Task 1.3 Assess risks and capabilities

Task 1.3.1 Assess climate risks

What is this task about?

This task is about gaining a clear understanding of the current and future climate risks that are most relevant for your region. For those hazards identified in your initial baseline analysis of adaptation and resilience needs (Task 1.1.1), a more rigorous Climate Risk Assessment (CRA) is conducted according to your *primary adaptation objectives* specified during Task 1.1.2. Assessing climate risks essentially consists of three main steps:

1. **Risk identification:** to ascertain the most relevant current and future climate hazards, impacts and risks to be the subject of further analysis.
2. **Risk analysis:** to analyse the interrelated determinants (hazard, exposure, vulnerability) of the identified risks and impacts on relevant key community systems (identified in Task 1.2.1). The aim is to improve understanding of: (i) the complex nature of risks and their associated interdependencies and **cascading impacts**, (ii) how these risks may evolve in time, and (iii) potential opportunities to most effectively intervene to mitigate risks.

Insight: When performing this task, it is already useful to start thinking about the types of adaptation strategies and options you may wish to later assess, as this may influence the design of your Climate Risk Assessment methodology. Ideally, you will assess their performance using the same methodologies and tools as for the CRA, however this may be difficult (especially) for non-structural measures.

3. **Risk evaluation:** to prioritise climate risks based on their urgency, severity, and local **capacity** to adapt or respond.

A number of associated activities are required to progress through these steps, including:

- Determining a fit-for-purpose risk assessment methodology
- Additional data collection and/or generation
- Specifying climate risk scenarios

Why is it important?

You need a comprehensive assessment of current and potential future climate risks, system vulnerabilities, and opportunities to build a shared vision and develop pathways towards your region's climate resilient future. The Climate Risk Assessment (CRA) provides essential risk information upon which to formulate your region's Climate Resilience Strategy. It provides you with rich information on the magnitude, frequency, and likelihood of any climate risks and impacts presently being experienced in your region, as well as plausible projections on how these may develop due to climate change. The CRA is crucial for identifying people, areas, sectors, and communities most vulnerable to current and future climate change impacts. It guides adaptation strategies and climate risk management practices toward the most pressing risks—those with the greatest potential for severe and likely adverse outcomes.

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Explainer: Adaptation limits or thresholds

Adaptation limits (or thresholds, or tipping points; Kwadijk et al., 2010) mark the point at which existing systems or adaptation measures can no longer meet their primary adaptation objectives and are considered to have 'failed.' For example, a flood protection dike may fail once water levels exceed its height, requiring further adaptation (e.g., raising the dike). These limits guide planners in maintaining system performance until new limits are reached.

When considering adaptation limits, distinction is drawn between hard and soft limits:

- Hard limits are physical constraints, like the maximum discharge capacity of a dam.
- Soft limits are value-based and subjective, such as the acceptable number of flood evacuations or tolerable flood damage. Soft limits are dynamic and can change over time as societal views evolve, requiring planners to stay responsive to shifting perceptions as this can serve to shift how adaptation challenges are viewed and affect the (future) success of any climate resilient strategies.

Adaptation limits shift the focus from planning for and reacting to specific risks to anticipating the conditions under which adaptation measures will fail. Such an approach reflects the uncertainty surrounding future conditions, and that these will likely differ to those foreseen in any specific scenario. The approach therefore renders risk analyses scenario independent.

Adaptation limits also serve as the basis for formulating adaptation pathways to address risks as conditions change (Task 3.2.1; Haasnoot et al., 2013). The approach helps planners adapt strategies as future scenarios (e.g. sea level rise or urbanisation) unfold. It allows for flexible, proactive planning by adjusting the timing of adaptation efforts without needing to redo risk assessments or formulate completely new strategies, thereby ensuring resilience across a range of plausible futures.

Further reading

Kwadijk, J. C. J., Haasnoot, M., Mulder, J. P. M., Hoogvliet, M., Jeuken, A., van der Krogt, R., et al. (2010). Using adaptation tipping points to prepare for climate change and sea level rise: A case study in the Netherlands. Wiley Interdisciplinary Review Climate Change, 1(5), 729–740. https://doi.org/10.1002/wcc.64.

Haasnoot, M, Kwakkel, JH, Walker, WE, ter Maat, J (2013). Dynamic adaptive policy pathways: A method for crafting robust decisions for a deeply uncertain world, Global Environmental Change, 23 (2), 485-498. https://doi.org/10.1016/j.gloenvcha.2012.12.006

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The CRA explains how any single climate hazard impacts the relevant key community systems in your region differently, and how these systems may be subjected to multiple climate hazards that interact, compound, or cascade. Understanding how climate risks vary over time and space, and how they propagate, can help you and your stakeholders strengthen your system understanding (Task 1.2.1); identify your most affected stakeholders (Task 1.2.2); and identify and choose effective adaptation measures (Task 3.1). The CRA can also reveal opportunities where adaptation efforts will deliver multiple benefits, leveraging points to build effective climate resilience while also considering wider impacts.

How can you complete it?

To assess your climate risks, you need to step through three risk assessment phases, supported by three associated activities. Complete each of the three phases as follows:

- **Risk identification:** With reference to your problem framing (Task 1.1.2), supplement the information contained within the initial baseline analysis (Task 1.1.1) with additional existing knowledge (e.g., hazard event databases, previous risk and vulnerability studies, expert and stakeholder input, etc.). Identify the most relevant hazards, impacts and risks to assess in the CRA. Consider both current and potential future risks when identifying those to be assessed.
- **Risk analysis:** Analyse current and future climate risks according to the specified CRA methodology (see below). Assess risks and their evolution in time using climate hazard, exposure and vulnerability data. Apply scenarios to determine the range of potential impacts that may be experienced depending on the conditions that emerge. Be sure to consider any integrated system interactions and interdependencies across the affected key community systems, and especially how risks and impacts can propagate through the systems. Where possible, and with reference to your scenario analyses, identify the conditions (and timing) when acceptable risk thresholds or adaptation limits are reached within any key community systems, such that (further) adaptation is required. Begin also to identify any opportunities to most effectively mitigate risks by addressing hazards, exposure or vulnerability.
- **Risk evaluation:** Evaluate the analysed risks according to their impacts and likelihood, as well as aspects such as their frequency and urgency (timing), your region's local **adaptive capacity** (tolerance), and preferences (risk perception).

Associated activities can be completed as follows:

- **Formulate risk assessment methodology:** Establish how you will undertake your climate risk assessment. CRAs can be undertaken according to one of three general assessment approaches: ***quantitative***, ***semi-quantitative***, or ***qualitative***. The selection of the approach largely depends on:
  - the level of detail required for the assessment
  - the availability of data and applicability of tools to inform the assessment
  - the resources available to conduct the assessment.

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- **(Supplementary) data collection/generation:** Collect and/or generate additional data according to the specified risk assessment methodology. Revise this methodology and/or problem framing if the necessary information cannot be collected/generated.
- **Scenario formulation:** From the system mapping (Task 1.2.1), prioritise the set of (uncertain) climate and socioeconomic drivers of risk. Use projections for these drivers to specify plausible sets of future conditions against which to assess climate risks and formulate your Climate Resilience Strategy.

External stakeholders, identified through the stakeholder mapping in Task 1.2.2, likely hold valuable knowledge for risk assessment activities such as data collection, scenario formulation, and impact validation. Determine their involvement based on their potential contributions. Data partners should be engaged early on (as part of Task 1.1.1), while stakeholders with unique insights or specific expertise should be consulted at key moments, such as during the refinement and validation of the risk evaluation phase.

Further detailed technical guidance on completing this task, along with useful tools and methods can be found in ***Appendix D6.***

Food for thought: You will likely need to adapt your Climate Risk Assessment methodology to the capabilities of presently available resources, tools, methods, data in your region, and to the level of analytical depth required for decision-making. Use this opportunity to also identify any gaps and areas in which to develop or enhance knowledge and data practices in the future.

What are key inputs for the task?

- **Initial evidence base of potential climate hazards (Task 1.1.1)**
- **Problem framing set of planning objectives and indicators (metrics) of system performance (from Task 1.1.2)**
- **Understanding of integrated system functions, including interactions and interdependencies (from Task 1.2.1)**

Note that during your risk assessment activities, any or all of the above inputs may need further refinement through additional iterations.

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What are the expected outputs?

The key output from this task is the Climate Risk Assessment (CRA), which will provide you with an overview of current and future climate risks for your region to which you may need to adapt. These should be expressed in terms of the specified primary adaptation objectives and associated metrics defined during the problem framing (Task 1.1.2). You should also gain an appreciation for any system performance thresholds or adaptation limits according to these criteria that may be encountered in the future. The CRA may take the form of a formal independent report, which will directly inform the respective chapter of the Climate Resilience Strategy.

Before moving on, have you...

- [ ] Developed a risk assessment methodology tailored to the decision and aligned with the anticipated outcomes?
- [ ] Collected, organised and analysed your climate risk information?
- [ ] Formulated a set of future plausible climate risk scenarios?
- [ ] Assessed and prioritised your current and future regional climate risks across KCS?
- [ ] Consulted relevant stakeholders in the risk assessment activities (data collection, scenario formulation, impact validation, etc.)?

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How can you complete this task?

Risk assessments are essentially conducted in three phases (see Figure D6.1): risk identification, risk analysis, and risk evaluation. Each of these three phases can be completed as follows:

Risk Assessment

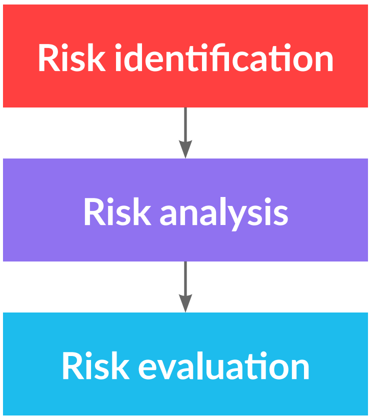

Figure D6.1: Three phases of risk assessment.

Risk identification:

With reference to your problem framing (Task 1.1.2), supplement the information contained within the initial baseline analysis (Task 1.1.1) with additional existing knowledge (e.g., hazard event databases, previous risk and vulnerability studies, expert and stakeholder input, etc.). Identify the most relevant hazards, impacts and risks to assess in the CRA. Consider both current and potential future risks when identifying those to be assessed.

> **Food for thought:** Consider engaging a suitably skilled consultant to assist you in this work if you do not have the necessary technical skills to undertake this task yourself.

Risk analysis:

Analyse current and future climate risks according to the specified CRA methodology (i.e. qualitative, semi-quantitative, quantitative, see below). Analyse current and future climate risks according to the specified CRA methodology (see below). Assess risks and their evolution in time using climate hazard, exposure and vulnerability data. Apply scenarios to determine the range of potential impacts that may be experienced depending on the conditions that emerge.

Establish adaptation limits

The evolution of risk through time is an important element to consider in adaptation planning as it is from this basis that adaptation pathways are formulated in Task 3.2.1. Here, applying the concept of adaptation limits or thresholds (see explainer in main guidance) is important to determine when further adaptation will be required as conditions continue to change. Establishing the conditions and (indicative) timings for these limits within both your existing regional system (as well as with various adaptation options implemented, in Task 3.2.1) therefore serves as an important component to your risk analysis.

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Adaptation limits are established depending on the CRA methodology being applied (see below). In more qualitative and semi-quantitative assessments, these can simply be estimated in terms of when risk impacts will be expected to exceed a specified narrative-based threshold (e.g. tropical night-time temperatures occurring 10 times per year), while in more quantitative assessments, such conditions can be calculated through interpolation or stress-testing methodologies.

Figure D6.2 **illustrates two examples of quantitative analyses to establish adaptation limits for coastal flood risks. The first (a) considers a single uncertain risk driver (sea level rise), while the second (b) presents the relationship between two risk drivers (population growth and sea level rise) in the form of a response surface generated through modelling. The question you are trying to answer with these analyses is, "under what conditions will my system no longer perform acceptably?"**

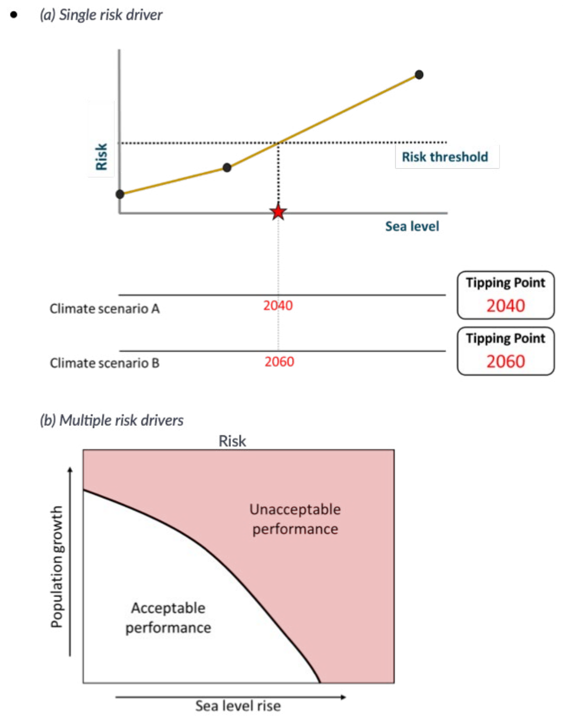

Figure D6.2: Analyses to establish adaptation limits (or tipping points). *(a) Single risk driver: coastal flood risk (green line) increases as sea levels rise, the red star indicates the (interpolated) point at which the adaptation limit is reached, and when risks begin to exceed the acceptable threshold. Scenarios can then used to determine indicative timings for this limit being reached. (b) Impacts from multiple (two) risk drivers expressed as a response surface: risk increases as population grows and sea levels rise. The response surface is generated by systematically modelling multiple combinations of the risk drivers against a specified impact indicator. The black line indicates the sets of conditions that yield the adaption limit, beyond which further increases lead to unacceptable performance. Multiple scenarios can then be overlaid onto the surface (not shown) at different time steps to determine when the adaptation limit may be breached. (Adapted from source: ADB, 2021)*

Consider system interactions and cascading risk impacts.

When analysing your drivers of risks, also be sure to take into account any integrated system interactions and interdependencies across the affected KCS, and especially how risks and impacts can propagate through the systems. These may amplify, trigger or otherwise exacerbate impacts. For example, extreme precipitation may directly yield flood damages, but it may also cause associated landslides that further increase the economic losses experienced. Failing to account for these effects could mean that unacceptable adaptation limits are breached much earlier than expected by the climate resilience strategy.

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Risk evaluation:

Evaluate the analysed risks according to aspects such as their urgency (timing), severity (significance of impacts in the local context), your region's local absorptive and adaptive capacity (tolerance), and preferences (risk perception). Risks can either be evaluated using qualitative or semi-quantitative risk matrices (see below), or directly through comparative evaluation of relevant calculated quantitative risk indicators (established via, e.g., modelling).

Insight: Make sure that your risk assessment methodology will deliver the necessary information on your specific primary adaptation objectives per your problem framing. Keep in mind that ideally you will assess the adaptation effectiveness of adaptation options during Task 3.2.1 using the same assessment methodology.

The three additional risk assessment activities associated with the preceding three phases can be completed as follows:

- Formulate risk assessment methodology: Establish how you will undertake your climate risk assessment. CRAs can be undertaken according to one of three general approaches: ***qualitative, semi-quantitative, or quantitative.*** The selection of the approach largely depends on:
  - the level of detail required for the assessment
  - the availability of data to inform the assessment
  - the resources available to conduct the assessment.

Each of these sets of approaches differ in the type of information they generate and their ability to be spatially explicit regarding risk impacts (see Figure D6.3). In addition to the three 'pure' approaches, hybrid approaches towards risk assessment are also possible, depending on the type of outputs (e.g. indicators) needed to inform decision making, and the capabilities to generate these qualitatively, semi-quantitatively, or quantitatively. The following paragraphs outline some of the key features, advantages and limitations of the three approaches.

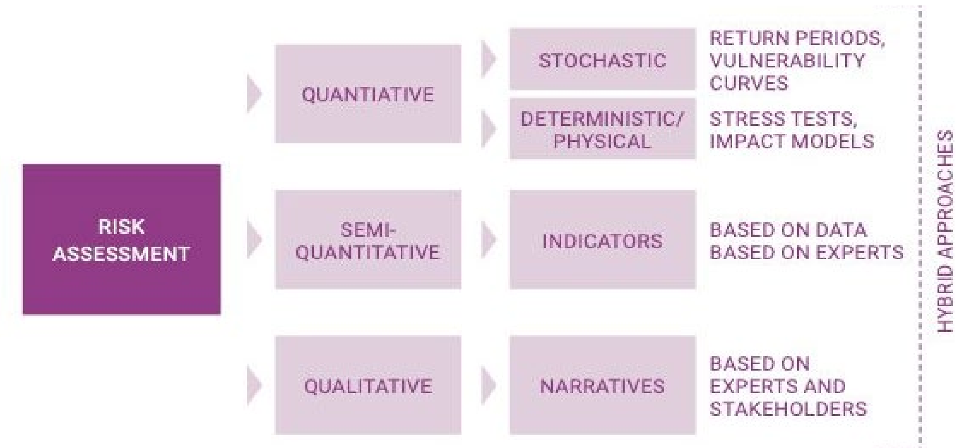

Figure D6.3: General approaches to assessing risks associated with climate change, the type of information these generate, and the information upon which they are based. Source: Technical guidance on comprehensive risk assessment and planning in the context of climate change

D6. Task 1.3.1 Assess climate risks – Technical guidance on how to complete

Qualitative approaches

Qualitative approaches are particularly useful in instances when knowledge about the risk to be assessed in limited or the available information is scarce. These are usually based upon expert knowledge and/or the inclusion of stakeholder-derived-information about risks that is organised into more narrative descriptions. Qualitative risk assessments usually evaluate risks using risk matrices (see Figure D6.4), in which one axis represents the likelihood of a hazard occurring and the other axis represents the magnitude of the consequences. Evaluating qualitative risk analyses are relatively straightforward as they do not require the precise (quantitative) definition of threats, but rather analyse these based upon general identified trends. Stakeholder participation in these processes and the inclusion of their (competing) knowledge and values is essential.

LIKELIHOOD	CONSEQUENCES				
	Insignificant	Minor	Moderate	Major	Severe
Almost Certain	M	H	H	E	E
Likely	M	M	H	H	E
Possible	L	M	M	H	E
Unlikely	L	M	M	M	H
Rare	L	L	M	M	H

Figure D6.4: Qualitative risk matrix. In this example, L: Low, M: Medium, H: High, E: Extreme (Source: DRMKC, 2017)

Semi-quantitative approaches

Semi-quantitative approaches are similarly useful in instances when there is insufficient knowledge, data or resources available to conduct a fully quantitative modelling assessment. Evaluations for these typically elaborate qualitative risk matrices by applying a scoring system to assess the relative severities of risk consequences and likelihoods (i.e. risk level = impact x likelihood). This provides a more structured and nuanced analysis compared to purely qualitative methods. The relative scores are informed by a mix of quantitative and qualitative indicators characterising the risk components (hazard, exposure, vulnerability), with risk analyses for these and the ensuing impacts derived from available data sources, modelling studies, or expert knowledge (see Figure D6.4). Typically, information on the spatial aspects of risk is available in these types of analyses, such that hazard effects can also be mapped and analysed within Geographical Information Systems (GIS).

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(a) Likelihood scale

1 - Very unlikely	2 - Unlikely	3 - Moderately likely	4 - Likely	5 - Very likely
<10%	10-33%	34-66%	67-90%	>90%
The event has a remote chance of occurring in the current year. e.g. seasonal hazards that have happened once in the last 20 years.	The event has a low chance of occurring in the current year. e.g. seasonal hazards that have happened one to three times in the last 20 years.	The event has a viable chance of arising in the current year. e.g. seasonal hazards that have happened three to five times in the last ten years.	The event has a significant chance of arising in the current year. e.g. seasonal hazards that have happened every second or third year.	The event is almost certain to arise. e.g. seasonal hazards that have happened every year in the last five years.

(b) Impact scale

1 - Negligible	2 - Minor	3 - Moderate	4 - Severe	5 - Critical
Minor additional humanitarian impact, 10,000-50,000 people affected. Government capacity is sufficient to deal with the situation.	Minor additional humanitarian impact, 50,000-100,000 people affected. Current country level inter-agency resources sufficient to cover needs beyond government capability.	Moderate additional humanitarian impact, 100,000-250,000 people affected. New resources up to 30 per cent of current operations needed to cover needs beyond government capacity. Regional support not required.	Substantive additional humanitarian impact, 250,000-500,000 people affected. New resources up to 50 per cent of current operations needed to cover needs beyond government capacity. Regional support required.	Massive additional humanitarian impact, >500,000 people affected. New resources over 80 per cent of current operations needed to cover needs beyond government capacity. L3- scale emergency.

(c) Risk matrix

Likelihood \ Impact	1 - Negligible	2 - Minor	3 - Moderate	4 - Severe	5 - Critical
5 - Very likely	5	10	15	20	25
4 - Likely	4	8	12	16	20
3 - Moderately likely	3	6	9	12	15
2 - Unlikely	2	4	6	8	10
1 - Very unlikely	1	2	3	4	5

Figure D6.5: Semi-quantitative risk assessment (a) likelihood scale, (b) impact scale, and (c) risk matrix, in which Risk score = Impact x Likelihood (Adapted from source: UNDRR, 2023)

Insight: In quantitative assessments, formulate a modelling approach that applies tools relevant to the climate hazards and KCS under consideration, e.g. for a flood risk analysis, use a suitable flood impact assessment tool.

Quantitative approaches

Fully quantitative approaches involve the application of mathematical models (e.g. climatic, hydrodynamic, ecological, impact functions, etc.) that are more or less complex but generally require a medium to high level of technical specialisation. These types of approaches rely upon the availability of detailed quantitative data to serve as inputs to the (often multiple) computational models used, which can be derived from local monitoring (preferred), global databases (e.g. populated via remote sensing), and/or climate and socioeconomic projections. Similarly, suitably qualified technical experts are needed to build, run, calibrate and analyse the models. These types of assessments provide the most precise estimates of risk impacts, insofar are they are capable of yielding spatially explicit, detailed results on the different biophysical and/or socioeconomic variables of concern. Model results can either be stochastic and expressed statistically (e.g., through return periods, vulnerability curves), or deterministically calculated from, e.g., stress tests and/or impact models.

D6. Task 1.3.1 Assess climate risks – Technical guidance on how to complete

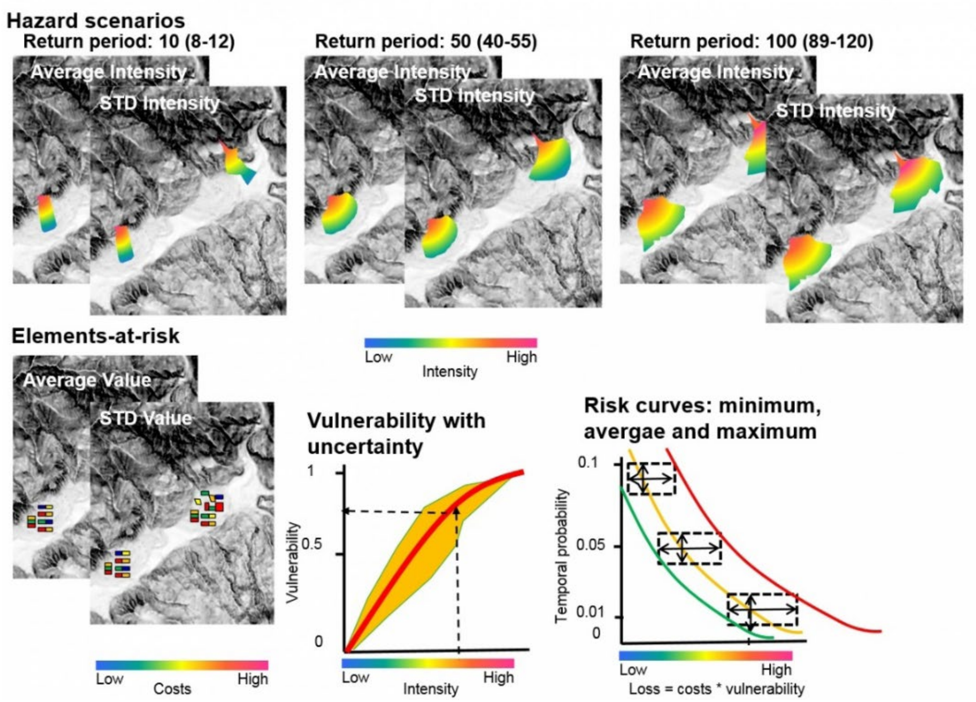

Figure D6.6: Quantitative (stochastic) risk analysis incorporating uncertainty in future hazard, exposure and vulnerability projections (Source: CEDMA, 2024)

Table D6.1 summarises some of the key differentiating features of the three approaches.

Table D6.1: Differentiating features of qualitative, semi-quantitative and quantitative risk assessments

	Qualitative	Semi-quantitative	Quantitative
Data collection	• Expert knowledge • Stakeholder interviews, focus groups, etc.	• Available data (reports, previous studies, modelling) • Expert knowledge	• Extensive data collection from monitoring and/or local/global databases for all modelling inputs
Spatial explicitness	• None	• Results can often be mapped	• Mapped with high precision
Reliability	• Dependent upon participating expertise	• Precision of results dependent upon level of detail of the available data and resulting analysis	• Numerical risk results often more objective, reliable and detailed. Level of precision dependent upon the resolution of the available data and modelling
Stakeholder participation	• Essential to incorporate and rationalise breadth of competing perspectives of risk	• Essential for validation of inputs and results, and especially for selecting, scaling and aggregating indicators	• Important for validation of input data sources and results

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Table D6.2 summarises the key advantages and limitations of the three types of approaches.

Table D6.2: Summary of advantages and limitations of qualitative, semi-quantitative and quantitative risk assessments

	Advantages	Limitations
Qualitative	• Flexible approach to risk assessment when knowledge and data availability and capacity are limited • Permits the incorporation of diverse qualitative information and local knowledge that may be highly relevant in certain contexts	• More subjective assessment given the possible incorporation of biases into the analysis • Inability to replicate results with different sets of experts/stakeholders • Impossibility of comparing results across different study areas
Semi-quantitative	• Ability to combine data from heterogeneous sources • Ability to combine both qualitative and quantitative information • Does not have to rely upon knowledge of empirical relationships between system variables • Permits objective, replicable assessments (subject to scaling and aggregation choices)	• Potential introduction of biases when selecting, scaling and aggregating indicators. Transparency for stakeholders surrounding these choices is paramount • Results often translated into categories (e.g., very low à very high), which do not allow for comparison of results between different study areas
Quantitative	• Robust modelling software has been developed for many problem domains in KCS (e.g. flood risk management) • These assessments tend to be more objective and replicable, and can help to resolve disagreements over drivers of risk impacts • Ability to compare results with other study areas	• Demand detailed technical understanding of variables and their relationships that influence the system: hazards, exposure and vulnerability and their evolution, as well as models to model these • Demand large amounts of data to feed these analyses (e.g. climate projections, biophysical data, socioeconomic data) • Provide a 'false' sense of certainty about the results, which is dependent on the quality of the input data and system model developed

(Supplementary) data collection/generation:

Collect and/or generate additional data necessary for the risk assessment according to whether a qualitative, semi-quantitative or quantitative assessment is being carried out. Qualitative data can come either from expert elicitation and/or social science research (e.g. interviews, surveys, focus group discussions). More quantitative data for modelling assessments can be drawn from European data repositories: e.g., Copernicus, CLIMAAX toolkit (if available), national or regional data repositories, etc. (refer to Task 1.1.1 for more information). Organise your data in a suitable database or information system. Revise your risk assessment methodology and/or problem framing if the necessary information cannot be collected/generated.

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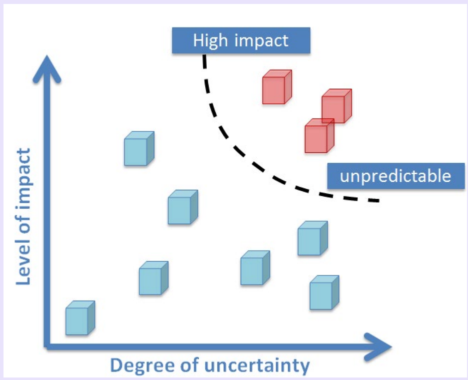
Scenario formulation:

From the system mapping (Task 1.2.1), prioritise the set of (uncertain) drivers of climate and socio-economic changes in the system (e.g. sea level rise and population growth). Do not include all potential drivers, but rather focus on those to which the system is most sensitive. Use collected data on projections for these drivers to specify plausible sets of future conditions against which to assess climate risks and to formulate your climate resilient strategy. Scenarios may be more narrative based for qualitative assessments or sets of quantitative indicators of future conditions derived from climate and socioeconomic projections.

The number of scenarios formulated depends on the CRA methodology adopted. While many scenarios can be computationally assessed in a fully quantitative assessment, it is only feasible to assess a much more limited number in qualitative and semi-quantitative assessments. Nevertheless, it is important to formulate (and analyse) multiple scenarios that cover the plausible (uncertain) range of potential future conditions such that the uncertainty surrounding these conditions can be reflected in the climate resilient strategy. This range should cover both the available historical record and any future (extreme) projections. Ideally, the scenarios should include a temporal component, such that your region's changing risks can be traced through time. This is achieved through either development of continuous scenario time series (quantitative assessments), or by formulating sets of scenario conditions at two or more specified time points in the future (all types of assessments).

Note that in quantitative assessments, it is also generally possible to incorporate many more scenario parameters into the analysis, and/or assess the impacts of multiple incremental changes in the system in the form of a stress-testing ensemble. The latter can be applied to help establish more precise conditions and timing of any adaptation limits.

Insight: Use an Uncertainty-Impact chart or matrix to prioritise your uncertain drivers from which to formulate scenarios (see figure below). Prioritise those which generate the highest impacts and are most uncertain. Make sure that your developed scenarios only include potential changes in your system lying beyond your direct control as planners. Elements within your system that you can control or manage are assessed through the later selection of appropriate adaptation options, innovation actions and their associated action planning actions.



Example Uncertainty Impact chart to prioritise risk drivers

Supporting resources: Useful tools

- Uncertainty-impact matrix
- Impact-Likelihood assessment framework
- CLIMAAX toolbox
- Urgency Scoring
- Climate impact chains