# Task 1.2 Understand the system

## Task 1.2.1 Map relevant systems

### What is this task about?

This task focuses on using systems thinking to create a shared understanding of the components and functions in your regional system that affect its climate resilience and are relevant to the problems identified in Task 1.1.2. The aim is to view the regional system as a whole, rather than as separate systems like the key community systems.

The task involves gathering and organising information on system components, functions, and characteristics into a comprehensive **systems map**. This map highlights key interactions and dependencies within and between relevant key community systems. By considering climate impact chains, you can prioritise climate hazards, their uncertain drivers, and potential risks to the key community systems. Understanding these among other system components and their relationships helps identify interactions, dependencies, feedback loops, opportunities, and barriers that affect your region's climate resilience. It also helps pinpoint system processes that can be improved by strengthening relevant key enabling conditions. The task includes the following activities:

- Identifying system boundaries
- Mapping the relevant systems
- Considering cascading effects
- Considering the role of the identified stakeholders in system functioning

**Insight:** Be aware of the continuous dialogue and feedback this task has with the parallel tasks of 1.1.1 Gather evidence, 1.1.2 Frame the problem, and 1.2.2 Identify stakeholders. As with all those tasks, the process of building your system understanding will remain a continuous process throughout the Regional Resilience Journey. The system maps you develop in this task will be subject to continuous updating and revision as new information comes to light or new insights are derived during later tasks.

Task 1.2

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### Why is it important?

Systems mapping serves to establish a common, agreed understanding of the integrated systems to be managed by the Climate Resilience Strategy. The issues you are likely to face in adapting to climate change are not straightforward; uncovering the opportunities and barriers to unlock transformative change is crucial to building resilience. Taking an integrated, whole-of-system approach helps to reveal key interdependencies between your regions' climate challenges and other social, ecological and economic functions, highlighting important trade-offs and synergies. It facilitates identification of solutions capable of addressing multiple challenges and objectives simultaneously. It maps the identified stakeholders (from Task 1.2.2) to the various system functions to help identify points of intervention for policy innovation (which will feed into task 3.2.3 on innovation actions). It also assists with distinguishing which system elements and behaviours are ripe for transformation and may benefit from strengthened key enabling conditions. Finally, it helps identify the (uncertain) drivers of changing risk, which inform the specification of risk-based scenarios against which to assess the performance of your adaptation pathways.

### How can you complete it?

**The actions described in this task are intended to be co-developed by a core group of representatives from the region, including different sectors and expertise. This group should perform the following actions during a (preferably in-person) workshop (series).**

- **Identify system boundaries:** Identify and prioritise which climate hazards, key community systems and sub-systems to include in the analysis, including all relevant system components, functions, and characteristics. Consider the integrated nature of your system and the bio-physical (e.g., geographical, environmental, infrastructural), socio-economic (e.g., demography, sectors, societal behaviours, technology) and institutional (e.g. policies, governance) aspects impacting on climate resilience.
- **Map relevant systems:** Map the identified system components, functions, and characteristics both spatially and conceptually. Consider the causal relationships present between elements (i.e. what leads to what?) to identify and highlight key system behaviours, interactions, feedback loops, barriers and enablers. Use your analysis to help identify:
    - principal uncertain drivers of risk and their associated impacts
    - how various components affect or are affected by each of the key enabling conditions
    - promising (initial) points of intervention in the system to reduce risk, unlock transformative change, innovate, and otherwise build resilience.
- **Consider cascading effects:** Do not limit your analysis to only direct effects of system elements onto other elements, but also the cascading indirect effects on elements situated further away. In particular, consider how climate hazards propagate through the system, amplifying or triggering additional processes. Also think about the potential impacts of compound or consecutive hazard events.

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- **Consider the role of the identified stakeholders in system functioning:** Building on the work undertaken in Task 1.2.2, analyse the key points of stakeholder contribution and influence on the functioning of the system.

Further detailed technical guidance on completing this task, along with useful tools and methods can be found in ***Appendix D4.***

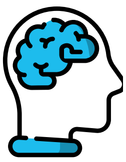
### What are key inputs for the task?

- Evidence gathered on baseline conditions in your region (Task 1.1.1)
- Problem framing (Task 1.1.2)
- Identified stakeholders to incorporate into the system map as well as to collaborate in system mapping activities (Task 1.2.2)
- Self-assessment of capabilities (Task 1.3.2)

### What are the expected outputs?

The key outputs from this task are the series of spatial and conceptual system maps that describe the complex problem context being addressed. These can be used to help communicate the common understanding of the problem to other stakeholders.

Generating these maps also helps improve system understanding, which allows the problem framing (Task 1.1.2) and stakeholder analyses (Task 1.2.2) to be further elaborated and specified. Such an improved understanding also identifies whether additional baseline evidence needs to be gathered (Task 1.1.1) and facilitates development of the risk-based scenarios for the climate risk assessment (Task 1.3.1). The system maps also serve as important inputs to Phase 2 of the Regional Resilience Journey and can be used to help elaborate possible futures (Task 2.2.1), define a shared vision (Task 2.3.1), and identify potential drivers of your region's transformation (Task 2.4.1). Finally, these maps serve to help identify points of opportunity to intervene in the system in terms of both adaptation and innovation (Tasks 3.1.1 & 3.2.3), while also illustrating the synergies and adaptation trade-offs between the key community systems under consideration.



**Food for thought:** Given the objective to establish a common, shared understanding of system behaviour, collaboration with stakeholders on the development of the systems map can be highly beneficial to avoid later disagreement and stakeholder conflict. At the very least, its core underlying assumptions will need to be validated with your stakeholders as you encounter them through the Regional Resilience Journey (particularly in Task 2.4.1, understanding how change happens).

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### Before moving on, have you...

- [ ] Developed a series of integrated system maps that describe your regional system's boundaries, components and elements, as well as their key causal relationships?
- [ ] Identified your principal (uncertain) drivers of risk and their associated direct and indirect impacts?
- [ ] Identified any opportunities and vulnerabilities in your integrated system that impact your region's climate resilience?
- [ ] Considered how the various functions in your system can be affected by the key enabling conditions?
- [ ] Identified promising points of intervention in the system to reduce risk, unlock transformative change, innovate or otherwise build resilience?
- [ ] Validated your system understanding with a core group of representatives from the region, including different sectors and expertise?

# D4. Task 1.2.1 Map relevant systems – Technical guidance on how to complete

## How can you complete this task?

### Identify system boundaries:

Identify and prioritise which climate hazards, key community systems and sub-systems to include in the analysis, including all relevant system components, functions, and characteristics. This list serves as the foundation from which you will build your systems map in the next activity. Commence by identifying the system boundaries of the key community systems being managed. The key question to answer while you are completing this activity is, 'What is important to include in the analysis of the climate risk-related problem?'

**Key considerations may include:**

- Spatial and geographical extent of the problem area potentially impacted by the climate risks.
- Temporal extent and resolution (i.e. planning time horizons) of the risk-related planning challenge.
- Relevant sectors, population centres, infrastructure, natural features for the key community systems situated within the problem area or indirectly impacted if located elsewhere.
- Key system functions, characteristics, and constraints to include in the analysis. Although not mandatory, breaking integrated systems down into constituent aspects can help in this regard. For example, you could consider each of the biophysical, socioeconomic, administrative/institutional subsystems of the key community systems in turn (as demonstrated in Table below). Alternatively, you could apply a more extensive PESTLE (Political, Economic, Social, Technological, Legal, Environmental) analysis of the key community systems. Comprehensively unpacking your systems in this way ensures that you identify the functions, characteristics and constraints across your entire system that are relevant to addressing your climate-related problems.

***Note that it is not the intention to account for every possible element and relationship present in the system, but rather prioritise these according to the core risk-related issues being addressed.***

## D4. Task 1.2.1 Map relevant systems – Technical guidance on how to complete

*Table D4.1: Example system functions, characteristics and constraints for biophysical, socioeconomic and institutional sub-systems.*

| | Biophysical | Socio-economic | Institutional |
|---|---|---|---|
| Functions | • Rainfall, river discharge<br>• Heat regulation<br>• Primary production<br>• Hazards, e.g. extreme weather, flooding, pandemic | • Water supply<br>• Flood protection<br>• Food production<br>• Energy production<br>• Tourism services<br>• Transportation<br>• Health services<br>• Recreational services, e.g. fishing, swimming, hiking<br>• Financial crisis | • Governance responsibilities<br>• Subsidies<br>• Penalties/fines<br>• Hazards, e.g. state capture, corruption |
| Characteristics | • Self-regulating<br>• Suffering scarcity or degradation | • Social values, e.g. allowable water use, transportation preferences, dietary requirements<br>• Economic dependencies, e.g. supply chains | • Hierarchies, within and between institutions<br>• Institutional dependencies, e.g. transport fines that fund road improvements |
| Constraints | • Resource availability, e.g. water, wind, soil<br>• Environmental requirements, e.g. e-flows, maintenance of biodiversity | • Demand requirements, e.g. water, energy, food, transport<br>• Minimum production limits | • Regulatory limits<br>• Jurisdictional boundaries<br>• Planning controls, zoning |

** Note that this table is to serve as inspiration only. You do not need to consider all the listed elements, but only those (and others) of relevance to your climate challenges.*

## D4. Task 1.2.1 Map relevant systems – Technical guidance on how to complete

### Map relevant systems:

Within the constraints of the identified boundary conditions, analyse and elaborate the included (sub-) systems spatially and/or conceptually. Here the aim is to generate either/both a geographical representation of the integrated system and its functions or/and an integrated conceptual model of the key processes influencing the key impacts of concern (to be expressed by the planning objective metrics to be specified in Task 1.1.2). The level of detail needed for this activity does not need to be particularly deep, but deep enough to sufficiently inform your problem framing (Task 1.1.2).

Geographical representations can be based on GIS data, land use maps, or similar (see Figure D4.1). The objective is to agree on the set of physical features and regional functions to include in your analysis. This can include both natural features and infrastructure, as well locations for any critical service facilities, economic activity centres, etc. Focus on those features which are most relevant to the climate challenge being addressed. For example, in an urban centre vulnerable to flooding, make note of any existing water courses, flood defences, as well as any critical services (energy facilities, health facilities, educational facilities, major transport routes), commercial zones, and/or vulnerable groups that may be situated in potentially vulnerable locations. Identify any interactions or interdependencies that may be present between these elements, and which may result in indirect risk impacts.

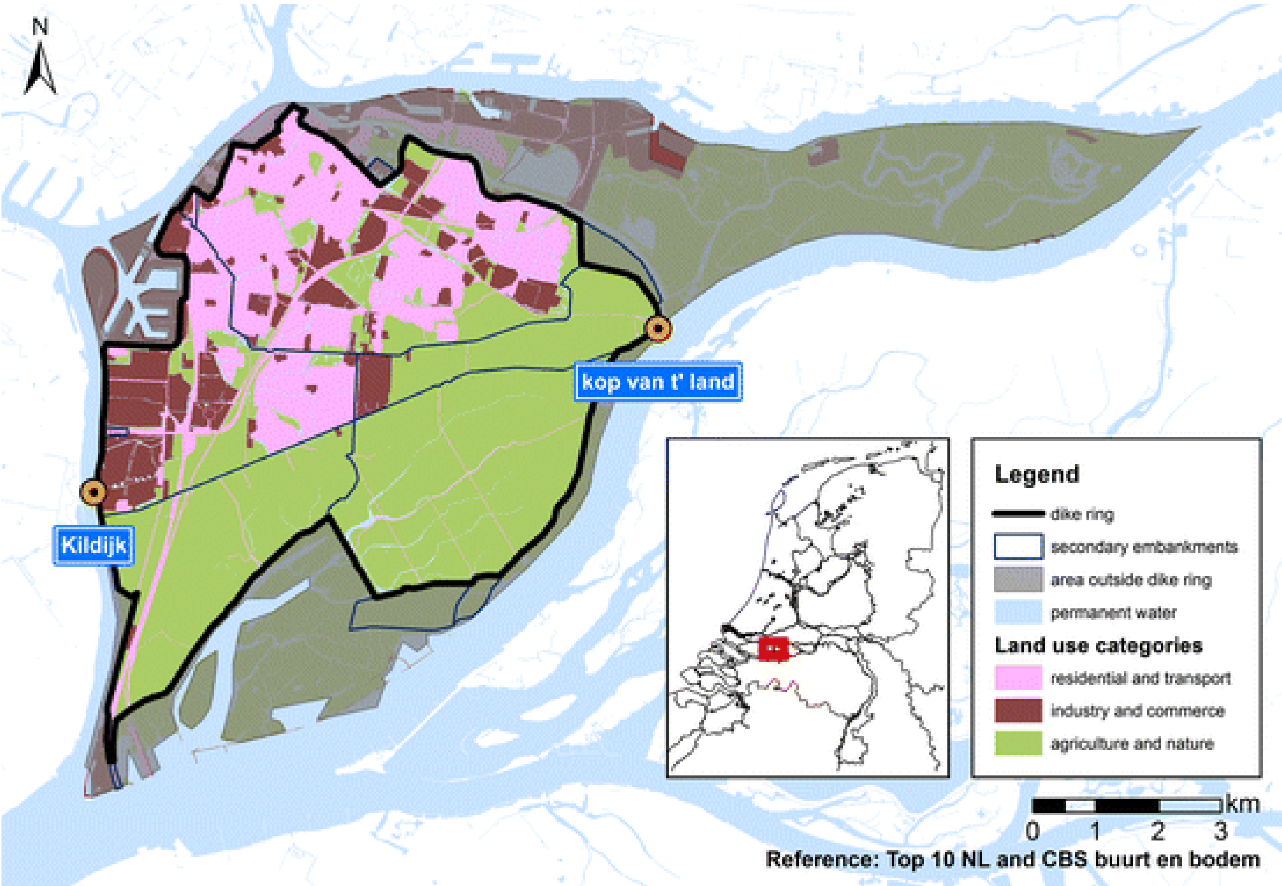


*Figure D4.1: Example geographical system map indicating land use and key flood defence infrastructure for the City of Dordrecht, Netherlands (de Bruijn et al., 2016)*

## D4. Task 1.2.1 Map relevant systems – Technical guidance on how to complete

Conceptual models can be developed through analysis of causal relationships present between the various system elements. The objective is to develop an agreed representation of how the system functions overall, which can then be later used to highlight both its vulnerabilities but also the opportunities present to transform it and improve its resilience. It is therefore important to establish both the main drivers of changes within the system as well as the principal impacts generated. Here, applying conceptual frameworks such as DPSIR (Drivers, Pressures, States, Impacts, Responses, EC, 1999, see Table  below) can help to structure your thinking in terms of upstream drivers and pressures that lead to downstream state changes and impacts in your system.

*Table D4.2: DPSIR framework for causal relationships (EC, 1999)*

| | |
|---|---|
| Drivers | Social, demographic, and economic developments which influence human activities and which directly impact the environment. |
| Pressures | Consequences of the driving force, which in turn affect the state of the environment. They are usually depicted as unwanted and negative, based on the view that any change in the environment caused by human activities is damaging and degrading. |
| States | Physical, chemical and biological conditions in the environment or observed temporal changes in the system. These may refer to natural systems (e.g.: atmospheric CO2 concentrations, temperature), socio-economic systems (e.g.: living conditions of humans, economic situations of an industry), or a combination of both (e.g.: number of tourists, size of current population). |
| Impacts | How changes in the state of the system affect human well-being. Often measured in terms of damages to the environment or human health, or by simply indicating a change in environmental parameters. |
| Responses | Actions taken to address the problems of the previous stages, by adjusting the drivers, reducing the pressure on the system, bringing the system back to its initial state, and mitigating the impacts. |

## D4. Task 1.2.1 Map relevant systems – Technical guidance on how to complete

Figure D4.2 provides a simple example of applying the DPSIR framework in the domain of flood risk management.

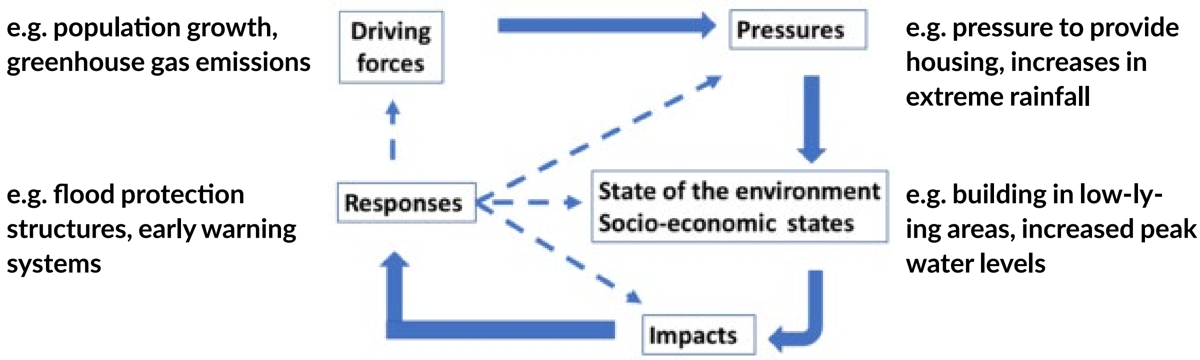


*Figure D4.2: DPSIR framework of causal relationships (EC, 1999)*

When mapping your system, be sure to identify and map all relevant processes across the integrated system, to highlight any important interactions, dependencies, barriers, obstacles and enablers present between key community systems and/or their various sub-systems. One way to visualise your systems map by way of a causal relationship diagram (see Figure D4.3). These can take the forms of chains, loops, matrices, or webs, and can be generated using a variety of available manual or digital drawing tools (e.g. whiteboards and post-its, Miro, Kumu, etc.).

As the key community systems are typically complex systems, consider analysing each of the included sub-systems individually first before exploring the interactions and interdependencies present between these. Limit your analysis to those aspects of the systems which are relevant to adapting to the risk-related challenge being confronted in your region.

## D4. Task 1.2.1 Map relevant systems – Technical guidance on how to complete

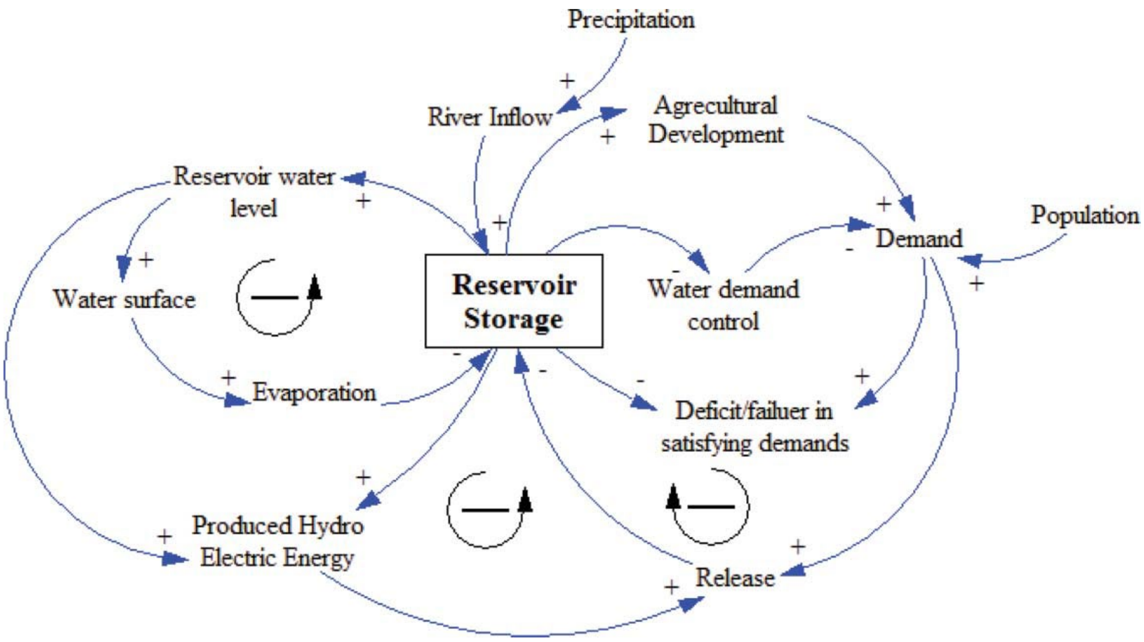


*Figure D4.3: Example causal loop diagram for water management (Source: Felfelani et al., 2013)*

### Consider cascading effects:

When mapping your systems, do not limit your analysis to only the direct effects of risk drivers and pressures. Consider also how climate hazards may indirectly propagate through the system, amplifying or triggering additional processes in other key community systems . Also think about any additional impacts that may occur during compound or consecutive hazard events. For example, heavy rainfall that causes direct flooding in an area that triggers an electrical blackout as energy facilities are inundated. Diagrammatically visualizing your system as suggested above can help to explore and illustrate these effects as well as identify additional interdependent elements impacted by the climate hazards.

### Consider the role of the identified stakeholders in system functioning:

Building on the work undertaken in Task 1.2.2, elaborate the systems maps with the key stakeholders influencing and affected by the various system elements and functions. Map their key functional relationships and dependencies in relation to the governance of the key community systems, which can then be used to identify how these may either enable or obstruct effective risk management.

### Supporting resources:

- Useful tools
- The Context map
- Toolkit for designing climate change adaptation initiatives
- Systems innovation climate toolkit
- Useful methods
- Group model building
- Collaborative (geographical) mapping
- Network analysis
- GIS-based spatial analyses