CLIMATE SERVICES FOR A RESILIENT INFRASTRUCTURE: PLANNING PERSPECTIVES FOR SUSTAINABLE FUTURE OF VIET NAM

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Abstract

Viet Nam currently is one of the top five countries most vulnerable to climate change (World Bank, 2019). Every year, Viet Nam invests billions of US dollars into long-term infrastructure projects, particularly coastal protection infrastructure (Nguyen X. T. and David D. 2009). However, future climate conditions are seldom considered systematically in the planning of such infrastructure, leading to bad investment decisions and consequently to high risks for economic losses in the face of emerging climate change. In compliance with Viet Nam's commitment to achieve goal 9 (Industry, Innovation and Infrastructure) of the UN Sustainable Development Goals (SDGs), part of which is making infrastructure sustainable and resilient, and plan to set out and implement its Socio-Economic Development Plan (SEDP), National Adaptation Plan (NAP) and Nationally Determined Contributions (I) NDCs, efforts are being made to increase resilience of infrastructure nationwide. This article summarizes some initial findings of Viet Nam's efforts and presents an innovative approach with 3 strategic measures: 1) To enhance provision of user-friendly climate services for infrastructure planners; 2) To enhance the use of climate services and consideration of climate risk assessment for infrastructure planning process and 3) To mainstream the approach of climate-proofing for infrastructure into the SEDP, NDC and NAP of Viet Nam. A case study of climate risk assessment for a sluice gate investment project in the Mekong Delta was conducted as a showcase of collaboration between a climate service provider and an agricultural infrastructure planer for comprehensively considering/re-considering the infrastructure construction and operation design with regards to their resilience to climate change. Lessons learnt from several countries in dealing with climate risk such as Costa Rica, Brazil and Nile basin are also reflected and shared through a global forum and cooperation framework.

The combination of these measures will form the key element of an effective, feasible and sustainable solution for the inter-sectoral effort to comply with the strategic orientation of the government in response to climate change.

Keywords: Mekong Delta, Resilience, Climate Services, Infrastructure

1. Challenges

Infrastructure is the backbone of society and serves as the foundation for the economic, social, and cultural life of communities and countries. As infrastructure systems are built to last for a lifetime of 20, 50 or even 100 years, in the context of unprecedented climate change, infrastructure projects are put at risks that need to be taken into account ().

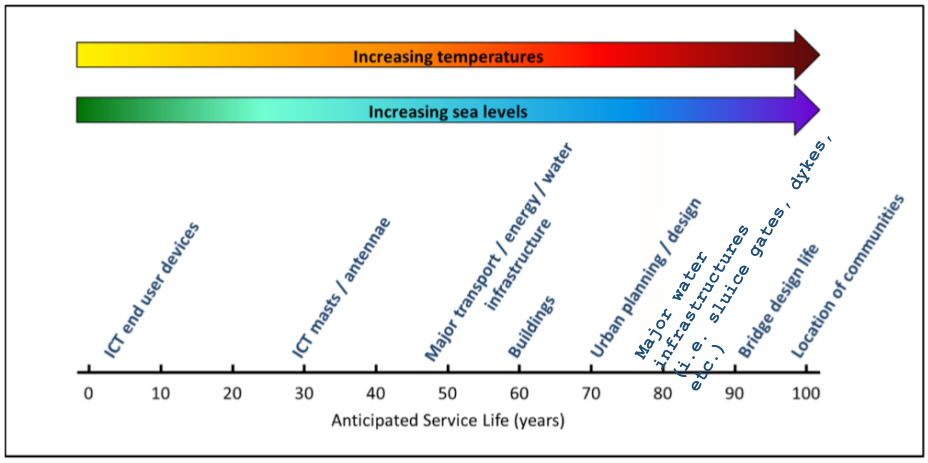

Figure 1. Service life of various infrastructures in the context of climate change (Source: Adapted from AEA, 2010)

Because infrastructure can be costly, every year, emerging economies and developing countries invest billions of USD in long-term infrastructure projects. However, as of yet, the risks posed to infrastructure by a changing climate are often not fully considered as these systems are planned, designed, and constructed. This leads to high risks of damage and misguided investments that harbor potentially serious consequences for the economy and society. Under impacts of both time and climate change, primary impacts of natural hazards on infrastructures tend to increase, leading to more threats to other industries with higher risk of service failures (Figure 2).

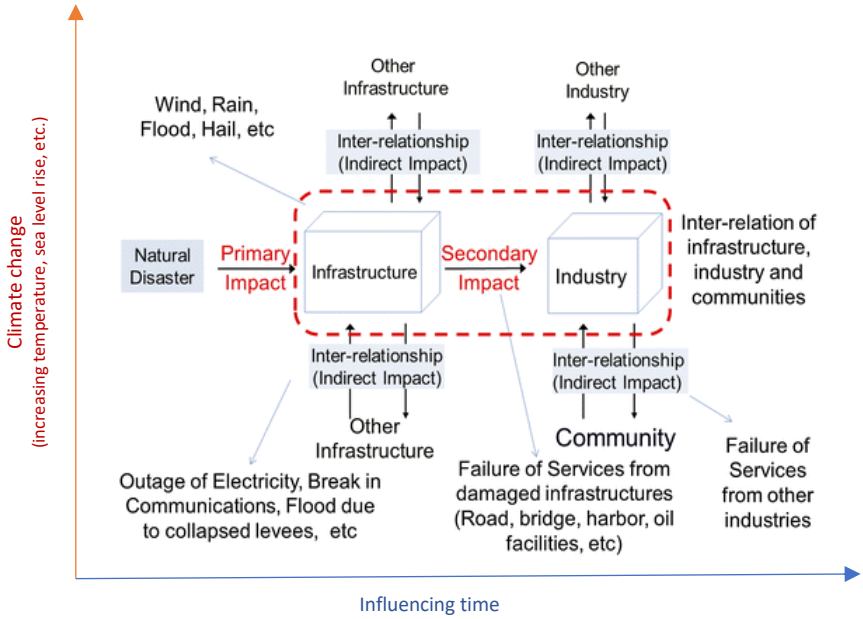

Figure 2. Impact mechanism of natural hazards and climate change on infrastructures and industries (Source: Adapted from Oh E. H. et al. 2010)

The 2030 Agenda for Sustainable Development recognized that climate change and ensuring the resilience of infrastructure are two of the greatest challenges of our time, with climate being one of the factors challenging the infrastructure resilience. This is why they form part of goal 9 (Industry, Innovation, and Infrastructure) and goal 13 (Climate Action) of the Agenda 2030. Ensuring security and resilience in the future requires a joint effort of the international community to ensure that investments in infrastructure consider climate risk. This includes thinking about existing infrastructure. Assessments should be conducted seeking to understand how the structures already in place can be serviced and repaired. Without consideration of climate risk, the quest for a sustainable future will remain elusive. This is why

it enters into the Agenda 2030, as truly sustainable development is reliant on resilient infrastructure as foundation on which success can be built. Resilient and reliable infrastructure is essential for the transport of goods and people, the provision of energy, clean water, commerce, communication, and emergency response to disasters.

The infrastructure planning process only incorporates basic climate information and services with few decision makers being aware of the necessity and advantages of enhancing both the usability and usefulness of climate services for infrastructure planning. Consequently, new infrastructure projects are planned without reference to the future climate, thereby making them vulnerable towards its impacts. In addition to the impact of climate change, the vulnerability of local infrastructure is aggravated due to a lack of maintenance and shortcomings in the planning process. The failure of critical infrastructure systems such as water and energy supply due to climate extremes acutely reduces the population's adaptive capacity and has a significant impact on the economy. Another deficit is the lack of knowledge about climate vulnerability of existing infrastructure. In general, infrastructure vulnerable towards the impacts of climate change presents a high risk for future damage, reducing potential returns from the infrastructure. Protecting durable infrastructure against the effects of climate change requires customized planning processes as well as a range of services making climate information more usable for decision-makers. Up to now, in developing countries in general and in Viet Nam in particular, the use of climate services in infrastructure planning processes remains limited.

2. Viet Nam context and national response

Viet Nam was ranked as the 5th 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 (World Bank, 2019). According to the Climate Change Vulnerability Index, Viet Nam is currently considered one of 30 "extreme risk countries" in the world (CCVI, 2016).

All existing response approaches on the national and provincial level in Viet Nam have also paved the way to advance Viet Nam's aspiration for a successful contribution to the COP 21 in Paris through the formulation of the Nationally Determined Contributions (NDC). Probably the most important outlook for Viet Nam'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. In accordance with the national strategy on climate change, the national adaptation program and national target program to respond to climate change, many ministries, branches, and localities have also issued action plans to respond to climate change. A number of policies and decisions related to climate change and protective infrastructures have also been addressed.

The dramatic growth in terms of infrastructure development in Viet Nam is supporting the national economic development on one hand but on the other hand potentially carries the risk of increasing the vulnerability towards climate change. Unlike traditional approaches to infrastructure planning, Viet Nam already considers both conventional aspects with regards to construction costs, as well as the potential effects of climate change on infrastructure. While the costs of climate change are a concern for most countries, they are of particularly impactful for developing countries, where the financial resources needed to address climate change are especially limited. A recent assessment of the potential impact of climate change by stressors, including sea level rise, precipitation, temperature and flooding, on the physical assets of road infrastructure in Viet Nam by Paul et al. (2015) revealed that across 56 climate scenarios, the mean additional cost of maintaining the same road network through 2050 amount to US$10.5 billion.

The challenge therefore is to identify the impacts of climate change on infrastructure, develop adaptation approaches, incorporate these into medium and long-term development

plans and to secure the resources needed to finance any additional costs for adaptation. In the high-level Ministerial Dialogue on Climate Finance at COP 24 in Katowice (Poland), it was acknowledged that the barrier to more climate finance is the lack of domestic enabling environments and adequate policy frameworks in developing countries. In order to support the negotiators of Viet Nam in scaling up climate finance, future technical work or political consultation on strengthening policy frameworks with adequate consideration of climate risk is necessary.

Reviewing the connection between Viet Nam's existing climate change policies and NDC tasks reveals that climate-proofing and adaptation of infrastructure are reflected in some of the tasks for NDC implementation (#19, 27, 37), building code (#3.30, 4.1, 10.1, 14.1, 33.4, 35.2, 51.3, 79.3, 80.9), Coastal Protection for Mekong Delta (#29, 30, 31, 35 36, 37, 38) as well as new and necessary planning procedures (#28, 65, 66, 67).

Table 1. Tasks related to Climate-proofing and adaptation of infrastructure in Viet Nam's existing climate change policies and NDC

Viet Namese 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

Reviewing the needs for mainstreaming climate risk into infrastructure investment planning and creating enabling environments also shows that regional and sectoral planning still needs a comprehensive guideline on how to incorporate climate risk considerations and appropriate adaptation solutions from the planning phase in decision-making processes.

In translating these strategic orientations into actions, another deficit in the domestic enabling environment is the lack of knowledge about the climate vulnerability of existing infrastructure. Protecting infrastructure against the effects of climate change requires customized planning processes as well as a range of services making climate information more useful for and usable by decision-makers. Up to now, not only in Viet Nam but also in other developing countries, the use of climate services in the infrastructure planning process remains limited. To date, the National Hydrological and Meteorological Service (NHMS) can provide only insufficient contributions to the downscaling of climate projections to the provincial level. Beyond this but also as one its results, guidelines for infrastructure planning and investments in public goods provision so far do include sufficient requirements to use climate data and scenarios. Besides the improvement of climate projections, it is therefore essential to create, in cooperation with provinces, new user-friendly climate service products suitable to solving current challenges. The domestic enabling environment can be enhanced by empowering

climate service providers to develop and deliver better services and by creating capacities to implement climate risk assessment as an essential tool for climate proofing infrastructure.

In the partnership with other the German Meteorological Service (DWD) and Engineers Canada and on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), GIZ supports Viet Nam, Costa Rica, Brazil and the Nile basin initiatives on enhancing the climate resilience of infrastructures focusing on: 1) Enhancing the provision of user-friendly climate services for infrastructure planners; 2) Enhancing the use of climate services and consideration of climate risk assessments in the infrastructure planning process and 3) Mainstreaming the approach of climate-proofing for infrastructure into the SEDP, NDC and NAP of Viet Nam. As part of this, capacities for conducting climate risk assessments are created in the context of a pilot risk assessment in the water sector in the Mekong Delta. The different perspective on strategies and measures for enhancing climate services, that of climate service providers, infrastructure planners and infrastructure investment planners, are reflected in the following sections.

3. Strategies and Measures to Enhance Climate Services - Climate Service Provider Perspective

The World Meteorological Organization (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).* Tailored climate services can effectively inform the decision-makers in infrastructure investment planning.

The key provider on the national level is the National Hydrological Meteorological Service (NHMS). Since March 9, 2018, NHMS has been upgraded to become the Viet Nam Meteorological Hydrological Administration (HMA) under the Ministry of Natural Resources and Environment (MONRE). With the strategic orientation of developing its subordinate units in the direction of financial autonomy, HMA is strengthening the policy framework, national standards and capacity for a better provision of climate services to potential users from the public and private sector. HMA is also planning to develop, modernize and upgrade the hydro-meteorological monitoring network (Figure 3). In its role as climate service provider, HMA concentrates on the collection of high quality data, including a structured, centralized and quality-controlled archiving of climate data as well as on the development of a processing-structure to be able to provide demanded products in a timely and efficient manner. This processing-structure should be integrated in a user-friendly interface that provides visibility to the available products and allows easy and non-bureaucratic access to this data and information. Overall, there already is a vast stock of climate data and information stored in the database of institutes, universities, and stations across the country. This represents a great potential for the future development of climate service products.

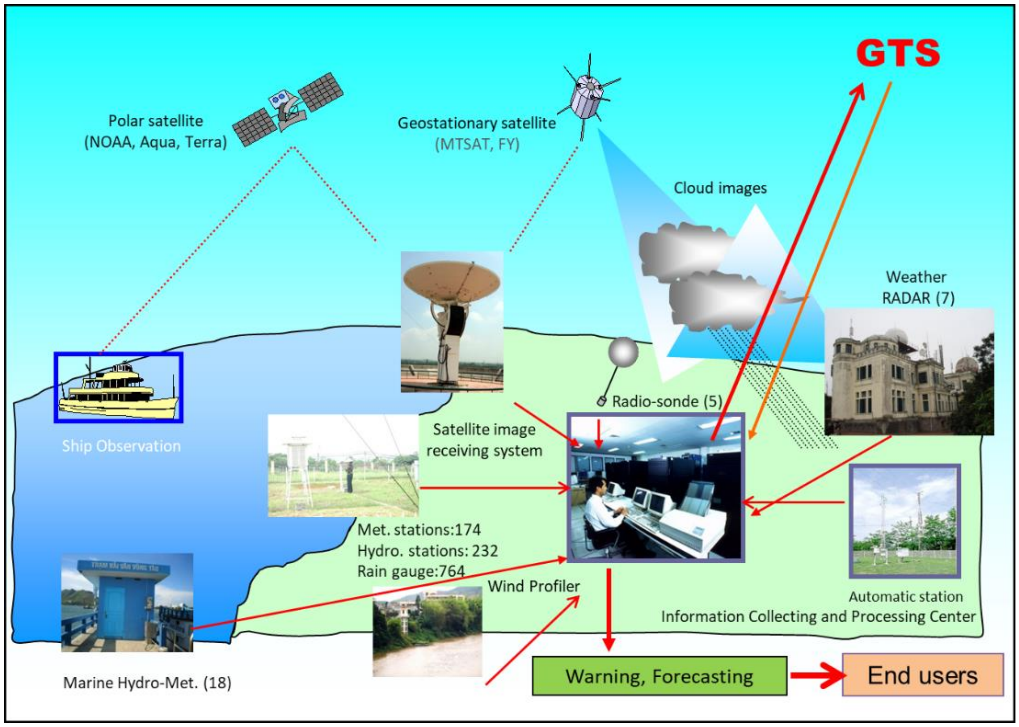

Figure 3: Meteorological and Hydrological Data Collection Network of HMA (as of 2018) (Source: HMA during LEDS/RCAP conference, HCMC, December 2017)

To improve the quality of climate data and systemize database management, the prokect "Enhancing Climate Services for Infrastructure Investment (CSI)", that is implemented by the Deutsche Gesellschaft of Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), has supported the southern center of HMA in data entry, digitalization and processing. Climate experts of HMA were also trained in the application of the Climate Change Hazards Information Portal (CCHIP) developed by the Canadian consultancy *Risk Science International (RSI)*. The capacities were developed following a learning-by-doing approach as part of developing the climate service for the climate risk assessment case study for the Cai Lon – Cai Be sluice gate investment project, led by the Ministry of Agriculture and Rural Development (MARD). Further support is planned in the upcoming time in enhancing capacities to develop tailor-made climate products as well as the interface between users and providers of climate services (website, software, dialogue fora etc.).

Climate information can be used to support decision-making that builds infrastructure resilience in the country, making Viet Nam better prepared to manage the effects of climate change and extreme events. Climate services require appropriate stakeholder engagement along with an effective access mechanism and must respond to user needs. A value-chain approach can improve the way climate information is understood and used by decision makers (Figure 4). This value-chain starts with the generation and provision of climate data and ends with the improved decision-making by different types of users. Ideally, if the value chain operates well, investments in producing climate information will result in societal benefits, such as improved preparedness to extreme climate events. However, to ensure that climate information is used appropriately, a high level of engagement is needed at each stage of the value chain, with feedback on the usability and usefulness of products and information on their limitations and optimal way of use flowing constantly between users, intermediates and providers in the manner of an end-to-end service. The nature of engagement between the providers and the users has strong implications for the success of information exchange and information uptake. Optimal conditions are provided by interactive, multi-stakeholder dialogue for a or via digital tools. This presents an opportunity for providers and users of climate information to exchange ideas in person, allowing for immediate feedback and decisions made in line with user needs.

Additionally, this method allows for a two-way engagement and collaboration on how to best prepare for and respond to climate hazards. The level of engagement between providers and users of climate information has a direct effect on whether climate information is used appropriately to inform climate-sensitive decisions. Therefore, it is vital that climate information providers and users engage openly and explore approaches that are suited to growing climate information needs under a rapidly changing climate.

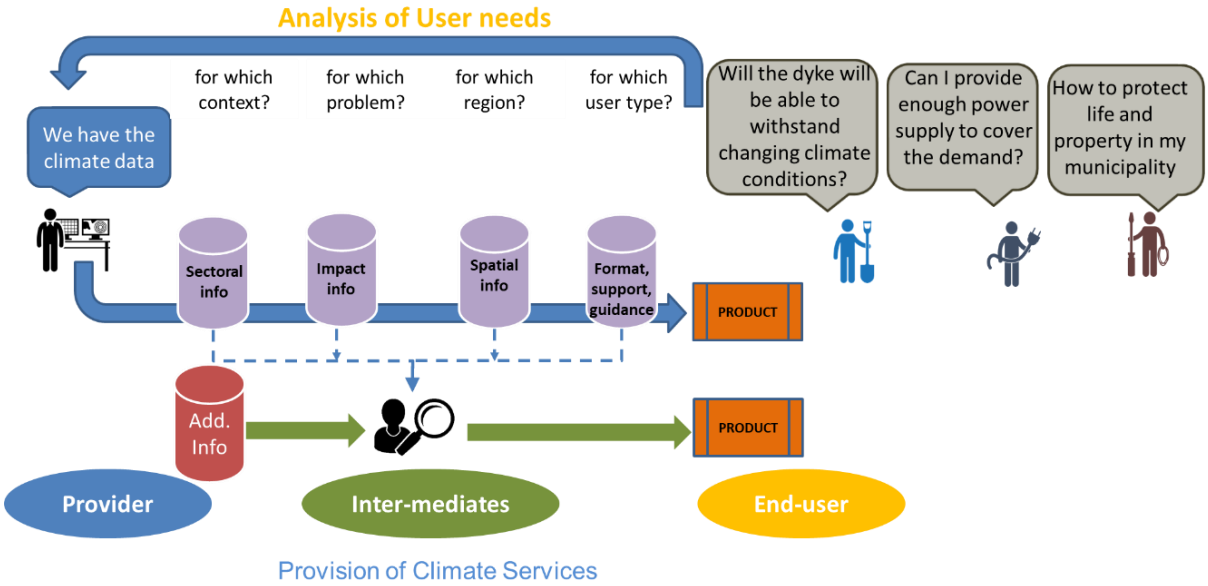

Figure 4: Conceptual flowchart for Climate Value-chain for improved decision-making by different types of users (Source: Presentation on Climate Services in context of the CSI project)

4. Strategies and Measures to Enhance climate services – Infrastructure Planner Perspective

Uncertainty and risk associated with climate change raise concerns for infrastructure operation and maintenance. From the perspectives of infrastructure investors, a high awareness of climate risk helps to avoid preventable failures and to improve the decision-making process. The PIEVC Protocol[1] for infrastructure vulnerability assessment, developed by Engineers Canada, defines climate risk for infrastructure as the probability of selected percentage changes in performance metrics under climate change scenarios relative to baseline conditions. The risk scores (R) can be calculated by the following formula:

$$R = P \times S$$

In which:

- P: probability score of climate and hydrological factors
- S: severity scores of infrastructure components under the impacts of climate and hydrological factors
- R: risk scores

[1] For more information on the PIEVC, refer to www.pievc.ca

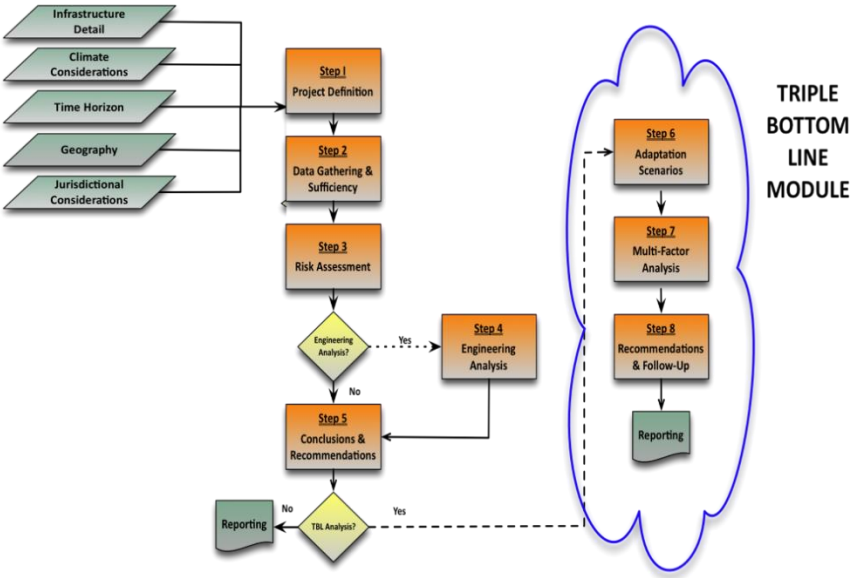

Figure 5: Flowchart of Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol – a climate risk assessment tool to assist infrastructure owners and operators to effectively incorporate climate change adaptation into design, development and decision-making developed by Engineers Canada (Source: Presentation by Engineers Canada during PIEVC assessment workshop, Can Tho, April 2018, for more information please refer to www.pievc.ca)

To reveal the climate risk for a specific infrastructure investment project, the Ministry of Agriculture and Rural Development (MARD) has been collaborating with the CSI project in applying the PIEVC Engineering Protocol, a step-by-step methodology developed by Engineers Canada, in the context of a pilot study for the Cai Lon – Cai Be sluice gate project in the Viet Nam's Mekong delta.

For an effective climate risk assessment, engineers of the Southern Institute of Water Resource Planning (SIWRP) and the Project Management Unit for the Cai Lon – Cai Be infrastructure project collaborated with the climate experts from the HMA to collect meteorological and climate parameters. Generally, global warming and climate change scenarios for Viet Nam show that many climate factors are changing significantly. This includes, among others, an expected increase in intensity of heavy rain, total annual rainfall, and extreme temperature events in the Mekong Delta. These climate factors play an important role for assessing the vulnerability of infrastructure. Combined effects of climate and hydrological factors also need to be considered and assessed and are part of the pilot risk assessment, such as: high water level combined with heavy rain, salinity intrusion combined with meteorological drought, and the decreased sediment load combined with erosion and flood flow or storm surges. The risk matrixes obtained from the assessment process show a picture of the potential risks for the Cai Lon - Cai Be Sluice Gates under the impacts of climate and hydrological factors for both historical conditions and future projections. The study also provided useful recommendations to support the next stages of the Cai Lon - Cai Be Sluice Gate project (i.e., the detailed design, construction drawing design, and operation and maintenance).

Based on results of the application of the PIEVC for concrete infrastructure investment projects in Viet Nam, it is essential to create, in cooperation with the provinces, a guideline for climate risk assessment for the planning of infrastructure projects as part of the efforts to standardly incorporate climate-risk considerations into planning in the future. The climate risk assessment as basis for effective climate risk management contributes to reducing the vulnerability of the infrastructure, as well as the cost of operating and repairing it. In particular, if the evaluation is considered at the planning stage, investors will have the most

comprehensive view of the possible impacts of climate on infrastructure and can use it as basis for identifying and selecting solutions to manage the underlying risks. If there is a comprehensive guideline for integrating climate risk assessment into infrastructure, the implementation in the future will follow a consistent system, bringing positive effects.

Once there are successful examples of integrating climate risk management into infrastructure investment planning, this will entice other investors to apply and integrate this approach into the investment process. The climate risk assessment pilot project for Cai Lon - Cai Be sluice gate receives the attention of investors because it is a very specific case study associated with practices and identified gaps in Viet Nam. Following the developed guideline, infrastructure project owners and engineers can apply this climate risk assessment for further infrastructures in Viet Nam as a replication and upscaling step. Besides, a strong connection between the infrastructure engineers and climate experts for a service of data collection and analysis as part of the climate risk assessment approach is also a key factor for the solution.

5. Strategies and Measures to Enhance climate services – Infrastructure Investment Planner Perspective

Decisions made today will determine the extent of future vulnerability to climate change. Development planners are now taking the effects of climate change into account in policies, strategies, projects and local government plans in fields such as agriculture, forestry, urban and infrastructure development. The consideration of climate services and climate change issues is tackled in a high number of laws and regulations. There are many laws, regulations and political strategies from various sectors that are valid for planning processes. Increasing the resilience of infrastructure through an enhanced use of climate services therefore constitutes an important field of work in the process of national adaptation planning (NAP). Political strategies include the Vietnamese Climate Change Strategy (NCCS, 2011), the Strategy for Green Growth (VGGS, 2013) and the INDCs (2015). Both INDCs and NCCS emphasize the need to modernize hydro-meteorological observations and forecasts.

Recently, MPI has reviewed how climate concerns enter infrastructure investment regulations as well as the items referring to infrastructure in legal documents related to climate change. Based on the determined gaps, a pilot-effort of integrating a climate proofing approach into the socio-economic development plan has been made in three provinces: An Giang, Kien Giang and Ca Mau in the Viet Nam's Mekong Delta. Several indicators which reflect concerns of climate risks were considered and included in the SEDP plan of 2019. Besides, whilst developing a draft decree on guiding the implementation of the Investment Law by the Ministry of Planning and Investment (MPI), GIZ and MPI experts have provided inputs on the consideration of climate change impacts in the planning process, particularly for public infrastructures. Further considerations of climate risk into the bylaws under the Law on Urban Management and Development by the Ministry of Construction (MOC) will also be conducted.

In order to support for a sustainable application of climate risk in the planning process, it's necessary to facilitate the establishment of a National Framework of Climate Service in Viet Nam. It will also be needed for further improvement in regulation, policies, mechanisms and guidelines in order to ensure a systematic and harmonized consideration of climate risk in planning processes for infrastructure. Considerations of climate risk in the design and investment planning of an infrastructure project, once reflected in planning policies, could be a firm basis for attracting more climate finance. The climate finance then may enable actions in the country to assure climate-resilient infrastructures that are planned, designed, built and operated in a way that anticipates, prepares for, and adapts to changing climate conditions (OECD, 2018).

6. Cooperation for a sustainable future of Viet Nam

A strong connection among climate service providers, infrastructure investors and planners, is crucial for a sustainable future of Viet Nam in terms of enhancing climate services. In the approach of climate-proofing infrastructure investments (Figure 6), the roles and interaction among these key actors can be reflected.

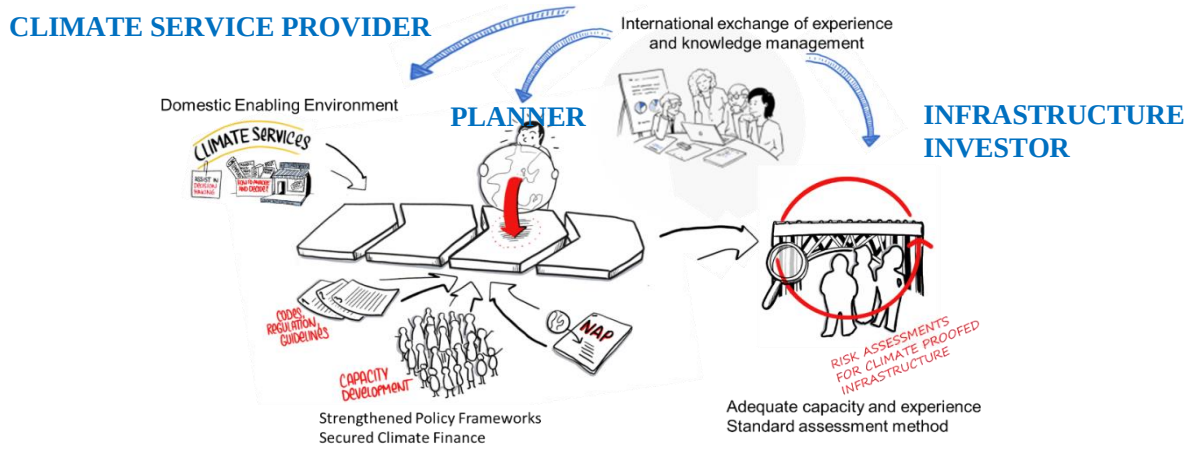

Figure 6. Approach for making infrastructure investments climate proof (Source: Presentation of the CSI project)

It refers the cooperation of stakeholders that are involved in the process of using climate services for infrastructure investment planning. 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. It also requires the cooperation of political stakeholders to ensure appropriate data policies (i.e. data access and availability), mandates and guidelines for the use of climate information.

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