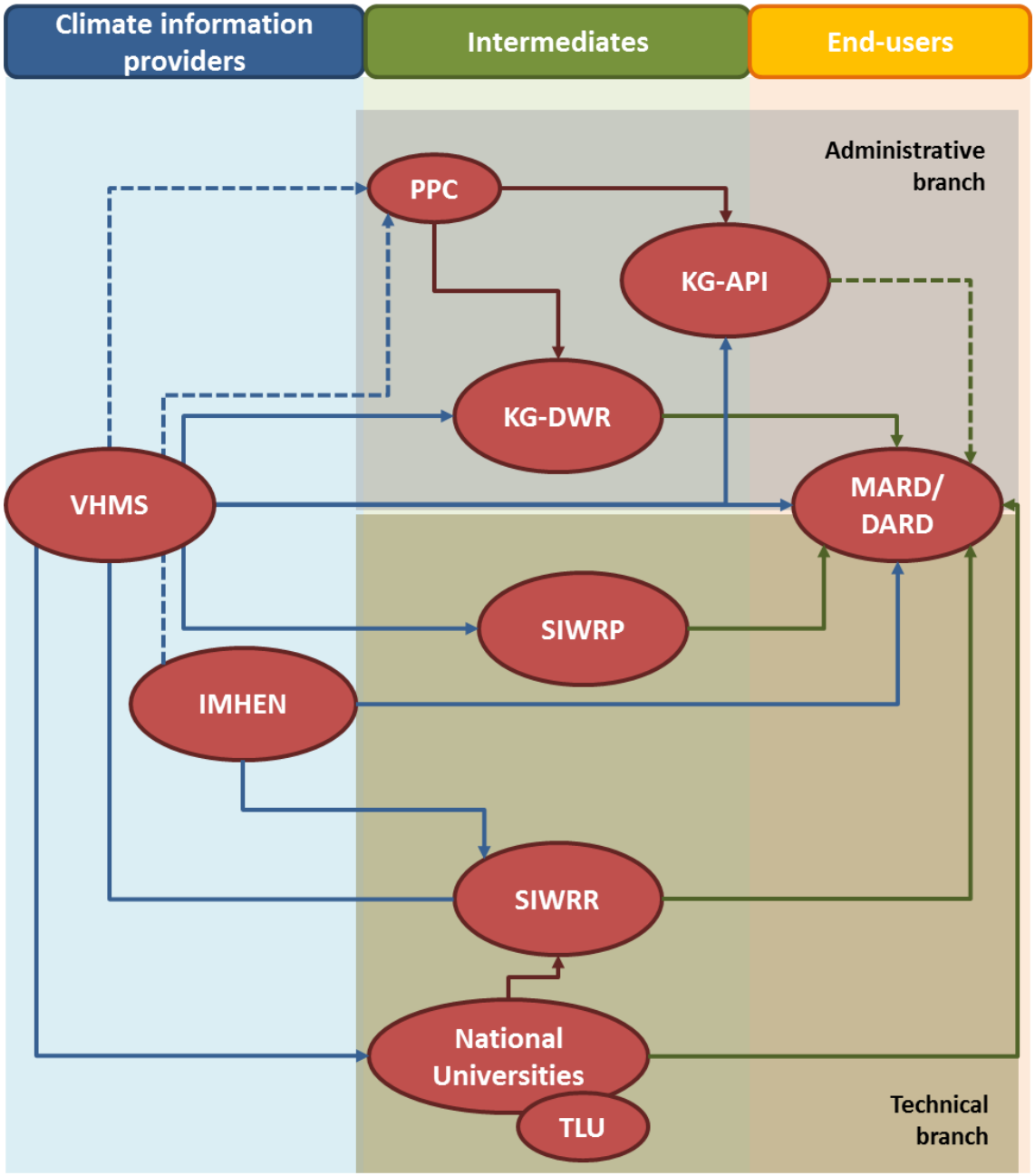

Figure 16: Overview of the climate information pathways for the coastal protection infrastructure sector in Vietnam. The graphic is structured according the concept of a climate-value-chain and roughly subdivides the stakeholders in providers (left), intermediates (middle) and end-users (right). Intermediates and end-users are sub-divided in different "branches" of climate information provision which refer to different decision-making processes: the strategic administrative branch (integration of climate info in spatial planning) and the technical branch (integration of climate in technical planning, e.g. technical design). Blue lines indicate the provision of primary climate data, red lines the provision of value-added information and green lines the provision of climate information ready for decision-making. Dotted lines indicate the provision of data and information which was not explicitly specified by stakeholders but which is assumed to be very obvious.

Further central stakeholders of the climate-value chain are SIWRP and SIWRR. It is primarily those two stakeholders that provide the climate information based on which MARD/DARD are making decisions with respect to infrastructure technical planning

and implementation. According to Table 5, especially SIWRR provides a big part ofthe NCS product portfolio especially for the sectoral context. Thus, SIWRR and SIWRP provide the relevant tailoring service of climate data as well as value-adding for the sectoral purpose. In the context of a climate value chain, they take an important intermediary position between the primary climate data providers (NMHS and IMHEN) and the end-user, which is MARD (DARD). However, as of yet, they are not integrated in a structured system of climate information production since they only work on request and primarily on a scientific basis. Consequently, the production of sectoral climate information is dependent on projects and mandates which provide the funding. Thus, the prevalent structure of climate information production for the context of the coastal protection sector provides no or only limited capacities for the establishment and maintenance of sector-specific monitoring activities like a database on climate-related and sector-relevant impacts and consequences as well as the regular production and dissemination of related products. Such a database, for example, is urgently needed by sectoral users (see Table 5).

The findings from climate pathway analysis can be used to delineate a climate-value chain for the context of the coastal protection sector (Figure 17) which defines the roles of the individual stakeholders within the value-chain. It is based on the conceptual model of a climate-value chain by WMO (Figure 2) and the findings from the baseline assessment. As both only had a limited scope, the analysis is yet preliminary. As mentioned above, the climate-value chain is very compact with fixed and pre-defined intermediate stakeholders and basically only one organizational level: at the technical branch, virtually all stakeholders (SIWRR and SIWRP) are of one organizational unit, since they belong to MARD. Details about the organizational and administrative relationship between MARD and SIWRR/SIWRP are not part of this analysis, but regardless, such administrative vicinity stimulates and enhances the establishment of agreements or MoUs regarding the exchange of data and information in order to enable a smooth and timely provision of required information. It furthermore fosters the organization of regular interaction of both stakeholders in order to guarantee a mutual understanding of information needs for decision-making by MARD/DARD as well as technical feasibility to provide required information by SIWRR/SIWRP. For the administrative branch various stakeholders are involved (KG-DWR and KG-DPI). However, they are all on a political level and thus under supervision of PPC. This constellation, again, fosters the organization of climate data and information provision as well as the interaction and exchange between stakeholders. Thus, for both branches of the value chain, there is no real sectoral landscape of stakeholders producing a market and thus an elaborate administrative process of coordinating an open competitive bidding for mandates on developing and producing climate information products. This also prevents an elaborate negotiation process which has to be conducted anew with many different stakeholders regarding scope, objectives and characteristics of climate information products. With respect to the climate-value chain, this supersedes the necessity for boundary organizations that communicate and mainstream climate information for specific sectors, the public or users (Figure 16). In contrast, the existence of a set and thus constant pool of stakeholders, which can also be denominated as sectoral champions that are in charge of the development and

production of sector-specific climate information products, is a perfect basis for the development of a sectoral branch of a NCS. Such a sectoral branch could provide sector-specific climate service products from one source on a standardized format and quality level. The sectoral champion(s) could represent a constant and thus reliable linkage to primary climate information providers in order to establish a mutual understanding and exchange of sectoral needs for climate data and information in terms of the User Interface Platform (UIP) as envisaged by the GFCS. Furthermore, the entire value-chain would be in public hand. This provides a great chance to produce and provide climate service products in a consistent way with meaningful content with respect to climatological standards (e.g. monitoring products with equal spatial, temporal coverage and fulfilling multi-sectoral needs). Products and services would be available irrespectively of specific requests enhancing the timely availability of data sets as well as the flexibility to serve various sectors and users.

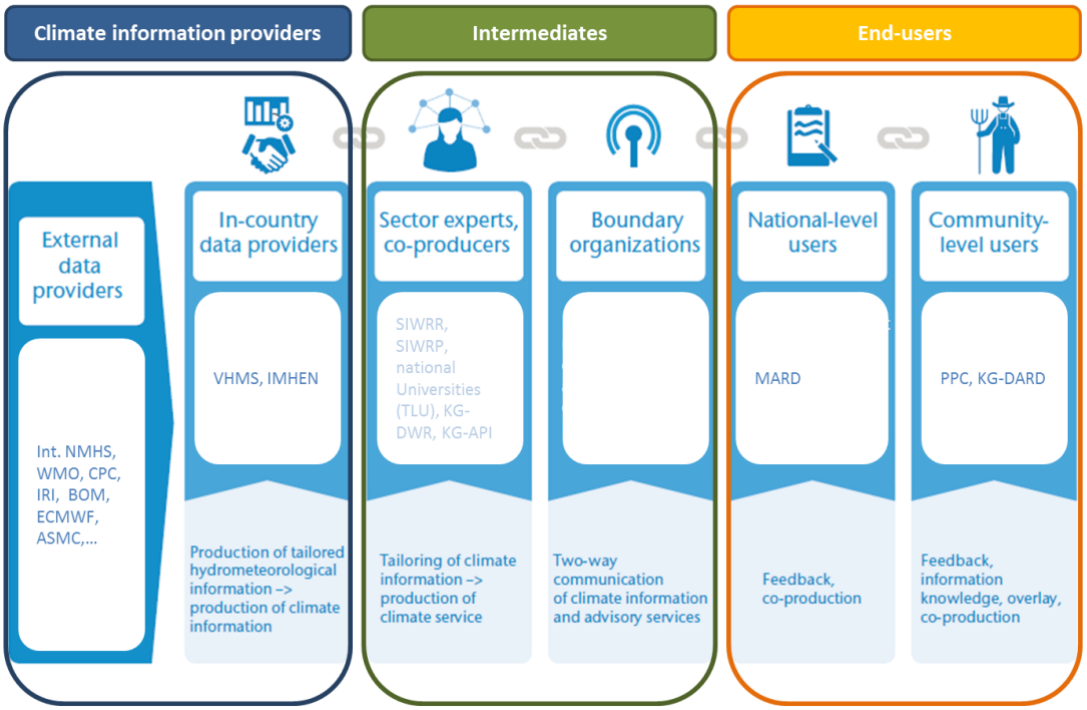

Figure 17: Preliminary climate-value chain for the coastal protection infrastructure sector in Vietnam (Kien Giang region). Identified stakeholders are based on the results of the baseline assessment. Grey colored stakeholders may potentially take the allocated role within the value-chain; however, they are not (yet) systemically and organizationally integrated in such a value-chain (modified and based on WMO 2018).

National Climate Service in Vietnam – roles and functions

The organisation of the stakeholders from the climate-value chain described above and delineated in Figure 17 as well as the institutionalization of their interaction processes would be an implementation of a National Climate Service for the coastal protection sector in Vietnam (Figure 18). In such a model of the NCS, the role of NMHS as primary provider would be focused on the task of climate observation and monitoring. Primary services (besides weather forecasts and warnings) would be basic monitoring and diagnostic products as well as the provision of data services. NMHS should

concentrate on the collection of high quality data, a structured, centralized and quality-controlled archiving of climate data as well as on the development of a processing-structure in order to be able to provide demanded products in a timely and effortless way. This processing-structure should be integrated in a user-friendly interface providing visibility to these products and allowing easy and non-bureaucratic access to this data and information.

All products which refer to long-term forecasts, climate projections as well as sector-specific tailoring would probably be covered by IMHEN (according the identified expertise). However, since IMHEN is rather a research institution, there will be no capacities for providing services on a regular basis. Such capacities need to be established in order to provide a profound climate service. Either within IMHEN itself or by further deepening the already existing close collaboration between NMHS and IMHEN, using existing capacities available at NMHS (e.g. a well-designed marketing system). Furthermore, the experience of IMHEN with the development of sector-specific climate information products and the networking and visibility of NMHS should be combined and used to develop the basis for a constructive UIP. Additional capacities should be established and provided exclusively for that task with specially trained staff.

Value-added, sector-specific climate information products of all product types will be developed and produced by a sectoral champion. The tasks of a sectoral champion would also comprise a permanent interaction with the primary climate information providers (NMHS & IMHEN) in order to guarantee the availability of useful and usable climate data and information products for the specific sector. This also implies the communication with sectoral users and the representation of their needs vis-à-vis the primary climate data and information providers. A sectoral champion in the coastal protection sector could be SIWRR from the expertise point of view. However, since SIWRR is only a research institute, it has probably no capacities to provide sector-specific climate information products on a regular basis. Thus, the organization of such a sectoral champion can also be a collaborative task between authorities (e.g. KG-DARD) adopting the communication and networking task; research institutes as well as technical consultancies (e.g. SIWRR and SIWRP) that are responsible for the input of knowhow and product development; and managing organizations (e.g. KG-DWR) that adopt the operational part comprising product management (e.g. archiving and maintenance) and dissemination.

Concluding the observations on the current state of the prevalent NCS in the context of the objective of enhancing the provision of Climate Services, the general focus should be put on the interaction and -relationship of the involved stakeholders. The existent product portfolio of the NCS Vietnam surely requires some degree of enhancement and optimization, but overall a comprehensive range of climate products is provided. However, major challenges are posed in the utilization of these products by the coastal protection sector in order to guarantee a best possible use of the available climate data and information for this sector. This implies the organization of all relevant stakeholders as one functional unit (climate-value chain) with respect to information generation and dissemination. Since the chain links (individual stakeholders) do exist and have a great

potential for a high qualitative sectoral value chain, the weak points are the interlinkages between the stakeholders. On a technical level, this comprises the establishment of an interface (UIP) enabling the exchange of providers, intermediates and users on the design of sector-relevant climate information products (e.g. parameters, indices, scales and resolution, tolerable uncertainty, etc.), the way they should be provided to the individual type of stakeholder (e.g. format, presentation, timing of delivery, etc.) along with the kind of support and other services should be given (e.g. guidelines, training on tools, advice on contextualization).

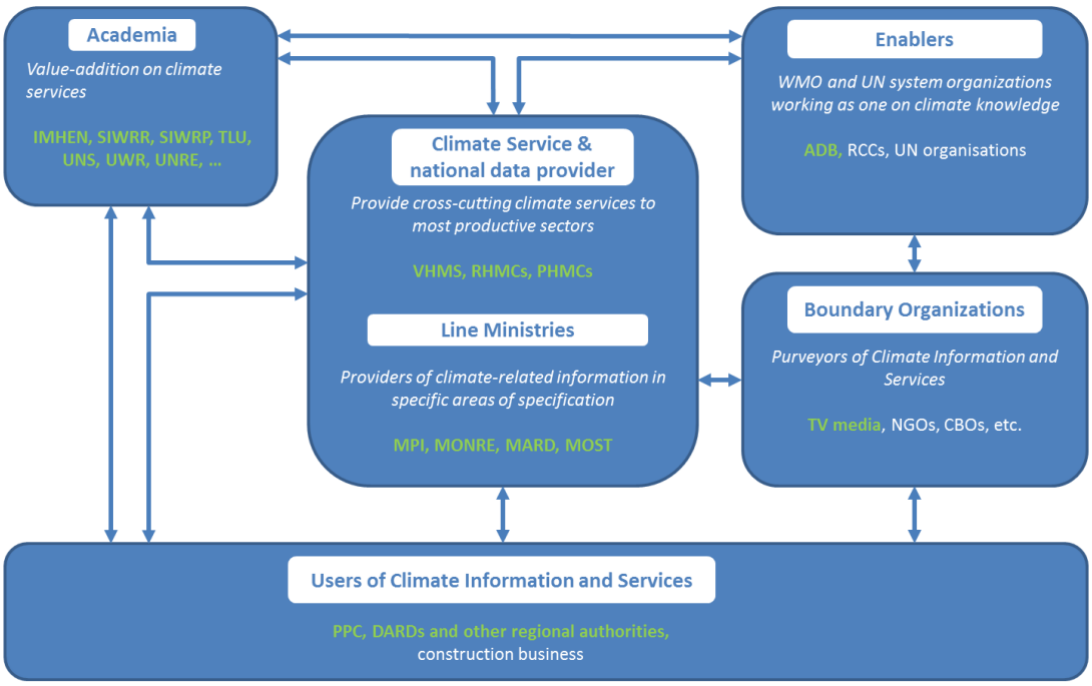

Figure 18: Model for an NCS in Vietnam for the coastal protection sector according GFCS (Figure 4). Abbreviations can be found in the abbreviations list.

IX Evaluation of results

Fundamental results from the assessment are summarized in this chapter. The results refer to the most comprehensive guiding question of this baseline assessment: *what is the current state of a National Climate Service in Vietnam for the context of the coastal protection sector?* The evaluation of the findings is structured according a SCOT analysis: *strengths* and *challenges* of a current NCS are identified regarding existing entities, stakeholders and processes which support the functionality of a NCS. Furthermore, *opportunities* and *threats* are identified regarding the establishment or enhancement of such a NCS.

1. *Strengths* of the current NCS for the coastal protection sector in Vietnam

1.1. The existent NCS of Vietnam has a committed and stably positioned NMHS with governmental mandate and budget.

The development of Climate Services is based on fundamental tasks and the related infrastructure which refer to observation and monitoring of climate variables as well as the archival storage of this data and quality control. These tasks require thorough and continuous operational processes which are often adopted by non-profit orientated but publicly funded and mandated organizations like most NMHSs. NMHS are furthermore main contact point to WMO facilities and thus provide access to regional and international resources and capacities regarding climate data, tools, standards and norms as well as training etc.

1.2. The NMHS has a salient position within the NCS.

Within the coastal protection sector the NMHS together with IMHEN are perceived as prime institutions of contact regarding the provision of climate data and information. Such a prime contact within a NCS is valuable in order to guarantee the quality of climate data and homogeneity of climate information as well as user-friendly access to climate information.

1.3. The National Climate Service of Vietnam is able to provide essential climate data services and information products (category 1 & 2) as well as important functions of category 3 & 4 (Appendix 2).

The product portfolio of the NCS covers all product types (Appendix 3) relevant for sector specific climate risk assessments for current and future climate conditions. Not all products of this product portfolio are yet usable for all sectors and users due to limited tailoring and quality but the general knowledge for the production of each product type is given and thus the potential for future extension of the portfolio.

1.4. The National Climate Service of Vietnam has profound expertise on the monitoring and forecasts of climate hazards

The systematic monitoring of climate hazards and events as well as the maintenance of a hazard database is a valuable basis for the execution of sector-specific climate risk assessments.

1.5. The NCS of Vietnam has experiences in cooperating with stakeholders from the coastal protection sector.

Key stakeholders from the coastal protection sector are known by NMHS and IMHEN as well as their climate-related problems and decision-making processes. The NMHS is experienced in dealing with very specific sectoral user demands especially with respect to forecasts and warnings in the context of climate hazards. Existing sectoral experiences facilitate the establishment of a sectoral branch of a NCS.

1.6. Users from the coastal protection sector already use the entire spectrum of available climate information products.

The entire spectrum of the available product portfolio of the NCS isalready being used by users from the coastal protection sector, even without specific tailoring.

1.7. Key-users from the coastal protection sector have advanced skills in using and processing climate data and information for their purposes.

Competences of the sector community in data processing enhance the usability of standard products without specific tailoring. That is due especially to the capabilities of appropriate value-adding providers (e.g. SIWRR and SIWRP) that are able to provide sector-specific tailored products and contextualization of these products.

1.8. Users from the coastal protection sector generally have a profound ability to formulate their needs regarding the required climate data and information.

This facilitates the provider-user interaction as well as the provision and use of climate information.

2. *Challenges* for the current NCS for the coastal protection sector in Vietnam

2.1. Needs for amendments of the Climate Service infrastructure of NMHS

Challenges which refer to technical infrastructure, product quality, etc. of the NMHS are listed and discussed in World Bank & UNISDR (2013). We refer to this report for further insights challenges in this specific area.

2.2. Absent connection to regional WMO institutions

There is no active engagement of the NMHS within any Regional Climate Centre of the WMO RAII. A regional connection on WMO level may provide the access to additional data and capacities especially with respect to seasonal forecasts and climate projections.

2.3. Negligence of the climate monitoring tasks by NMHS in the past

The NMHS adopts the task of systematic climate observation and monitoring since the decree No 36/2017/NĐ-CP from 4th April 2017. Before, there was no focus on that task, hampering the development of a structured process of climate data management and product generation as well as the consideration of standards especially with respect to data quality management. Amendments in this context will be necessary but demanding.

2.4. New role of the NMHS as by decree 20165

With the new law, the responsibilities of the NMHS have been greatly enhanced, making it the main institution in charge of managing Climate Services in Vietnam. As is also referred to in 2.3, the NMHS is yet developing the necessary capacities to fulfil these new tasks. As of yet, there is now comprehensive definition of Climate Services and what is the role of NMHS in their provision and in ensuring their quality. Besides climate monitoring capacities, building capacities and developing a solid concept of Climate Services and processes for their provision is among the major challenges for NMHS for fulfilling its new role in the future. Part of this challenge is the development of standards and regulations for Climate Services that would allow NMHS to ensure the quality of Climate Services.

2.5. Product visibility and transparency is limited and active marketing is non-existent.

Besides forecasts and warnings, there is no visibility of the available climate-product and -service portfolio provided by the NMHS but also by sectoral stakeholders. The visibility of provided products and services including detailed information about the products (like product description regarding technical limitations as well as the value and relevance for a specific application context) helps the user to identify a potentially useful product and to assess the usability of a product.

2.6. Restricted data access and availability of climate data and services

Climate data as well as specialized and tailored climate information products and services are not openly accessible and in general not free of charge for key stakeholders of the coastal protection sector, despite the hydrometeorological law.

Climate data products, monitoring products and diagnostic products are only compiled and provided by NMHS on request. No standard products are available to be provided if requested.

The purchasing and provision process is time-consuming and often non-transparent. This hampers the usability of climate data and information for decision-makers.

2.7. There is no cooperative integration of the coastal protection sector in the NCS.

Stakeholders from the coastal protection sector (e.g. SIWRR, SIWRP) that play a key role in the production and provision of sector-specific Climate Services have no institutional relationship to the NMHS. The initiation of the development and production of sectoral products by SIWRR and SIWRP occurs only by mandate of MARD or other authorities. Interaction processes of SIWRR/SIWRP and the NMHS/IMHEN are based on a customer relationship. No institutionalized interface exists that would enable a continuous interaction of NMHS, IMHEN and sectoral stakeholders (SIWRR, SIWRP) regarding the exchange of knowledge and formulation of needs as well as the co-production of sector relevant Climate Services.

2.8. The scientific orientation of key stakeholders' organizations

Some key stakeholders from the NCS Vietnam are organized in research institutions that have no capacities for routine tasks, such as the production and provision of Climate Services. This refers especially to IMHEN and SIWRR. However, these stakeholders are key for the provision of sector relevant Climate Services.

3. *Opportunities* for the current NCS for the coastal protection sector in Vietnam

3.1. The climate-value chain for the coastal protection sector is clearly defined and completely part of the public sector

The climate-value chain of the coastal protection sector consists of a well-defined set of stakeholders with clearly defined tasks. All stakeholders are part of the public sector. These circumstances provide a good starting position for a structural organization and coordination of sectoral stakeholders, also with respect to the allocation of tasks and their interaction. All of this is key for the development of a sectoral branch of the NCS.

3.2. Availability of sectoral champion for the coastal protection sector

MARD is a central stakeholder of the coastal protection sector. It has a good overview of and influence on all stakeholders, their decision-making processes as well as the range of required and applied climate information products. Furthermore, MARD participates in the development of laws and regulations for the sector. These preconditions make MARD a perfect sectoral champion that can coordinate the stakeholders and mediate the interaction within the climate information provider network.

3.3. The salient role of laws and regulations for the use of climate information

Laws and regulation are accepted by the sectoral users and specified as main motivating factor for the use of climate information. This constitutes a beneficial framework for the integration of guidelines on the use of climate information in the coastal protection sector.

3.4. Experience of the NMHS with the dissemination and mainstreaming of climate information

The NMHS has already profound experience in planning and implementing the dissemination of forecasts and warnings, including for specific sectoral contexts and by the involvement of external stakeholders (e.g. media). This experience can be used for the development of a UIP for a sectoral branch of the NCS.

4. *Threats* for the current NCS for the coastal protection sector in Vietnam

4.1. The restricted use and sharing of meteorological data in Vietnam and hierarchical organization of stakeholders

The opportunity of a climate-value chain totally in public hand (3.1) combined with a restricted use and sharing of meteorological data (2.5) may emerge as a fundamental risk of establishing a sectoral branch of a NCS: both hamper a cross-ministerial interaction of stakeholders and exchange of data and information independent from the hosting ministries and their explicit authorization. However, a direct and non-bureaucratic interaction between relevant stakeholders is essential for establishment and maintenance of a functioning sectoral NCS.

IX Conclusion & Recommendations

The prevalent National Climate Service of Vietnam is officially represented by the National Hydro-Meteorological Service (NMHS). In cooperation with IMHEN, the NMHS can provide a comprehensive range of climate data and information products covering the entire range of climate product types (Table 5; Appendix 3). However, the service component of climate information provision is, as of yet, rather underdeveloped. This comprises tools and processes supporting the access to climate information, the purchasing and provision process for specific demands and the visibility and marketing of products and services as well as an active support program for sectoral users. A limited service component consequently hampers the effective use of the provided climate information by sectoral users and thus the impact of climate information on decision-making.

Considering the climate-value chain of the coastal protection sector in Vietnam, a well-defined pool of stakeholders can be identified with pronounced competencies regarding the development and production of sectoral Climate Services for all steps of the infrastructure planning process. However, this value-chain can only be activated for the context of specific projects on the initiative of central planning authorities like MARD. Direct relationships between climate information providers and sectoral stakeholders, which are essential for the development of sector-specific Climate Services, are no provided in terms of MoUs or other agreements favouring the development and production of such services by institutionalized, non-bureaucratic channels for interaction and data-exchange. Furthermore, prevalent organizational structures of some stakeholders do not favour such institutionalized processes. To meet this shortcoming, the establishment of an extended National Climate Service with sectoral branches is recommended. This NCS should integrate relevant and potential data and information providers (e.g. IMHEN, Universities) as well as key sectoral stakeholders (e.g. SIWRR, SIWRP, provincial authorities) in order to co-produce sector-relevant climate service products. According to the vision of the Global Framework for Climate Services (GFCS), such a comprehensive National Climate Service aims for a higher impact of climate information on decision-making. Concurrently, organizational structures and process within NMHS should be reviewed in order to enhance their efficiency. Such a restructuring process provides the opportunity to achieve more output with prevalent capacities and funding.

Based on this conclusion, several recommendations are given in order to enhance the provision of Climate Services by the establishment of a National Climate Service. The recommendations are structured according the three levels of capacity development: (i) Societal level (cooperation systems; enabling framework); (ii) Organizational level and (iii) Individual level of activity (GIZ, 2015). The recommendations are also allocated to the 4 components of the GFCS which is indicated by the component's abbreviation.

IX.1. Societal level: enabling framework

RI. Establishment of a National Climate Service with the incorporation of the coastal protection sector (=> CSIS)

In order to allow the sustainable and efficient provision of Climate Services for the coastal protection sector in Vietnam, relevant tasks and processes should be institutionalized. This implies an expansion of the prevalent National Climate Service of Vietnam by integrating relevant climate information providers as well as sectoral line ministries and key stakeholders from the coastal protection sector.

Climate information providers comprise the area of climate and hydrological information and hazard information (NMHS), long-range forecasts and climate projections (IMHEN) as well as the academic sector (various national universities). Key sectoral stakeholders comprise line ministries (MARD, MPI, MONRE, MOST, etc.), sectoral authorities (KG-DWR) and expert organizations (SIWRP) and respective research departments (SIWRR) as well as KG-DARD as central user and potential coordinator of climate information within the coastal protection sector. NMHS (potentially in cooperation with IMHEN) should take a coordinating role in order to guarantee the quality, homogeneity and continuity of climate product and service production and provision for the sectoral level and to foster the regular interaction with sectoral partners (II.5). The collaboration within the NCS should be based on a cooperative partnership with MoUs regarding the use and exchange of data, knowledge and information. The exchange should be as open and barrier-free as possible (i.e. transparency, timely and non-bureaucratic access), in order to enhance a timely and qualitative production, provision and use of Climate Services on a sectoral level.

The benefit would be a common understanding and access to data, information and knowledge which is relevant for climate risk issues of the infrastructure sector. Products and knowledge produced by any of the partners would feed into this database and be available to all partners. Furthermore, resources and capabilities can be shared to produce costly and laborious tasks.

Specific recommendations on the embodiment of a NCS are given below. A recommended measure as part of the development of a NCS is the use of pilot cases of Climate Service development, allowing to build capacities and collect information and lessons learnt as basis for developing guidelines for Climate Service development and to document the process and stakeholder roles (for more see also IX.4.RX). The climate risk assessment implemented in the context of the CSI project is already one such Climate Service pilot product, but the option of having more pilots should be considered.

IX.2. Societal level: cooperation systems

RII. Systematic observation and archiving of sector-relevant climate impacts and consequences (=> OM)

Regarding climate risk assessments for the infrastructure sector, information on climate impacts is very valuable. Beyond the observation of climate variables and events, a National Climate Service should also support a systematic observation and archiving of climate impacts on terrestrial systems and relevant infrastructure objects as well as socio-economic consequences. Such observations need to be done directly by affected stakeholders. This information needs to be centrally collected and coordinated and cross-analysed with climate hazard information. Such a coordinating role could be adopted by the sectoral champion (MARD/DARD) in cooperation with NMHS (climate data) and SIWRR (sectoral data) (e.g. by the establishment of respective cooperation or agreements). However, hazard information and hydrological information, amongst others, should also be available for other sectors and tailored to their contexts. Thus, the role of coordinating entities should also be discussed in an inter-sectoral context, having the big picture of a NCS in mind. An NCS goes beyond the specific branch of the coastal protection sector. Consequently, key sectoral stakeholders from all sectors should be involved in the coordination on impact information.

RIII. Engagement of NMHS within WMO institutions at the regional level

A regional connection on WMO level may provide the access to additional data and capacities, especially with respect to seasonal forecasts and climate projections. There are several RCCs within RAII with varying scope regarding spatial coverage and focus of services. Especially emerging RCCs like Pune (India)[10] or RCC portals (United Arab Emirates)[11] might possibly be interesting for Vietnam. The option of engaging within any of the RCCs should be examined.

RIV. Establishment of a sectoral user-interaction platform (=> UIP)

A sectoral user interface platform is an essential part of a NCS. The scope of a sectoral User Interface Platform (UIP) is to provide a forum for climate information providers and sectoral stakeholders and users to meet and interact, to establish mutually beneficial collaborations and finally develop usable and decision-relevant Climate Service products. The UIP provides room for users and intermediates to formulate and explicate their needs regarding Climate Services related to all three dimensions: technical, service and institutional (chapter II.4). The UIP provides room for Climate Service providers and intermediates to define and explicate their (technical) capabilities and capacities of Climate Service development and provision. The objective of the UIP is to reconcile and harmonize user needs and provider capabilities at all three dimensions in order to establish potentials of feasible Climate Service products and organizational structures. Finally, the UIP provides room for the development and promotion of usable and decision-relevant Climate Service products and organizational structures in co-production with sectoral stakeholders. The format of an UIP can be, among others, regular meetings or workshops that help to maintain a continuous exchange of knowledge, experience and needs regarding climate information for the coastal protection sector.

[10] http://www.imdpune.gov.in/Clim_RCC_LRF/Index.html
[11] http://ra2.asia/

It is recommended to establish such a UIP for the sectoral context of the coastal protection sector, incorporating all relevant sectoral stakeholders (Figure 9). NMHS as central stakeholder and coordinator of the NCS in cooperation with MARD/DARD as potential sectorial champion may be in charge for this user interface.

RV. Development of an informative and transparent product information system and data portal (=> UIP)

The visibility of climate information products as well as information on their potential use for specific sectoral contexts helps the user to value Climate Services and can increase the readiness to use them. An attractive public appearance in form of a information system and data portal for the National Climate Service is recommended. This includes providing detailed information on available or potentially available Climate Services, their technical scope and potential use for specific applications within a sectoral context. Ideally, additional material like guidebooks, case studies etc. is provided as well as guidance for further consultation and advice as well as on data or product purchase procedures.

It is recommended to the NCS to establish a web-interface which provides a clear overview on the existing Climate Services of the NCS for the coastal protection sector which is intuitive to handle and informative regarding the usability and usefulness of specific products and services for specific sectors. NMHS as central stakeholder and coordinator of the NCS in cooperation with MARD as potential sectoral champion may be in charge of such an information system. Such a web interface may be an extension or add-on of existing interfaces (e.g. web-page of NMHS and/or MARD) but can also part of an inter-sectoral climate knowledge portal which integrates similar information from other sectors. As a first step, the scope and objectives of such a system or portal should be evaluated as well as where it should be allocated. Potentially existing best practice solutions should analyzed as points of reference. Advice on this can be provided in the context of the CSI project.

IX.3. Organisational level

RVI. Review of the data management, data archiving and data quality control systems and processes (=> CSIS)

High quality and comprehensive historical climate time series of sufficient length and spatial coverage are essential for any climate risk assessment. Besides the observations and monitoring, the adequate management of this data is of fundamental relevance for the provision of qualitative Climate Services. It is recommended for the NMHS to review these systems regarding current WMO standards, especially with respect to quality control, as well as to organize data query and analysis processes in order to guarantee timely provision of climate information products and services. The review of existing systems should be accompanied by training for staff in data quality control methods and processes. Options to provide this training and exact training needs are evaluated in the context of the CSI project.

RVII. Perpetuation of the tasks and products of the IMHEN project "High resolution Climate Projections for Vietnam"

The IMHEN project on climate projections for Vietnam provides an essential basis for the development of Vietnamese climate change adaption policies and strategies. However, specific adaption projects and measures at local scale require continuous work on downscaling and tailoring of model runs for the specific regional and sectoral context. Capacities and expertise need to be guaranteed on a regular basis, ideally beyond the scope of individually funded projects.

RVIII. Development of an effective and transparent access and purchasing system (=> CSIS)

The current procedure of access to and purchasing of climate data and information from NMHS is perceived as intransparent and time-consuming for users from the coastal protection sector. This is one of the major reasons for the limited use of climate information. It is recommended to review this procedure and redesign it in order to become more transparent regarding fees and more efficient regarding access and timely availability of climate information products. A concept for such a system should be developed in conjunction with a data portal system (RV). Existing webpages of the NMHS and RMHCs together with existing best practices for such portals could be used as starting points for this.

RIX. Reviewing the organizational structure of IMHEN and SIWRR

IMHEN and SIWRR play essential roles for the provision of Climate Services in general and specifically for the coastal protection sector. However, they are primarily organized as scientific organizations that are dependent on external funding. In the context of a conceptualization of a sectoral branch of the NCS, the organizational structure of these two organizations should to be reviewed with regard to the need of producing and managing Climate Services in a regular way and how this may best be ensured.

IX.4. Individual level

RX. Training on user-interaction at the NMHS and RMHC

The identification of user needs for climate information is key for the provision of user specific climate information that has an impact on decision-making. A lot of existing climate information products might be much more useful and usable for decision-makers if NMHS-staff understands the context of use of the demanded climate information as well as the type of user and his specific demands. Up to now, this process is not structured, relies on the experience of individual staff members and is often elaborate and time-consuming with a high rate of unsuccessful requests. In order to make this process more efficient and products more useful and usable for decision-makers, staff members from the Information Department should be trained in structured methods regarding user interaction and assessment of user demands.

A suggested measure to achieve this is the development of a pilot Climate Service product, serving two purposes, the development of capacities in the area of structured user-provider interaction as well as the development of guidelines to be used in the

future for this type of interaction. This is already covered in part by the contribution of the SMHC in the implementation of the climate risk assessment of the Cai Lon Cai Be sluice gate system, as the assessment itself is a Climate Service product. As part of the assessment, a documentation of user-provider interaction will be elaborated to inform the development of a guideline for user-provider interaction in the context of climate risk assessments. At the same time, the involvement of SMHC also entails the development of capacities in the area of developing the necessary Climate Service products for risk assessments, such as the appropriate processing and modelling of data and information. Further opportunities for trainings and pilots in this area are evaluated in the context of the CSI project with NMHS and SMHC. Beyond pilot product development and the development of guidelines, trainings on aspects of user-provider interaction especially important for NMHS and RMHC are recommended and are envisioned as part of the CSI project, based on the specific needs of NMHS and RMHC.

X Outlook

Vietnam's commitment to climate change adaptation, as witnessed by their NDC and Resolution No. 120 on inter-regional coordination of the Mekong Delta to respond to climate change, to name just a few, is a proof of the importance of enhancing Climate Services in the country. Big investments are planned in the area of coastal protection. Investments that will need to be climate-proof in order to fulfil their function in the decades to come. Climate Services allow making evidence-based adaptation decisions in the future. The NMHS and its regional and provincial counterpart fulfil a key role in this and have taken up the challenge and which at the same time present a great opportunity in an environment of changing roles and responsibilities.

The establishment of a National Climate Service (NCS) for the context of the coastal protection sector is the key recommendation of this baseline report. The recommendations above provide specific ideas on how such a NCS might be implemented, based on the current institutional and organizational structure of climate service provision for the coastal protection sector in Vietnam. All recommendations are given specifically for the coastal protection sector. However, as long-term objective, a NCS of Vietnam should cover the needs of all relevant sectors. Similar sectorial champions can be established for other sectors, yielding an equivalent mandate for the respective sector. However, this would involve the coordination of several sectoral champions with key stakeholders of climate information provision (NMHS) as well as key intermediate stakeholders that provide inter-sectoral information. For example, SIWRR provides information for the water sector in general, which is useful for coastal protection, water management, agriculture, etc. In order to realize a comprehensive inter-sectoral NCS, the transfer of the recommendations for the coastal protection sector to other sectors in Vietnam should be considered and their feasibility assessed. The presented and recommended organizational model of a NCS should be discussed in the future in order to guarantee a successful and sustainable impact of technical and educational capacity development measures on climate information provision on the use of sectorial stakeholders and the impact on decision-making.

The provided recommendations align to the concept of the GFCS and attempt to transfer this concept to the specific context of Vietnam. The GFCS envisions a central role for the NMHS within the NCS based on the assumption that the NMHS is integrated in the governmental service structure. However, national governance structures may not always allow for the implementation of all of the elements of the GFCS, depending on the context of the specific country. E.g. the envisaged role of individual stakeholders may not be realized due to various structural, juridical or other reasons. Consequently, roles and responsibilities of NCS stakeholders, the regulating framework and scope of the NCS and as well as the characterization of specific operational processes and the nature of agreements between stakeholders need to be negotiated and adjusted to the national conditions. In Vietnam, this especially refers to the essential role of IMHEN and SIWRR for the development and production of sector-relevant Climate Service products which is in contrast to their organizational structure impeding the adoption of regular tasks. Furthermore, NMHS intends to become a

commercial institution envisaging a market for Climate Services. This has implications for the recommendations made in this report and some of them would need to be adjusted to the idea of a commercialised NMHS. The way how such issues could be solved and conflicts of interests could be harmonized in the context of the implementation of a sectoral NCS needs to be identified, negotiated and decided by respective political stakeholders.

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APPENDIX

Appendix 1: Global Climate Observing System climate monitoring principles

(Revised Reporting Guidelines as agreed by the UNFCCC at Bali, December 2007, decision 11/CP.13)

Effective monitoring systems for climate should adhere to the following principles:

(a) The impact of new systems or changes to existing systems should be assessed prior to implementation;

(b) A suitable period of overlap for new and old observing systems is required;

(c) The details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting data (i.e. metadata) should be documented and treated with the same care as the data themselves;

(d) The quality and homogeneity of data should be regularly assessed as a part of routine operations;

(e) Consideration of the needs for environmental and climate-monitoring products and assessments, such as Intergovernmental Panel on Climate Change assessments, should be integrated into national, regional and global observing priorities;

(f) Operation of historically-uninterrupted stations and observing systems should be maintained;

(g) High priority for additional observations should be focused on data-poor regions, poorly-observed parameters, regions sensitive to change, and key measurements with inadequate temporal resolution;

(h) Long-term requirements, including appropriate sampling frequencies, should be specified to network designers, operators and instrument engineers at the outset of system design and implementation;

(i) The conversion of research observing systems to long-term operations in a carefully-planned manner should be promoted;

(j) Data management systems that facilitate access, use and interpretation of data and products should be included as essential elements of climate monitoring systems.

Furthermore, operators of satellite systems for monitoring climate need to:

(a) Take steps to make radiance calibration, calibration-monitoring and satellite-to-satellite cross-calibration of the full operational constellation a part of the operational satellite system;

(b) Take steps to sample the Earth system in such a way that climate-relevant (diurnal, seasonal, and long-term interannual) changes can be resolved.

Thus satellite systems for climate monitoring should adhere to the following specific principles:

(a) Constant sampling within the diurnal cycle (minimizing the effects of orbital decay and orbit drift) should be maintained;

(b) A suitable period of overlap for new and old satellite systems should be ensured for a period adequate to determine inter-satellite biases and maintain the homogeneity and consistency of time-series observations;

(c) Continuity of satellite measurements (i.e. elimination of gaps in the long-term record) through appropriate launch and orbital strategies should be ensured;

(d) Rigorous pre-launch instrument characterization and calibration, including radiance confirmation against an international radiance scale provided by a national metrology institute, should be ensured;

(e) On-board calibration adequate for climate system observations should be ensured and associated instrument characteristics monitored;

(f) Operational production of priority climate products should be sustained and peer-reviewed new products should be introduced as appropriate;

(g) Data systems needed to facilitate user access to climate products, metadata and raw data, including key data for delayed-mode analysis, should be established and maintained;

(h) Use of functioning baseline instruments that meet the calibration and stability requirements stated above should be maintained for as long as possible, even when these exist on decommissioned satellites;

(i) Complementary in situ baseline observations for satellite measurements should be maintained through appropriate activities and cooperation;

(j) Random errors and time-dependent biases in satellite observations and derived products should be identified.

Appendix 2: Hierarchy of national Climate Services (WMO, 2012)

Category 1: Basic climate data services and information products

Functions of a Category 1 capability include design, operation and maintenance of national observing systems; data management including QA/QC; development and maintenance of data archives; climate monitoring; oversight on climate standards; climate diagnostics and climate analysis; climate assessment; dissemination via a variety of media of climate products based on the data; participation in regional climate outlook forums and some interaction with users, to meet requests and gather feedback. All NMHSs should be able to function at the Category 1 level, i.e. performing the basic functions of a national climate centre. At present all but a very few NMHSs provide some measure of the basic Climate Services through their observing, archiving, data services and basic analysis capabilities. Optimally, climate service staff should be proficient in climate statistics, including basic homogeneity testing and quality assurance techniques, etc. They should also be capable of interpreting products provided by RCCs in order to place national/local conditions within a broader scale context.

Category 2: Essential climate data services and information products

In addition to encompassing all Category 1 functions, Category 2 Climate Services should include the capacity to develop and/or provide monthly and longer climate predictions including seasonal climate outlooks, both statistical and model-based; be able to conduct or participate in regional and national climate forums; interact with users in various sectors to identify their requirements; provide advice on climate information and products; and get feedback on the usefulness and effectiveness of the information and services provided. A NMHS delivering Category 2 Climate Services would add value from national perspectives to the products received from RCCs and in some cases GPCs, conduct climate watch programmes and disseminate early warnings. Staff in category 2 NMHSs should be proficient in the development and interpretation of climate prediction products, and in assisting users in the application of these products.

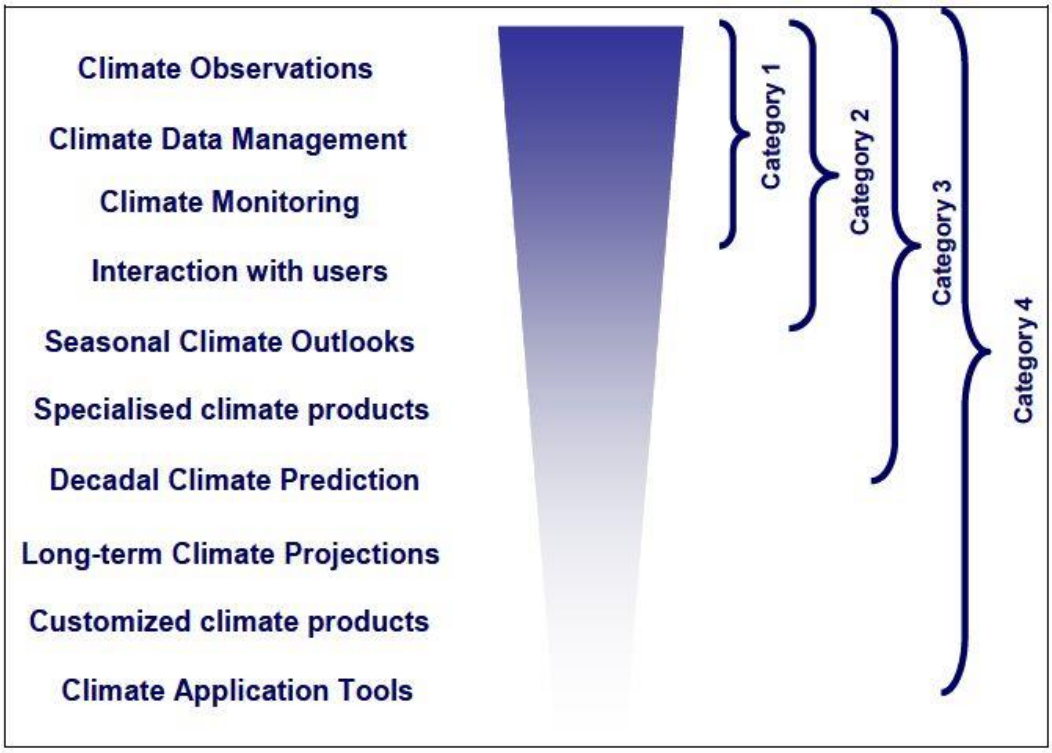
Category 3: Comprehensive range of climate data services and information products

In addition to encompassing Category 2 services, organisations delivering Category 3 Climate Services would have the capacity to develop and/or provide specialised climate products to meet the needs of major sectors and should be able to downscale long-term climate projections as well as develop and/or interpret decadal climate prediction (as and when available). They would serve to build societal awareness of climate change issues, and provide information relevant to policy development and National Action Plans. NMHSs delivering Category 3 Climate Services would be capable of supplying climate information to all the elements of Climate Risk Management, and would include products supporting risk identification, risk assessment, planning and prevention, services for response and recovery from hazards. They could also supply information relevant to longer-term climate variability

and change, as well as advice related to adaptation. A NMHS functioning at the Category 3 level would contribute to regional-level climate activities and could serve as a node in a Regional Climate Centre Network. Category 3 NMHSs would have staff with special knowledge in risk assessment and risk management, and who may have knowledge of financial tools for risk transfer.

Category 4: Advanced Climate Services

In addition to the ability to deliver Category 3 services, organisations delivering the Category 4 services would have certain in-house research capacities, and would be able to run Global and Regional Climate Models. They would be able to work with sector based research teams to assist them in developing applications models (e.g. to combine climate and agriculture information and produce food security products), and to develop software and product suites for customised climate products. NMHSs functioning at the Category 4 level could serve as a Global Producing Centre, a Regional Climate Centre or as a node in a Regional Climate Centre Network. Staff would have modelling and statistical expertise in a multi-disciplinary context, and would be able to downscale global scale information to regional and national levels. They would also be required to receive and respond to user requirements for new products.



Appendix 3: Product types

Product type	Examples & Definitions
Climate data	raw or processed station time series; gridded data: other data sets, etc.
Climate statistic products	information about means and extremes for individual parameters for a specific region and period in form of maps, graphs, etc.
Tailored climate data/statistics for specific purpose	climate statistic products for specific sectoral contexts (e.g. indices).
Data / statistics on hazardous climate events / extreme events	information on magnitude, frequency, duration of climate hazards; hazard information (e.g. hazard maps); etc.
Information on regional climate conditions	review and analysis in form of bulletins, synthesis reports, statements, etc.
Analysis and interpretation of climate statements or products for specific users/sectors	analysis of consequences of past and prevalent climatic conditions for specific sectors
Hydrological data / statistics and events	discharge, floods, low-flows, etc.
Data/statistics on climate impacts on terrestrial systems	impacts on ecosystems (vegetation etc.), geomorphological impacts (soil erosion, landslides, etc.))
Information/data on climate impacts/consequences for specific sectors	information on expected crop yields, losses, costs, damage, disruptions or fatalities, etc. for various sectors like agriculture, transport, health, energy, etc.
Climate vulnerability/risk information in general or for specific sectors	data and information on exposures, sensitivities and possible consequences of regions, sectors to historical climate conditions (e.g. maps for specific sector/region)
Climate forecasts/outlooks for specific parameters/events at various time scales	Climate predictions, projections or outlooks for upcoming weeks, months, years, etc.
Climate change projections	Climate model output (data/maps) for specific parameters, events, etc.
Climate change impact data/model outputs	Climate impact model output on ecosystems, water availability, etc.
Climate change vulnerability/risk information	data and information on exposures, sensitivities and possible consequences of regions, sectors to climate change conditions (e.g. maps for specific sector/region)
Training, workshops, lectures and information material on climate issues, e.g. climate change and its impacts	qualitative information/education material to raise awareness; general or sector-specific
Tools which support decision-making, strategy development and financial planning	Decision-making-support systems which integrate climate information and provide recommendations for actions

Appendix 4: Product matrix

Guiding Questions (provider)	Climate product types						Guiding Questions (user)
	Processed climate data sets (historic)	**Climate diagnostics (historic)**	**Climate monitoring (present)**	**Monthly/ seasonal/ decadal climate predictions**	**Climate change projections**	**Climate-related hazards**	
Product-type specific attributes/ foci	*Length, homogeneity, continuity and spatial coverage of time series*		*Data transfer from stations; data processing structures (temp. availability)*	*# used GCMs; # used RCMs; downscaling method (dynamical, statistical); capacity to run RCMs & make statistical analysis; cooperation/ external access; skill/ uncertainty info*		*parameters (time, location, magnitude, frequency, duration, etc.); consequences; early warning;*	
A1 Products: Which products do exist for this product type? • Parameter/ statistical analysis/ indices / event • Spat./ temp. scale/ res. • Format • Periodical/ occasional/ on demand, standard / specialized							**A1 Specifications**: Which products have been used (past/currently) for your *sector-specific* context? Products of which product-type are required for your *sector-specific* context?
A2 Secondary products: do you make (sector-relevant) impact products / provider climate information for impact products (who is the user?) / cooperate with impact modelers? (*e.g. hydrological information products, etc.*)							**A2 Secondary products**: Which secondary (climate-impact) products have been used (past/currently) for your *sector-specific* context? Secondary-products of which product-type are required for your *sector-specific* context?
B Sector-specific products: Are there tailored variations available for the *sector of concern*? Which products have been used / may be of potential use for the *sector of concern*?							**B Sector-specificity:** Is the product specifically tailored for your sector/purpose? What are the characteristics of this tailored product? Do you have specific needs on tailoring?
C Data source & co-production: what is the data source for this product-type? Are there other organizations involved in							

providing/producing this data? What is the relationship to these organizations? (*e.g. Universities, private companies, RCC/COF, WMO, external data*)							
D User & value: Who are users of the product within the *sector of concern*? What is the specific purpose/context/decision-making for which the product is being used?							**C Data sources & provider:** where is the data coming from? Which organizations provide the climate data/information? Are there 'intermediates' involved? What is the relationship to these organizations?
							D User & value: What is the consequence/output of your decision-making? Are there other stakeholders who use this output/ who are affected by this decision-making? What is the relationship?
E Services: are there any sector -specific services provided with this product with respect to dissemination (e.g. channel, format, access, timing & frequency of delivery) and guidance (e.g. support, training, advice and outreach, visibility)?							**E Services:** are there any specific services you receive with this product with respect to dissemination (e.g. channel, format, access, timing & frequency of delivery) and guidance (e.g. support, training, advice and outreach, visibility)?
F User-interaction: Are there specific interaction-characteristics with user(-groups) regarding the provision/development of this product-type? (e.g. meetings, fora, MoU, contracts, etc. for access, feedback, exchange)?							**F Provider-interaction:** Are there specific interaction-characteristics with your provider regarding the provision/development of this product-type? (e.g. meetings, fora, MoU, contracts, etc. for access, feedback, exchange)?
G Gaps and needs: what are the major gaps in providing sector-specific and usable products (e.g. capacity development)?							**G Gaps and needs:** what are the major gaps in using climate information products (e.g. access, knowledge, capacities, etc.)?

Appendix 5: Table of levels for operation and use of hydrological and hydro-meteorological data (source: Government of Viet Nam, circular No.23/2009)

TT	Type of service document	Exploiting factor	Fee for one operation (1,000 VND)	Documentation unit
1	Surface Meteorology			
1.1	BKT1	a) Air temperature	200	1 year
		b) Warm air	200	1 year
		c) Air pressure	200	1 year
		d) Dew point temperature	200	1 year
		đ) Vapour pressure	200	1 year
		e) Saturation difference	200	1 year
		g) Quantity and type of cloud	200	1 year
		h) Foresight	200	1 year
		i) Direction and wind speed	200	1 year
		k) Amount of rain	200	1 year
		l) Evaporation	200	1 year
		m) Ground temperature	200	1 year
		n) Hours of sunshine	200	1 year
		o) Days with weather forecasts	200	1 year
1.2	BKT2- Heat	Temperature according to self-recording	200	1 year
1.3	BKT2- Warm	Humidity by self-recording	200	1 year
1.4	BKT2- Apply	Pressure according to self-recording	200	1 year
1.5	BKT3	Temperature of deep soil layers	200	1 year
1.6	BKT10	Direction and hourly wind speed	200	1 year
1.7	BKT13	Evaporation pots	200	1 year
1.8	BKT14	Precipitation by self-recording	200	1 year
1.9	BKT15	Hours of sunshine according to self-recording	200	1 year
1.10	SKT1	Clouds Wet temp measured Dew point temperature	200	1 year

TT	Type of service document	Exploiting factor	Fee for one operation (1,000 VND)	Documentation unit
1.11	SKT2	a) Actuators measure four observation, calculated for one factor:	200	1 year
		b) Air temperature 4 observation	200	1 year
		c) Absolute humidity 4 observation	200	1 year
		d) Saturation difference 4 observation	200	1 year
		đ) Dew point temperature 04 observation	200	1 year
		e) Wet temp 04 obs	200	1 year
		g) Type of cloud 4 obs.	200	1 year
		h) Altitude of clouds 4 obs	200	1 year
		i) Pressure 4 obs	200	1 year
		k) Direction and wind speed measured 4 obs	200	1 year
		l) What little (overview, clouds under) 4 obs	200	1 year
		m) Vision 4 obs	200	1 year
1.12	Thermal Manager	The time is extreme	200	1 year
1.13	Moisture	The time is extreme	200	1 year
1.14	The rain	a) Precipitation hours	200	1 year
		b) Short-term rainfall	200	1 year
1.15	BKT5, BKH6	a) Rainfall day	200	1 year
		b) Short-term rainfall	200	1 year
1.16	Radiation BKT12A		200	1 year
		a) Real time radioactivity measurements	200	1 year
		b) Month / day radiation	200	1 year
		c) Real-time metering	200	1 year
		d) Month / day daylighting	200	1 year
		đ) Real time scattering measurements	200	1 year
		e)Month / day radiation	200	1 year
		g) Monthly radiation characteristics	200	1 year
2	Agricultural meteorology			

TT	Type of service document	Exploiting factor	Fee for one operation (1,000 VND)	Documentation unit
2.1	BKN1 (report the case KTNN)	a) Data on the stock for a crop	180	1 service
		b) Meteorological data (10 days)	180	1 service
		c) Technical data (each period of growth)	180	1 service
		d) Comments boards summarize the incident	180	1 service
2.2	BKN2 (Monthly report about KTNN)	a) Data on plant phenology to 1	180	1 service
		b) Meteorological data (day)	180	1 service
3	Meteorology is not high			
3.1	Non-radio detectors (calculated according to the value of each element measured on each side of the pressure)			
	(7 factors measured, on 16 sides of the pressure)	a) Measurement factor: height (H)	680	1 year
		b) Measurement factor: pressure (P)	680	1 year
		c) Measurement factor: temperature (T)	680	1 year
		d) Measurement factor: moisture (U)	680	1 year
		đ) Measurement factor: dew point (Td)	680	1 year
		e) Measurement factor: wind direction (dd)	680	1 year
		g) Measurement factor: wind speed (ff)	680	1 year
3.2	Wind data pilot, Table SL on altitudes above the ground	(Measured by the value of each element measured on each elevation)		
		a) Measurement factor: pressure (P)	130	1 year
		b) Measurement factor: wind direction (dd)	130	1 year
		c) Measurement factor: wind speed (ff)	130	1 year
3.3	Ozone and ultraviolet radiation	a) Solar height	350	1 year
		b) Temperature	350	1 year
		c) Clouds	350	1 year
		d) Weather	350	1 year
		đ) The total number of sample cells is measured in 02 bands of the solar spectrum	350	1 year
		e) The average number of ounces of the hour	350	1 year
		g) Total amount of ozone observed by the zenith	350	1 year

TT	Type of service document	Exploiting factor	Fee for one operation (1,000 VND)	Documentation unit
		h) Total daily amount of ozone	350	1 year
		i) The intensity of the ultraviolet radiation measured	350	1 year
		k) Ultraviolet radiation intensity (QEA) at each resolution	350	1 year
3.4	Multi - weather Radar	a) Radar map	80	1 map
		b) Weather radar has been digitized	5	1 image file
4	Environment			
4.1	Automatic air environment	a) The hourly / daily / 1-month data set consists of 19 elements	720	1 year
		b) SO2	720	1 year
		c) NO	720	1 year
		d) NO2	720	1 year
		đ) NH3	720	1 year
		g) CO	720	1 year
		h) O3	720	1 year
		i) NMHC	720	1 year
		k) CH4	720	1 year
		l) TSP	720	1 year
		m) PMIO	720	1 year
		n) OBC	720	1 year
		o) WD	720	1 year
		p) WS	720	1 year
		q) Temp	720	1 year
		r) Hum	720	1 year
		s) SR	720	1 year
		t) UV	720	1 year
		u) ATP	720	1 year
		v) Rain	720	1 year

TT	Type of service document	Exploiting factor	Fee for one operation (1,000 VND)	Documentation unit
	Resulting in pH, EC, T, t and precipitation	y) point pH	720	1 year
		x.1) EC	720	1 year
		x.2) T	720	1 year
		x.3) Rainy time	720	1 year
		x.4) Precipitation of the rain in the month	720	1 year
4.2	a) Rain water, sediment	- Analysis of chemical composition of rain water and sediment: 10 factors		
		-Rainfall each battle	140	1 year
		- Rainy time	140	1 year
		- NH4+	140	1 year
		- N03-	140	1 year
		- CI-	140	1 year
		- HCO3-	140	1 year
		- SO42-	140	1 year
		- Ca2+	140	1 year
		- Mg2+	140	1 year
		- Total dust settling	140	1 year
		- Statistical data of check mark height, pile, water level in month (T-1c)	90	2 per year
		- Special note data (T-1d)	90	2 per year
		- Statistics of the top of the pile and point "0" of the hydraulic / hydraulic (CB-1)	90	2 per year
	b) Work-set	- Data record water level per hour and average daily water level (CBT-1a)	90	2 per year
		- Statistical table of the tide peak daily (CBT-1b)	90	2 per year
		- Table record high tide water, low tide daily (CBT-2)	90	2 per year
		- Daily water level record (CB-2)	90	2 per year
		- Record day rainfall (CBM-3)	90	2 per year
		- Table of average daily water temperature (CB-4a)	90	2 per year

TT	Type of service document	Exploiting factor	Fee for one operation (1,000 VND)	Documentation unit
		- Table of average daily air temperature (CB-4b)	90	2 per year
		- Explanatory report	90	2 per year
		- Documentation of water flow survey	90	2 per year
		- Cross-section (measured by a depth gauge and a theodolite)	90	2 per year
		- Speed recorder (T2)	90	2 per year
		- Tide flow calculator (T3)	90	2 per year
		- Tide calculator (CBT4)	90	2 per year
		- Calculate water flow by mobile vessel method (T4)	90	2 per year
		- Calculate the flow of water every hour (CBT13)	90	2 per year
		- Characteristics of the tide daily (CBT14)	90	2 per year ear
		- Calculate seasonal water flow (CBT9)	90	2 per year
	c) Sediments	- Suspended flow data	90	2 per year
		- Measurement and treatment of suspended solids	90	2 per year
		- Data on water flow and suspended matter (CB – 5)	90	2 per year
		- Average content of suspended particulates (CB-11)	90	2 per year
		- Average daily floating data (CB-12)	90	2 per year
		- Average daily suspended flow calculation (for dry season calculation) (CB-13a)	90	2 per year
		- Average daily flow of suspended particulate matter (for flood season calculation) (CB-13b)	90	2 per year
		- Data on the content of horizontal suspended particulate matter on average (CB-14)	90	2 per year
		- Content of suspended particulate content - The average table at the tide, tide down (T-11)	90	2 per year

TT	Type of service document	Exploiting factor	Fee for one operation (1,000 VND)	Documentation unit
		- Data on the content of suspended substances - The table average when the tide, tide down (T-12)	90	2 per year
		- Content of suspended particulate content - The average table at the tide, tide down (T-13)	90	2 per year
		- Suspended particulate matter analysis data (P-1)	90	2 per year
		Suspended particulate matter analysis data (P-1)	90	2 per year
		- Suspended particulate matter analysis data (P-2)	90	2 per year
		- Daily particulate matter analysis data (P-3)	90	2 per year
		- Grain diameter and average settling velocity data (P-4)	90	2 per year
		- Distribution data of suspended particulate matter tide average, tide down (PT-3)	90	2 per year
		- Average monthly particulate matter distribution data (P-5)	90	2 per year
		- Quantitative particle size distribution data (P6)	90	2 per year
		- Data for counting the delegation of delegates to the horizontal (P-7)	90	2 per year
	d) Documentation of salinity line	- Surveillance data of salinity MTN1	60	2 per year
		- Data on results of salinity monitoring MTN2	60	2 per year
		- Data of the results of the analysis of salinity MTN3	60	2 per year
		- The report demonstrates the results of the MTN3 salinity analysis	60	2 per year

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