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# ESSAY #4

# THE RELATIONSHIP BETWEEN CLIMATE CHANGE ADAPTATION & COASTAL PROTECTION PLANNING IN THE MEKONG DELTA

## – THE ROLE OF CLIMATE SERVICES FOR THE DECISION SUPPORT SYSTEM TO AVOID LOSS AND DAMAGE AND MINIMIZE FUTURE COSTS

BY

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## I Summary

The Decision Support Tool (DST) for the Coastal Protection for the Mekong Delta (CPMD) provides an analysis of the current geographical, geological and hydrological situation along the Mekong Delta's coastline. Besides a surveillance of changes of the coastal regimes over the last decades until today, it also includes an assessment of the major coastal protection infrastructure, including dykes and sluice gates, embankments as well as eco-based foreshore protections such as the mangrove belt. The combination of coastal regime analysis (including changes in the past) with a description of protective qualities of the coastal infrastructure provides thorough information about the existing exposure and basic vulnerability of the delta's coastline. It is therefore possible to indicate a risk-level that offers the basis for a prioritization of newly planned protection infrastructure.

Climate Change, however, adds the future as a new perspective and changes the parameters of the DST "equation" through the application of different climate models and scenarios. In conjunction with different local downscaling applications, the result will be a medium or long-term timeline with different degrees of certainty towards changes in local temperature, sea level rise and weather patterns, including hazards and potential extreme weather events. Thus, the DST can also offer a way to include climate information and apply future scenarios in its decision-making advice for coastal infrastructure. For this, it needs to incorporate climate information and products tailor-made to be used in decision-making and planning processes, so called Climate Services (CS). If not applied, the vulnerability of coastal infrastructure will increase along with higher rates of loss and damage. Consequently, this essay will not only deal with the question how Climate Services (CS) provide necessary added value to the CPP, but what financial investment planning has to bear in mind to avoid an acceleration of future costs due to inaction in adaptation.

## 1. Climate Change, the consequences for the Mekong Delta coast and Vietnam's national response

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 yet, 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.

The Mekong Delta's estuary region along the east seacoast (Ben Tre, Tra Vinh and Soc Trang province) as well as the southern peninsula (Ca Mau, Bac Lieu and Kien Giang provinces) will be more affected by coastal erosion, saltwater intrusion in connection with droughts, storm surge and sea level rise in the future.

## 2. Coastal Protection Planning – essential for successful NDC implementation

The debate about the relation between coastal protection and climate change, its consequences and vulnerabilities for Vietnam, has also influenced the country's policy formulation. Hence, multiple strategies, policies and action plans addressing the challenges of climate change have been prepared. Vietnamese coastal areas play a vital role in these strategies. The most prominent ones are the National Climate Change Strategy (NCCS) and the Action Plan to Respond to Climate Change and Sea Level Rise, both from 2011. 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 advance Vietnam'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 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. The right column of the table below displays 14 NDC tasks that are in line with the principals of developing a Coastal Protection Plan (CPP). 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), areas relevant for the DST (#26) 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. However, as most tasks have not yet been translated into action, the CPP has the potential to showcase a decentralized approach for NDC task fulfillment. In addition, the 14 NDC tasks will be also highly relevant for the elaboration of Vietnam's National Adaptation Plan (NAP), which will be finalized in 2018, underlining the question of climate-proof infrastructure. The coherence between the CPP as a sector plan in line with the national policies and strategies is therefore on the one hand a requirement for the allocation of sufficient funds for capital investments. On the other, full coherence between policy and plan is the prerequisite for actual implementation and offers entry points for harmonized cooperation between national ministries such as MARD, MONRE and MPI as well as for integrated geographical plans which have to be steered through improved inter-provincial coordination.

**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;<br>#27 guidelines for public infrastructure;<br>#28 SEDP climate change planning<br>#29 prevention of natural disasters (floods, etc.)<br>#38 complete coastal dykes, control of salinity intrusion<br>#65 integrate cc into policies and plans of ministries and provinces |
| Action Plan to Respond to Climate Change | #30 integrated water management<br>#31 sustainable forest development/ coastal forest<br>#35 ecosystems based adaptation<br>#36 …integrated coastal management<br>#37 resilient infrastructure, water supply, prevent flooding<br>#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 |

(Author's own table. Adapted from Vietnam's NDC annex "Plan for the Implementation of the Paris Agreement")

## 2.1 Future coastal protection costs due to climate change

The table above does not only show the conceptual relation between climate change and coastal protection, it also implies that adaptation-related successful NDC implementation in the future will be largely dependent on effective coastal protection strategies. It is therefore important for coastal protection to abandon business-as-usual (BAU) planning approaches and instead include climate information to assure it continues to fulfill its resilience function in the future. In addition, much-needed local implementation will be dependent on sufficient financial allocations, as costs for adaptation will in all likelihood increase due to climate change. In UNFCCC's adaptation cost assessments, the global need for financial flows for adaptation until 2030 will especially increase for infrastructure, followed by agriculture, coastal zones and water (UNFCCC, 2009:9). To better reduce unpredicted costs for loss and damage, one major objective for decision-makers must therefore be to align budget and investment planning with future climate projections.  The following analysis presents the current BAU costs for provincial coastal protection. It offers the opportunity for a baseline and a starting point linked with the DST, to estimate the cost-benefit ratio of long-term investment decisions vs. high contingencies. Climate Services are a key input, providing climate-related parameters necessary for such a calculation to take into account climate change. For the designs resulting from the DST to become climate-proof, the use of Climate Services needs to be part of it. As public budgets tend to be scarce, climate change scenarios provide the possibility to calculate costs due within 20 or 30 years. Decision-makers at all government levels will therefore gain more time to negotiate an adequate flow of financial allocations either from central government, the private sector or the donor community.

Since 2015, Mekong Delta provinces have started to classify their investment spending according to climate change adaptation. Based on an initiative of MPI, GIZ and UNDP to support all 13 Mekong Delta provinces and apply classification methods either based on OECD-DAC principals or newly introduced World Bank approaches. Although the cooperation with the 13 provinces is still ongoing, some results for coastal provinces such as Ca Mau, Bac Lieu, Kien Giang and Soc Trang show that coastal protection investments play a major role in overall investments (GIZ, 2017:18-22).

**Table 2: Share of coastal protection of total investment**

| Province | 2015 total planned capital investments (exchange rate USD 1= VND 22,500; in present day value) | 2015 planned investments in | Share of coastal protection | *Additional investments relevant for integrated coastal protection* | | | |
|---|---|---|---|---|---|---|---|
| | | **Coastal Protection** | | *Disaster prevention infrastructure* | *Saline Water Intrusion* | *Forestry* | *Irrigation* |
| **Bac Lieu** | **USD 95,531,260** | **USD 9,634,854** | **10.08%** | USD 5,018,153 | | USD 602,178 | USD 602,178 |
| **Ca Mau** | **USD 129,809,867** | **USD 11,137,735** | **8.58%** | USD 1,272,884 | | USD 4,455,094 | USD 8,273,746 |
| **Kien Giang** | **USD 222,688,142** | **USD 4.902.457** | **2.20%** | USD 817,076 | USD 5,991,892 | | |
| **Soc Trang** | **USD 55,399,378** | **USD 8.765.905** | **15.82%** | | USD 559,525 | | |

(Source: Author's own table, based on GIZ, 2017)

The analysis of the four provinces was based on their provincial investment budget plans for the three years from 2013 until 2015. The table above highlights the overall share of coastal protection in relation to the overall investment budget plan.

Based on the 2015 average exchange rate (USD 1 = VND 22,500), Bac Lieu, Ca Mau, and Soc Trang planned to spend between USD 8.7 and USD 11.1 million for coastal protection alone. This accounts for more than 8.5 % of the total planned investment budget in Ca Mau, more than 10 % in Bac Lieu and almost 16 % in Soc Trang. The figures of Kien Giang province deviate slightly as the province planned to spend approximately USD 5 million for coastal protection in 2015. If a wider "integrated coastal protection" or even coastal zone definition had applied, it would have also made sense to include larger shares of the right hand columns, highlighted in grey. The detailed provincial budget plans proof that highest spending for disaster infrastructure relates to coastal areas (e.g. storm shelters). Irrigation and saline water intrusion prevention costs are also mostly in connection with dyke or sluice gate investments along the coast. Even forestry investments are usually made in coastal areas e.g. to rehabilitate mangroves.

In conclusion, the CPP is supposed to function as a cross-provincial sector plan, which will decide for shares of up to 10% and even 20% of the total annual provincial investment plans. This is only to highlight the current value and extent of how provincial spending has already burdened by coastal protection. According to MPI's, GIZ's and UNDP's studies it is safe to say that those planned investments for the years 2013 until 2015 already included an adaptation margin, future scenarios however are not yet included. It is therefore most likely that the provincial burden will even increase in a medium-term-period.

## 2.2 Purpose of knowing the costs

The figures presented in the table above indicate large provincial spending commitments towards coastal protection. At first sight, this appears to be in line with the references made in chapter 1, which underscore the relationship between climate change adaptation and coastal protection.

On behalf of MPI, ongoing GIZ and UNDP surveys further assess the question of how far provincial coastal protection investments of recent years have already taken national climate change strategies into account. Debates on using classification methods in Vietnam will further define the actual share of coastal protection investments with relevance for climate change adaptation. In line with this debate, the question goes as far as to determine whether e.g. the total costs of a new dyke line are creditable with adaptation or whether only the costs for the margin between a BAU dyke height scenario and climate change scenarios will be creditable. In countries with a well-functioning coastal protection system, the latter definition has been used in recent years. In countries like the Netherlands or Germany, dyke-systems have mostly fulfilled their function to prevent floods in the last decades and recent past. Recent climate change scenarios have been introduced to climate proof or upgrade the dykes accordingly. This approach is debatable for the Vietnamese case. "Living with water", either inland along rivers and canals of the Mekong Delta or along the coast, has always challenged people's lives and livelihoods. Additionally, the last decades have led to constant population growth and a much more extended land use. Coastal areas that did not need an integrated protection system in the 20$^{th}$ century are facing much higher risks today. Based on the IPCC diagram, presented below, risks = exposure x vulnerability x hazards. "Living with water" and even the history of the Mekong Delta suggest that vast areas of the delta coast have always been exposed to a certain extend. From a geological point of view, the Mekong Delta is mainly alluvial land and especially the southern tip of Mui Ca Mau and parts of the east seacoast even gained land through sedimentation, which might indicate partly less exposure of the coastal land in those regions. The CPP's DST, however, also shows that the coastal regimes on both the east and west seacoast have undergone changes. Areas marked orange and red indicate higher current risks e.g. due to erosion and the current insufficient state of protection infrastructure. The fact that Mekong Delta provinces are spending large amounts for coastal protection is thus largely creditable to increased exposure and vulnerability. Even under BAU assumptions, grown population density in coastal areas has automatically increased exposure rates. In addition, the various orange and red areas in the DST clearly document that insufficiently protected areas also increase the local vulnerability. Of course, in this case both, vulnerability and exposure are mainly explained by human interventions. The relation between climate change and the current risk level in the Mekong Delta is, in some cases, debated or based on the general assumptions of global climate change scenarios. Although the DST clearly indicates costal regime changes over time, neither the current influence of climate change (beyond sea level rise) nor the expected future impacts have been incorporated so far.

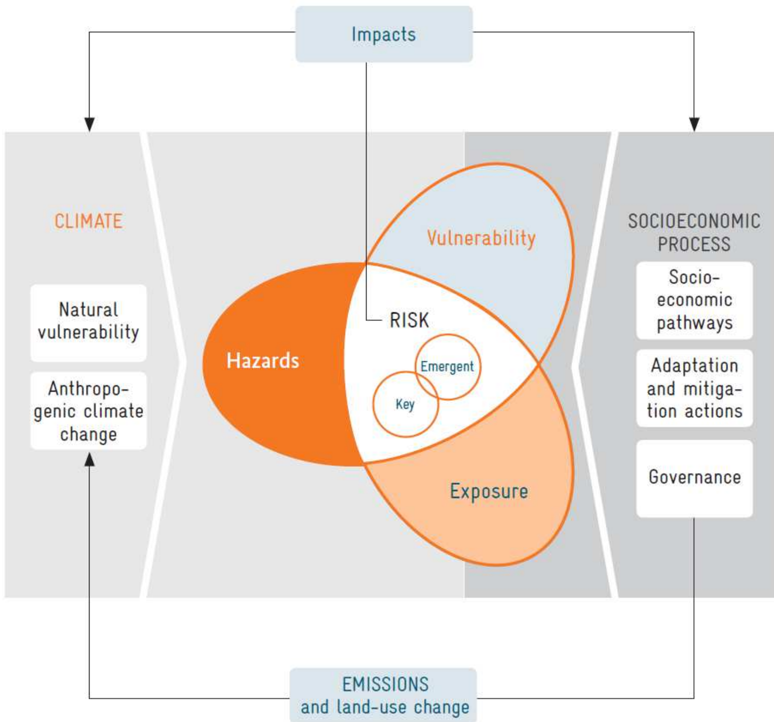


*Figure 1: Source: IPCC, 2014:1046*

What does that mean for investment costs and investment planning procedures? In a nutshell, an adequate use of adaptation budget classification definitions might be important to compare country and sector efforts and to provide much-needed tools to transparently assess whether the national climate change strategies have been implemented according to plan. A final definition of whether an entire new dyke or only the needed additional height margin due to climate change will count as adaptation investment is part of an ongoing iterative debate to quantify adaptation efforts. In light of the current challenges however, a quantification signifies a first step to ensure policy coherence between the formulation of national strategies (such as the NDC) and local implementation. It will also offer a reality check for the formulation of the NAP, which also needs a breakdown to the provincial level and also has significant connections to climate-proof and protection infrastructure. Quality and efficiency of adaptation interventions, however, must be the focus of the second step. Shaping an adequate coastal investment planning consequently also aims at including climate change impacts. It uses Climate Services for the development of adequate adaptation measures that are to minimize loss and damage costs in the future. The assessed cost level of coastal protection and related investment measures hence provide a baseline to enable future cost calculations based on BAU and projected loss and damage versus climate-proof scenarios.

The large amounts of provincial investment costs for coastal protection already account for higher risk levels due to already existing exposure and vulnerability. The authors suggest a more in-depth consideration of Climate Services. More accurate and reliable downscaled scenarios of climate change project the frequency, intensity and persistence of hazards and therefore the change for exposure and vulnerability rates that lead to different risk assumptions. The following chapter will describe an approach towards the better inclusion of Climate Services and how these are to be used as a basis for strengthened risk assessments and cost benefit analysis. Although the CPP already provides best potential answers for the present situation, this “add-on” offers additional pathways for decision-makers to adjust adaptation spending over the next years.

## 3. Climate Services – more than just scenarios!

The two previous chapters explained the relevance of coastal protection for national climate change adaptation and the tremendous cost burden they already represent in present day. The following will highlight the need to include Climate Services (CS) to ensure the sustainability of the CPP, taking the medium and long-term future perspective, with climate change impacts becoming more and more relevant in the future.

***Box 1: What are Climate Services (CS)?***

*A climate service is a decision aide derived from climate information that assists individuals and organizations in society [for] improved ex-ante decision-making. A climate service requires appropriate and iterative engagement to produce a timely advisory that end-users can comprehend and which can aid their decision-making and enable early action and preparedness. Climate services need to be provided to users in a seamless manner and, most of all, need to respond to user requirements.*

*As indicated by the well-known adage "climate is what you expect and weather is what you get" used to distinguish between the climate and weather, climate information prepares the users for the weather they actually experience. For most users climate and weather are mutually interchangeable. It is, therefore, imperative for climate and weather services to operate in close tandem, so as to be seamless to the end-user. The seamless delivery of services from the long-to short-term time scales is critical to ensure effective and consistent use of information for various real-world decision-making contexts. Timescales are key in understanding climate services (WMO, 2013).*

From the WMO definition on Climate Services, it becomes obvious that the approach goes well beyond scientific analysis and data provision, but needs to include the formulation of a defined and agreed process of exchange between information providers and users.

In case of coastal protection in the Mekong Delta, the global scale of scenarios and models is insufficient as foundation for decision-making. Only downscaling of the models provides the necessary information on frequency, intensity and persistence of relevant extreme events, such as floods and storm surges. Additionally, for climate-proof investment and planning decisions, regionalised predictions and projections and the information on hazards need to be matched with locally available and sector relevant information. Hence, a well-functioning Climate-Service-Value-Chain is needed.

Within this value chain, intermediates are translating climate and other decision-relevant information into products usable by planners and operators of coastal protection. Agreement on standardised processes along this value chain and among the actors involved ensures an efficient flow of information, tailor-made to the needs of decision makers.

### 3.1 Institutionalize a framework for CS delivery

Tailored Climate Services for coastal protection and the DST can effectively inform the decision-makers in investment planning. A CPP can thus evolve from a planning tool for the present to a medium and even long-term strategy. As described above, it requires "[…] a multi-disciplinary and cross-sector collaboration, and an agreed upon framework within which such collaboration can take place (WMO, 2013)." The diagram below summarizes the framework relationship between end-users, climate information providers and intermediaries, through i) the definition and communication of needs, ii) the definition of provider capabilities, and iii) the harmonization and refinement between needs and capabilities. Hence, the framework is based on dialogue, feedback, outreach and evaluation of all involved stakeholders. Such a framework, also outlined in a similar fashion by WMO, is of course a theoretical structure, which, for the case of coastal protection in the Mekong Delta, misses the appropriate analysis of different stakeholders, both at national and provincial level, and at their perceived positions in a negotiation process. The interface diagram suggests an iterative process, starting with the end-user and a collaboration between information provider and intermediate. Further analysis of the institutional and legal set-up concerning the development of the CPP should then suggest an appropriate and timely process. Further sensitization of the importance of CS as an integrated part of CPP will be necessary to allow for a legalization and a routinized framework process.

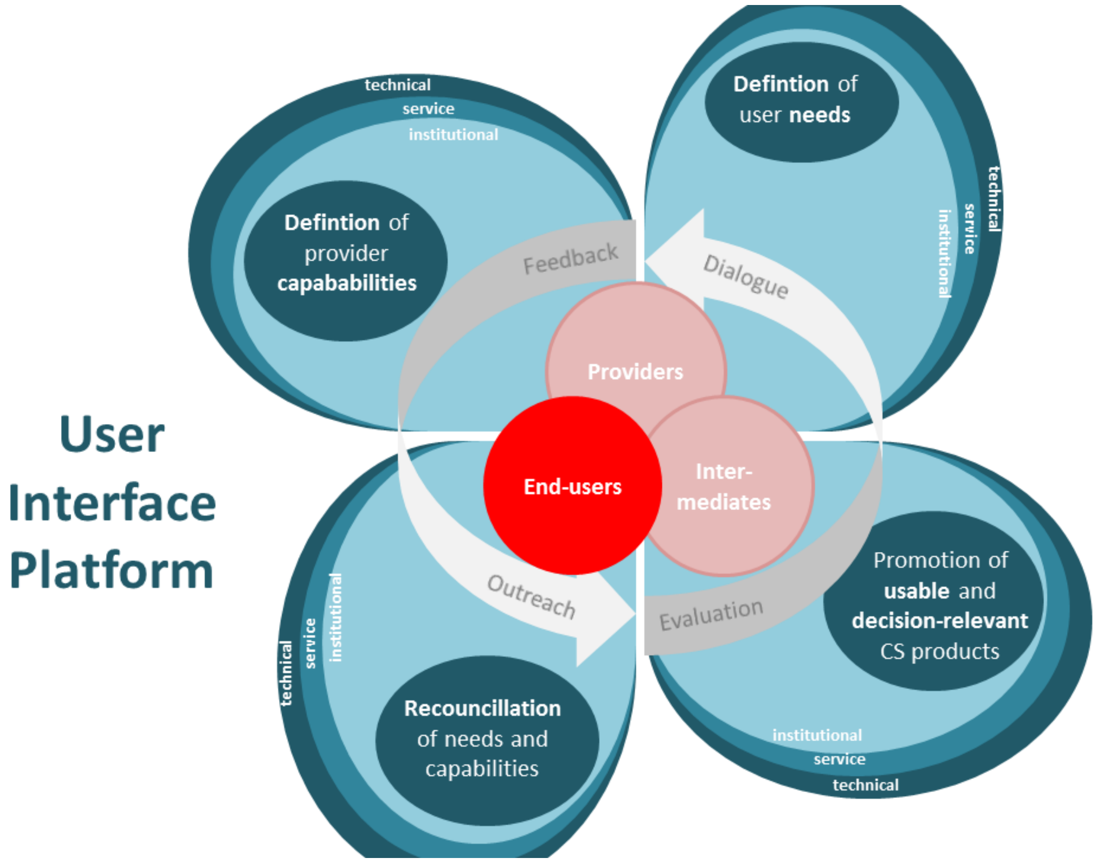


*Figure 2: Climate Service User Interface Platform (Author's own figure)*

### 3.2 Provision of climate information

In 2016, MONRE released a survey with two alternative climate scenarios. The predictions see an increase in sea-level rise of about 55 cm (from 33÷75 cm) in RCP 4.5 up and to 77cm (from 51÷106 cm) in RCP 8.5 until the late 21th century. Combined with storm surge and a tidal regime change, 38.9 % of the Mekong Delta will be at risk of inundation.

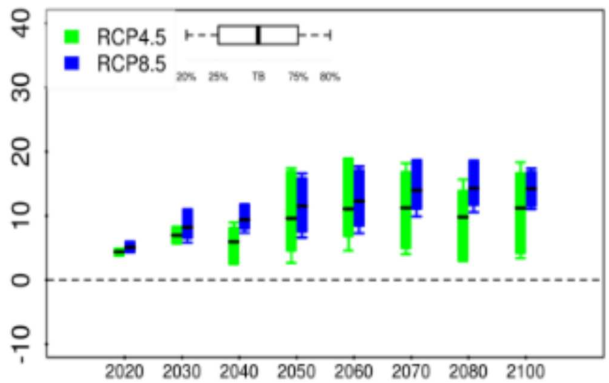


*Figure 3: Source: (MONRE, 2016).*

This is an important foundation for future perspectives. So far, the "Coastal Web-Map Toolbox" and in particular the DST, with its cost-benefit calculation sheet, has the potential to give basic advise on investment costs and design of coastal protection infrastructure, with regard to different climate change scenarios along the coast of the Mekong-Delta.

The downscaling of the global information permits providers and intermediates to recognize regional to local trends and developments that are not visible in global models due to their very coarse resolution (for example 10° grid). There are several downscaling techniques available. Their goal is to increase the resolution spatially, temporally and often vertically. Secondly, the downscaling process can make use of local climate data (e.g. based on the measurements of local weather stations) and can therefore calibrate to the specific area.

So far, of the relevant climate-change-related parameters, the DST only considers sea level rise. However, many other variables relevant for and used in coastal protection planning are affected by climate change. Their development over time and for all the areas surrounding coastal protection measures, from offshore to the hinterland, need to factor into decision-making. Relevant hydro-climatic variables not yet considered are, among others, changing tides and ocean currents, predictions on changes in frequency, intensity and persistence of extreme waves and storm surges, predictions of wind speed and directions as well as rainfall patterns. Those need to be matched with the information already part of the DST, on inundation risk zoning, erosion, coastal morphology and bathymetry, as well as socio-economic information (e.g. on agricultural land use and settlements close to the coast). All of the above-mentioned variables determine the risk for coastal areas and need to be part of a climate risk analysis.

There are different reasons climate information is not yet utilized to the extent it would be advisable. In many cases, those are related to the technical, service or institutional dimension of the Climate Service value chain. Technical reasons are for example missing data or the lack of tools and capacities especially for the downscaling of climate projections and the development of impact models to get useful information on i.e. changes in wind and wave patterns. The service dimension focuses on the user-specific tailoring of data as well as dissemination and support efforts of providers and intermediates for providing the information to users in a fashion that makes it usable and understandable and thus supporting effective decision-making. The institutional dimension, on the other hand, focuses on the mechanisms of cooperation and interaction along the value chain. As planners do not always know all the climate information relevant to them or how to formulate their information needs, an iterative process of dialogue and mutual feedback on user-needs and provider-capabilities is needed to develop the climate products that are needed (figure 2 above).

Intermediate users, such as the Southern Institute for Water Resources and Planning (SIWRP), refine information through the combination of the different types of data. Enlarging the scope of data used for planning by incorporating different climate products with applications for site-specific infrastructure for a CPP helps making better decisions, strengthening resilience. In order to make sure that the data provided by climate information providers, such as the Vietnamese National Hydro-Met Agency, fits the needs of planners, cooperation along the Climate-Service-value-chain is key. To ensure that this cooperation is sustained and efficient, end-users, such as MARD and Mekong Delta provinces, and providers and intermediates need to define their cooperation procedures. WMO and its Global Framework for Climate Services (GFCS) refer to this kind of institutionalised exchange for the development and use of Climate Services as Climate-Service-Interface (WMO, 2013).

## 3.2 Climate Proofing and the DST – Intermediate use of CS

The DST basically, besides its function as tool for designing coastal-protection measures, provides coastal-protection planners with a basic climate-proofing tool for a specific infrastructure in the context of coastal protection. In general, the climate-proofing concept is used to ensure that planning, both on a strategic level as well as for specific investment and construction projects, is in-line with efforts to increase resilience to climate change. In other words, climate proofing ensures that investment objectives are met under conditions of climate change. With the tool, elements and objectives of strategies and planning processes that are affected by climate change and in need of adaptation are identified in order to incorporate climate-change considerations into them. In the context of coastal protection, climate-proofing planning can be used to ensure that the desired protection level is not eroded over time due to the effects of climate change. The climate-proofing process spans from the definition of the subject of interest and the participating stakeholders in the process via the identification of adaptation needs to the implementation of adaptation measures or, in the case of the strategic planning as with the CPP, to the integration of climate change adaptation into planning. The last step ensures continuous feedback via monitoring and evaluation and is supposed to lead to regularly updating designs and strategies according to changing circumstances.

By design, the DST guides coastal-protection planners through a variation of the climate-proofing process depicted below, with the caveat mentioned above of not yet considering all the relevant climate parameters. In the Climate Service value chain, the DST thereby serves the purpose of matching climate information with other decision-relevant parameters providing decision makers with recommendations for planning. Ideally, the use of the DST should be accompanied by the support of an intermediate provider in the value chain assisting the decision-maker in its utilization and the interpretation of its results.

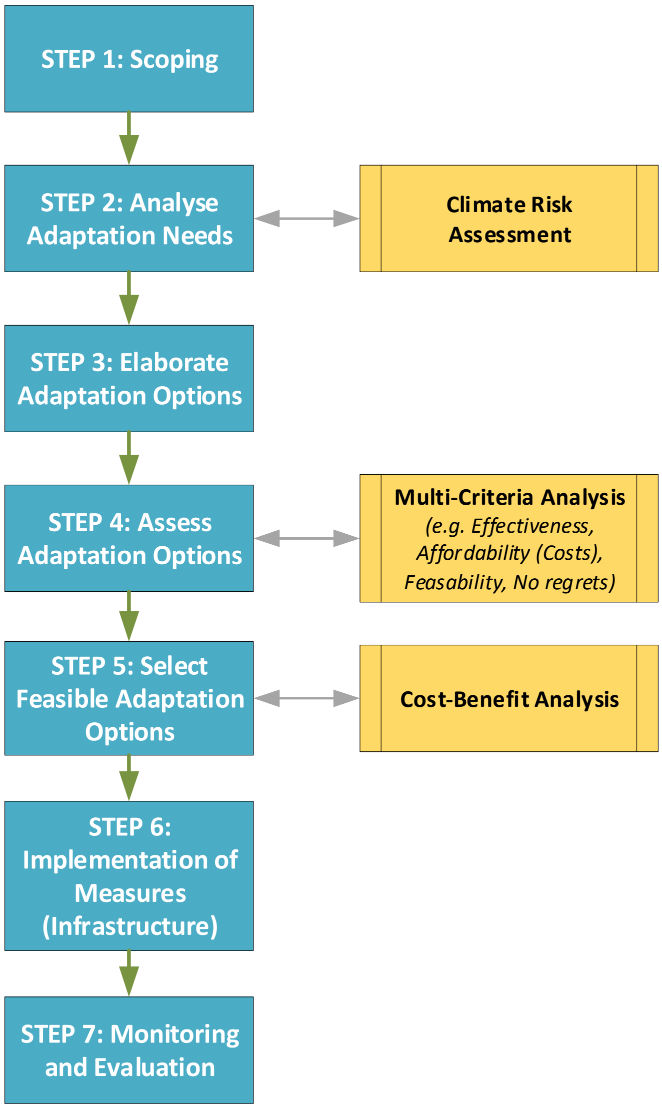


*Figure 4: Process of Climate Proofing for Investment Projects (Source: Author's own figure)*

The climate-proofing process starts by scoping, where the objective and or target of protection is defined and all actors relevant for its adaptation identified. This can be a specific part of the coast, a city or just a specific site. In the second step, the adaptation needs are to be identified. In the case of the DST, this is where the tool provides the user with site-specific risk information relevant for coastal protection planning (i.e. shore slopes, hydraulic conditions for different return periods, vegetation, land use etc.), both in the present as well as for the future, based on the climate change scenario and functional lifetime of coastal protection measures selected (see figure 5). It shows how sea level rise, erosion, subsidence, consolidation etc. affect the area or subject of interest. However, as noted above, the only climate change variable in the DST is sea level rise.

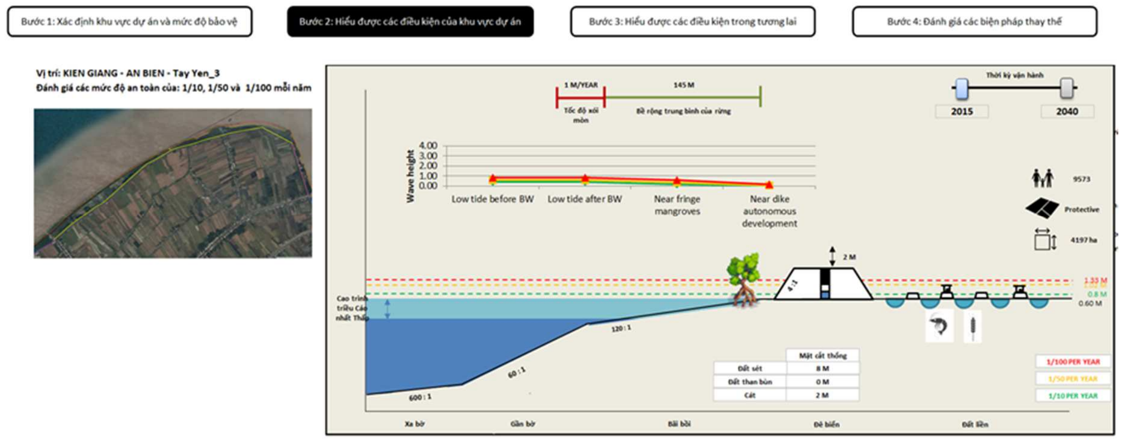


*Figure 5: Kien Giang – An Minh: Current Conditions (Source: Manual Decision Support Tool)*

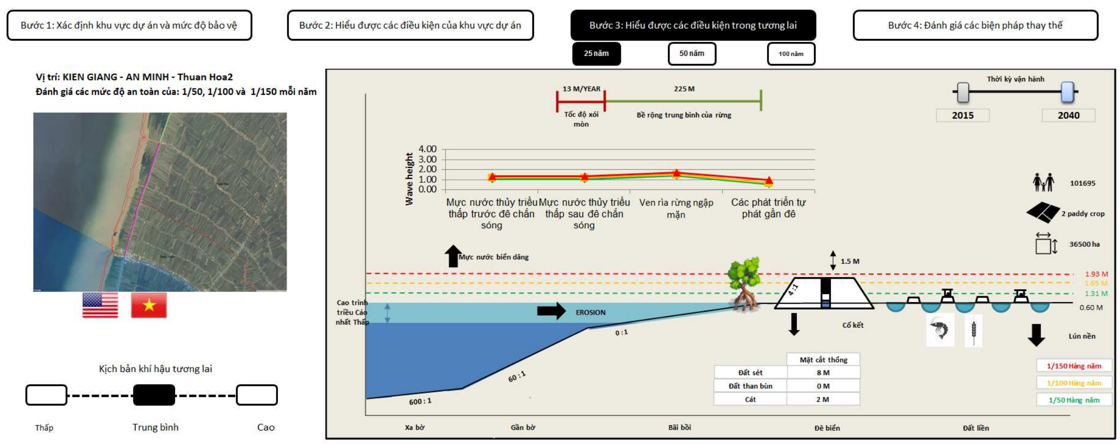


*Figure 6: Kien Giang – An Minh: Future Conditions (Source: Manual Decision Support Tool)*

In providing the user with information on all the different factors affecting coastal protection measures, the DST has a build-in basic risk assessment. In general, during a risk assessment it is analysed what risk factors influence the object of interest and, given the actors' risk tolerance, ends in the elaboration, assessment and selection of risk management options.

In the context of climate change, it is necessary to not only consider current risks, but to also take into account how given risk-factors change and how climate change might reveal new risk factors not yet relevant for the object of interest today. Taking the example of coastal protection, factors influenced by climate change are, among others, the aforementioned changes of rain patterns and potential changes in ocean currents. Additionally, parts of the coast so far unaffected by extreme events, might be hit by typhoons and increased wave impacts in the future, when the paths of storms change due to climate change.

| | **Risk Assessment Matrix** |
|---|---|

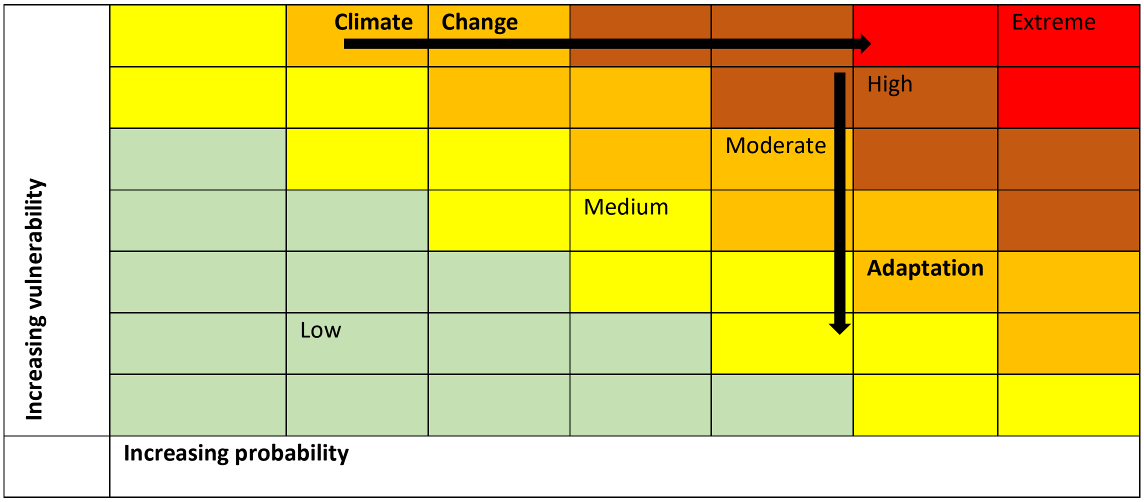


*Figure 7: Risk Assessment Matrix (Source: author's own diagram, based on UNFCCC, 2011)*

The risk assessments matrix above is a combination of the consequences for an infrastructure and the probability of the occurrence magnitude of, e.g., a hydro-meteorological extreme event, which determines the level of risk. Dependent on the agreed level of risk-tolerance, the matrix provides information whether any action to reduce the risk is necessary as well as the urgency of action. Green, in this case as in most cases would mean that no action is necessary, whereas red indicates the need for urgent action. Floods e.g. have the potential of devastating effects on the coast as well as coastal protection infrastructure. In the worst case, floods are destroying dykes and accompanying structures, as well as parts of the hinterland. Hence, floods rank high with regard to consequences. However, the probability of such an event occurring and exceeding the level of coastal protection is low (green or yellow in the matrix), given that the coastal protection infrastructure is designed according to the current level of risk. This might change due to climate change. Climate change may increase the probability of occurrence of an extreme flooding event significantly, as it leads to increases in frequency, intensity and persistence of hydro-meteorological extremes. This pushes the risk to the right of the matrix and makes urgent action necessary. Only via implementing appropriate adaptation measures, the risk can be reduced to an acceptable level.

As mentioned, the DST already includes a basic risk analysis. However, to make sure the coastal protection measures designed using it ensure the maintenance of a desired risk level over time, it is necessary to accompany the analysis covered by the tool with a climate risk analysis or to update the risk information included in the DST regularly. In addition to including the climate-related risks still missing from the tool, it would also benefit from incorporating the influence of climate change on the risks already covered. Moreover, other factors determining vulnerability also change over time, such as settlements and economic activity in coastal areas. To be able to project climate risk into the future, predictions on their future development also need to be incorporated.

After the identification of the relevant risks comes the selection of appropriate adaptation options. The steps 3 and 4 of the climate-proofing process are not part of the DST. Adaptation options are pre-set, hence, a multi criteria analysis to select and prioritise eligible adaptation options based on criteria such as effectiveness, feasibility, social equity and efficiency, is not included. While providing the benefit of simplifying decision-making concerning coastal protection, this comes at the cost of not including more-recent innovative and potentially cost-saving solutions in coastal protection technology into design decisions. To avoid this, it would be important to regularly update the options offered by the DST based on technological progress.

While skipping steps 3 and 4, the DST includes step 5 of the climate proofing process, selecting the adaptation option via cost benefit analysis. Here, the DST compares the cost-benefit ratio for different alternatives for coastal protection, each comprising of different combinations of elements (i.e. dykes with hard and soft revetments, concrete and wooden breakwaters, different width, etc.) which in turn depend on location specifics, such as mangrove width. This is another area, where the DST and coastal protection planning in general would greatly profit by incorporating climate change considerations in their cost benefit considerations. Why this is the case is illustrated in the figures 8 to 10. Figure 8 highlighs the flow of social cost and benefits of coastal protection. The benefits include, as with the DST, the benefits of flood protection (avoided loss of life, costs avoided for disaster response and recovery, higher values of assets protected, losses avoided due to disruption of economic activities, etc.), of erosion, production and carbon sequestration by mangroves, etc.. Estimation of all these benefits is difficult even with good data availability. However, the lack of data on the variables for flood-protection benefits means that currently the DST does not provide a realistic cost-benefit ratio, severely hampering the explanatory power of its cost-benefit analysis.

It becomes even more difficult when considering climate change. Climate change, with a rising sea level and changes in the patterns of extreme events, leads to an increase in the probability of an event overwhelming the capacity of coastal protection, increasing the risk of flooding over time. With increasing risk, benefits of coastal protection such as higher asset prices and encouragement of economic activities decline. What the DST already takes into account is that throughout the lifetime of coastal protection measures, extreme events do occur which require the rebuilding or repairing of coastal protection measures (shown by the gap in figure 8). If the coastal protection infrastructure is destroyed, benefits are lost until it is completely recovered. This recovery leads to additional costs (CERR). However, due to climate change, the probability of these events occurring rises leading to, on average, a more frequent necessity for repairs and consequently higher expected costs.

Figures 9 and 10 show how the consideration of climate information can improve the cost-benefit flows for coastal protection. If climate information is used in order to design coastal protection in a fashion that ensures a continuous level of safety (in most cases not completely precluding the possibility of flooding), not only are the cost for reconstruction saved but the benefits of flood protection remain constant. Figure 10 shows the marginal social cost and benefit flows. Even though the figures suggest higher investment cost, for an inefficient BAU scenario an increase in protection may also be achieved without additional cost. In addition to strengthening resilience, this can have huge budgetary implications . An important caveat for the cost benefit considerations is that they are all based on the assumption that a regular regime of operation and maintenance (O & M) is maintained, as otherwise even a climate-proof initial design may erode in its protection properties over time. Consequently, the cost for O & M need to be budgeted as well as contingencies to cover any recovery costs for the future, as a safety level of 100% is rarely achieved and even more rarely cost-efficient.

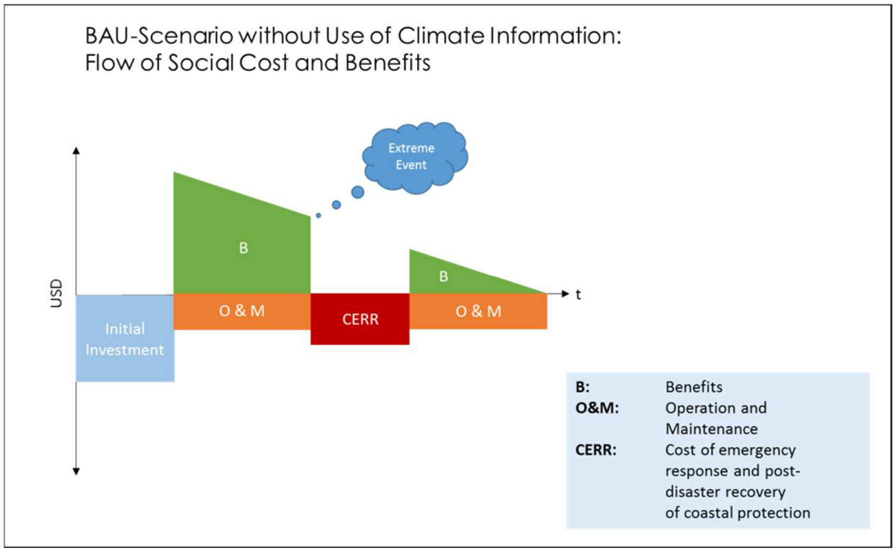


*Figure 4: Cost-benefit flow over time for BAU scenario (Source: Author's figure; c.f. SNIP Perú (2013))*

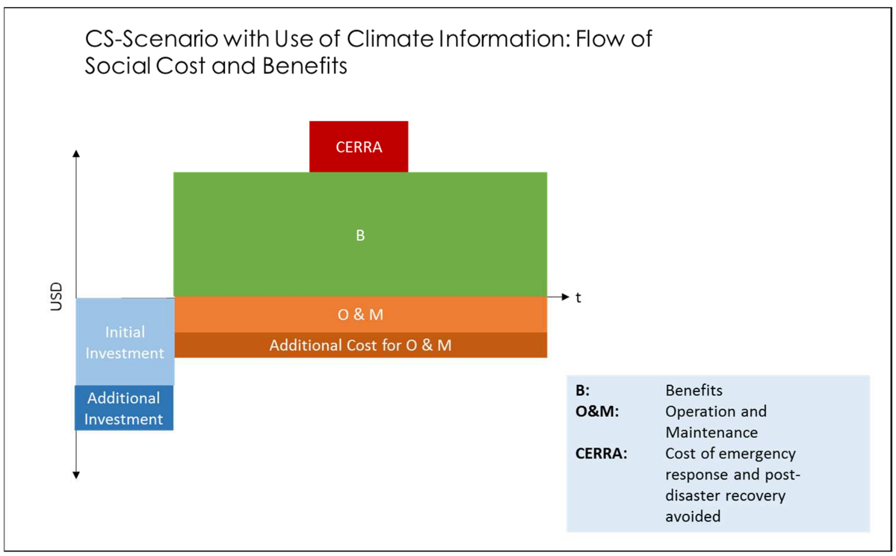


*Figure 5: Cost-benefit flow for climate-risk-informed planning (Source: Author's figure; c.f. SNIP Perú (2013))*

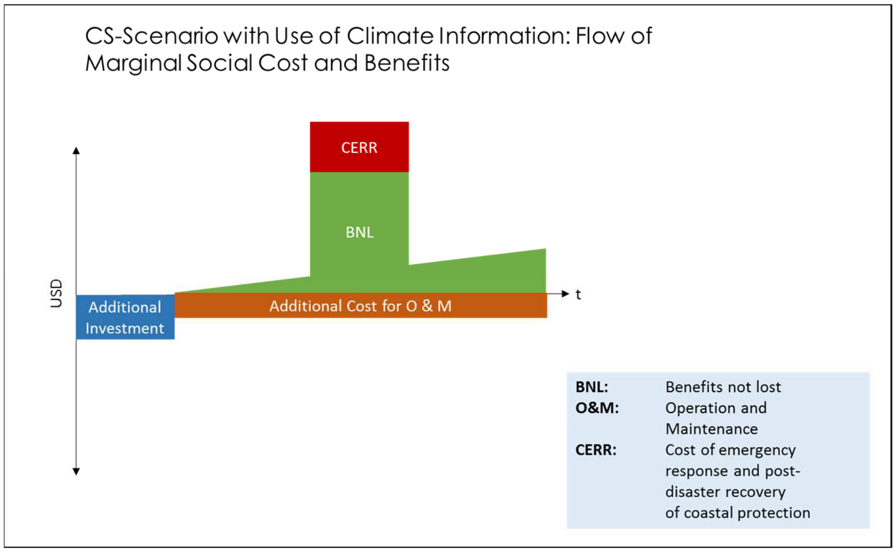


*Figure 6: Cost-benefit flow of marginal social cost and benefits for climate-risk-informed planning (Source: Author's figure; c.f. SNIP Perú (2013))*

In general, cost-benefit analysis is an important tool for ensuring expenses for coastal protection are spend efficiently. It is important to have it as part of the DST, even given the limitations mentioned above. However, to ensure the efficiency of spending of public budget on coastal protection, it is important not to limit cost-benefit-comparisons to coastal protection measures on single sections of the coast, but rather to apply an integrated approach that considers the whole coast. If the cost-benefit ratios of different sections of the coast are compared (given that all relevant cost and benefits are properly estimated), cost-benefit allows to prioritize spending. This way, a given budget for coastal protection can achieve the maximum possible amount of resilience. Considerations of this kind should be part of a future integrated Coastal Protection Plan.

## 4. Conclusion

### Feedback loops to adjust planning procedures – a change process

As was shown above, climate information and products are indispensable for sustainable and efficient coastal protection planning. Even though it makes the planning more complicated, it is the only way of ensuring a constant level of protection.

The DST incorporates basic climate-proofing principles is already a first step to simplifying decision-making for coastal protection. As such, it is also providing an essential contribution for the coherence between climate policies (such as NDC and NAP) and (local) implementation. A further incorporation of the outlined Climate Services would enrich the tool and to ensuring the resilience of Vietnam's coastal areas. This requires a joint effort in an iterative, multi-stakeholder process involving all actors along the Climate-Service value chain in Vietnam in order to make it easier for coastal protection planners to translate information on climate change and other relevant variables into their designs and strategic planning. Thereby, it can be guaranteed that the most recent information on changing risks and innovations in coastal protection is utilized.

For the CPP as a whole, the integration of climate-change considerations is necessary for making it a valuable strategy or sector plan for medium and long-term horizons. As coastal protection makes up a substantial share of public spending, it is vital to make it climate proof. A climate-proof CPP can also help to inform budgetary planning, thereby ensuring sufficient funding for future adaptation and avoiding future loss and damage. This way, it can also serve the implementation of national strategies on climate change adaptation, such as the NDC and the future NAP at the provincial level or Mekong Delta regional level.

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