NEVERMORE

New **E**nabling **V**isions and Tools for **E**nd-use**R**s and stakeholders thanks to a common **MO**deling app**R**oach towards a Climat**E** neutral and resilient society

D2.2 Analytical framework for socio-economic factors

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Abbreviations and acronyms

Acronym	Description
WP	Work Package
D	Deliverable
SDGs	Sustainable Development Goals (UN 2015)
SJS	Safe- and just Space (Raworth 2013)
DLS	Decent living standards (Rao & Min, 2018a)
EIGE	European Institute for Gender Equality
EU-SILC	EU statistics on income and living conditions
EU-LFS	EU labour force survey
ILO	International Labour Organisation
WB WGI	World Bank World Governance Indicators
WB WDI	World Bank World Development Indicators
SI	Social Innovation
NPO	Non-profit organisation
NGO	Non-governmental organisation

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Executive Summary

This document presents an analytical framework for socio-economic factors and constitutes deliverable D2.2 of the NEVERMORE project. NEVERMORE aims to develop integrated models and tools for simulating and assessing the impacts and risks of climate change, to make mitigation and adaptation policies more effective.

Although it is mainly written with project partners in mind, it may be relevant to other modelling efforts in the area of climate change adaptation and mitigation, especially on the EU national and regional (sub-national) level.

The work done is based on the understanding that transdisciplinary research is a key requirement when it comes to investigating processes or events which themselves do not correspond to the boundaries of scientific disciplines, as is the case with climate change responses. Consequently, the research done captures inter- and transdisciplinary perspectives and follows a carefully selected mixed-methods approach of qualitative and quantitative methodologies to inform the analytical framework presented in this document.

Furthermore, the methodology is based on a comprehensive literature review drawing from psychology, sociology, and political science while considering the state of the art in climate change modelling. The literature review revealed six key themes, which in turn form the basis for this analytic framework: behavioural change, political system, resilience and vulnerability, social priorities, social provisioning, and finally, social innovation. The first of the three subsequently developed research guidelines comprise a set of 59 quantitative indicators to be included in the climate change modelling, also referencing international data sources. The second research guideline is geared towards supporting the investigation of specificities of local actors in the case studies of NEVERMORE project. It follows a decidedly qualitative and critical perspective with regard to power and agency to better understand how climate change interests are being negotiated in the target regions. Lastly, the purpose of the third research guideline is to capture social innovation activities and initiatives that already exist in the case study regions. This is mainly done to cover a bottom-up perspective. The guidelines offer three distinct strategies to collect the desired data and help the case study leaders and supporters to better understand potentials and barriers in their region and to gain a more complete picture.

In the assessment of social and behavioural aspects in existing climate change models, we briefly outline the different approaches that can be found in the scientific literature in the realm of climate change modelling. We describe two approaches in particular that are being used in the context of the NEVERMORE project. The first is WILIAM ("WIthin LImits Integrated Assessment Model") which itself is based on the System Dynamics approach but tries to alleviate some of the shortcomings of the latter, in terms of human behaviour, complexity, comprehensiveness, diversity of interests, inter-generational consequences, and damage functions. Some of WILIAM's improvements include the heterogeneity of agents in combination with high detail in the representation of economic and biophysical processes, a high level of links, feedback loops, and disaggregation. More importantly, some important social and behavioural elements have been identified that could help to improve the modelling approach that touch upon the representation of behavioural change, mitigation and adaptation policies, climate change impacts, and inequality.

The second modelling approach follows a risk assessment framework whose main strength within the context of the NEVERMORE project is that it can cover the local scale. The framework is based on the basic components of hazard, exposure, and vulnerability, as well as the key concept of resilience to climate change impacts on people, physical systems or infrastructure, and service continuity. Local scenarios will be implemented in the model on the basis of historical or current data and will deal with acceptable levels of risk and the development of interventions to increase resilience and lower vulnerabilities.

The theoretic basis for the research guidelines comprises psychological, societal, and socioeconomic factors relevant to climate change research.

- Behaviour change plays a crucial role, along the dimensions of everyday pro-environmental behaviour, environmental policy support, and environmental activism. Demographic factors pertaining to an individual or their household include, in addition to common ones like income or formal education, household size, homeownership, dwelling size, and length and area of residence, factors in society and politics. These encompass political trust or cynicism, social trust, trust in science, and political interest. Lastly, this dimension covers factors describing an individual's relationship with the environment and with climate change, such as personal norms and values, environmental norms and values, environmental identity, climate change engagement, and beliefs and knowledge around climate change and the environment, that are accompanied by risk perception and exposure and, more broadly, a person's perceived quality of life.
- Another theme is the national political system and its environmental policies and quality for the case study regions. The literature review covered a comparison of political systems and their relationship with environmental degradation and measures. Based on the results of this review, we propose the *Varieties of Democracy* and the *Environmental Democracy Index* as indicators for the modelling approaches, including the three main pillars of environmental democracy, i.e. access to information or the right to freely access information on environmental quality and problems, public participation, as it covers the right to meaningfully participate in decision-making processes regarding environmental matters, and access to justice, including the right to seek enforcement of environmental laws or compensation for harm.
- Resilience and vulnerability constitute another key theme relevant to the climate crisis. Here, we distinguish between the individual level, the household level, the community level, and the societal level. On the individual level and in relation to vulnerability, *discrimination* plays a key role; in relation to resilience, the *sense of agency*, *financial security*, as well as *access to a mobile phone and the internet* are vital. *Social capital* can be key to increasing individual and community resilience, as can the provision of infrastructure, which is why we suggest the adoption of *satisfaction with local infrastructure*. To capture the perception of whether the government cares about respondents and their confidence in public institutions, we propose *trust in institutions* as a suitable indicator.
- Another essential theme is social priorities and basic needs. Here, were largely draw on the United Nations Sustainable Development Goals, like ending poverty and hunger, achieving gender equality, or taking urgent actions to combat climate change and its impact. As indicators for social priorities, we suggest access to drinking water and safe sanitation facilities, sufficient nourishment, healthy life expectancy, and the absence of energy and financial poverty.
- In terms of social provisioning, indicators regarding sustainable communities, renewables, the share of collective transport, municipal recycling, public service quality, public health coverage, democratic quality, decent work, income equality, and gender equality have been selected as candidates to be adopted by the modelling approaches.
- Lastly, the role of social innovation in the societal transformation towards sustainable climate futures is being explored. We propose that social innovations and transformation should be investigated at different levels (micro, meso, macro), considered at different stages of development and within its context. This has big implications for the research guidelines in terms of tackling the inherent complexity.

The first research guideline is related to the assessment of the socio-economic situation and structure of the case studies. The guideline relies on a comprehensive list of indicators which can be applied to the case studies assessment either by using existing survey databases (secondary data collection) or by implementing a survey within the context of NEVERMORE (primary data collection). It also discusses how indices can be created and how they are used.

The second research guideline relates to researching a target region's configuration of stakeholders in the area of climate change. The main method employed is semi-structured interviews. The guidelines lay out how exactly those interviews can be planned and conducted and how their results can be analysed. The proposed interview guidelines have been developed and tested by ways of cognitive probing and cover several investigative dimensions, such as the general regional situation or actions and actors in the region to combat climate change.

The third research guideline is geared towards collecting data on social innovation initiatives in the case studies. Due to the complexities involved, we propose three different but complementary strategies; a) investigating regional (or national) indicators based on an existing measurement model of social innovation, b) mapping social innovation actors and initiatives, whereby the guideline outlines the mapping process, and c) an in-depth exploration of social innovation initiatives whereby the guideline show how those can be captured by ways of a collective thought process via focus groups.

The three research guidelines, based on a solid theoretical foundation, which will inform the NEVERMORE modelling efforts, constitute a comprehensive and practical guide for further research on the case studies, especially in relation to psychological, societal, and socioeconomic factors relevant for climate change.

1. Introduction

The work underlying this document has been undertaken in the context of the NEVERMORE project which aims at developing integrated models and tools for simulating and assessing the impacts and risks of climate change, to make mitigation and adaptation policies more effective.

This document comprises *Deliverable 2.2*, i.e. the **analytical framework for socio-economic factors** that is foreseen to be used as an essential input for the case study characterisation (WP6), the modelling activities going on in WP4 (WILIAM) and WP6 (damage functions), and the climate change mitigation and adaptation policy analysis in WP5.

Therefore, the primary target audience is the experts working on the respective tasks of the above-stated work packages. That said, by making this document public, our hope is that other modelling endeavours and interested readers might benefit from the substantial effort that was poured into this work by taking up some of the results and using them in their own efforts to combat climate change.

One of the key parts of this document is the presented theoretical foundation which covers the complex package of psychological, societal, and socio-economic factors that are relevant to climate change research. They are organised along six primary themes, namely behavioural change, the political system, resilience and vulnerability, social priorities and basic needs, social provisioning, as well as the role of social innovation for sustainable transformation.

These six themes are described in detail, as they need to provide a solid foundation for the research guidelines presented in subsequent chapters. Moreover, they are necessary to understand how untangling the inherent complexity of social systems can be approached. For instance, to understand behaviour change in the context of climate change, it is first necessary to realise what behaviour is and how it is determined by demographic, societal, political, and environmental factors.

The three research guidelines build on this foundation, whose goal is to guide the NEVERMORE case studies, which are representative for all major types of climate change impacts in Europe. The purpose of the guidelines is to elicit much needed data within each case study, and their focus is on a) collecting data on the local socio-economic situation, b) researching on the local configuration of stakeholders relevant for climate change, and c) collecting data on social innovation initiatives already existing each case study.

The research guidelines differ in terms of their depth, as each of them involve challenges of different scope and nature. Therefore, each of the guidelines provides means and strategies to help the targeted partner to successfully implement their research endeavour and ensure that high data quality can be attained.

Lastly, the final chapter concludes with the main results and provides selected recommendations to this document's main target audience.

2. Inter-and transdisciplinary approaches in climate change research

Inter- and transdisciplinary research is a key requirement when it comes to investigating processes or events which themselves do not correspond to the boundaries of scientific disciplines. In particular, research on grand societal challenges, with the climate crisis as a strong example thereof, requires inter- and transdisciplinary perspectives.

While a changing climate demands natural science perspectives investigating possible causes, impacts, and pathways for mitigation and adaptation, one of the largest challenges remains to change dominant and climate change inducing patterns of the ways societies use scarce resources (Overland & Sovacool, 2020). Social science perspectives, therefore, not only represent an add-on but a crucial approach in its own right to investigate dominant structures and institutions which facilitate a resource and energy-

intensive lifestyle amongst wealthy individuals and societies around the world as well as rising inequalities at a global level.

Between the 1950s and 2021 approximately only 0.12% of international funding for climate research was attributed to social science perspectives (Bohnenberger, 2022; Overland & Sovacool, 2020). While social science research in the field has tremendously grown within the last decade, economic perspectives are the dominant theoretical lens used in the social sciences. This can be related to histories of framing climate protection as technological innovations and changed market incentives (Bohnenberger, 2022; Scholtz, 2020). Social science perspectives such as sociology or psychology, however, remain underrepresented when it comes to funding until today. Evidently, social sciences can do much to improve climate change models, but it is also important not to relegate their role to the realm of solutions as it has traditionally been the case, but to also use social science perspectives for understanding the causes of the climate crisis in general (Leyshon, 2014).

A fruitful integration of multiple disciplines requires a shared metatheoretical foundation, i.e., a shared understanding of the ontologies and epistemologies at play (Kapp, 1978, p. 287). Every scientific approach has an underlying, guiding metatheoretical foundation or a pre-analytic vision in Schumpeter's terms (Costanza, 2001; Spash, 2012). This vision delineates what is from what is not (ontology) and what is knowledgeable from what is not (see Table 1). On this basis, methodology is the theory about how research can be done, given certain claims of what is (ontology) and an idea of what knowledge is possible (epistemology). Robert Costanza (2001, p. 459) considers the pre-analytic vision being "the major source of uncertainty about current environmental policies result[ing] from differences in visions and world views".

Table 1. Metatheoretical Levels.

Metatheoretical Level	Explanation
Ontology	Defines what is (entities, their relationships and possibilities)
Epistemology	Defines what can be known about the defined world
Methodology	Defines how knowledge can be gained

As Clive L. Spash (2012), Robert Costanza (2001), and many others argue, a shared pre-analytic vision and hence a shared idea of what is, what can be known and how this is to be done, is crucial for fruitful dialogue and collaboration across disciplines - specifically in the context of climate change research. Social sciences also have much to contribute regarding the definition of epistemologies and ontologies in climate change research (Skoglund, 2015). These ideas are further elaborated in Deliverable 2.1, where there is a specific section on the role of social sciences in climate change research. This section tries to answer the question *'what currently is and should be the role of social science in climate change research?'*, paying attention to challenges, power relationships in academia and insights from critical social science studies.

On this basis, we consider it crucial to outline our metatheoretical assumptions underlying this analytical framework and the selected social science indicators for the interdisciplinary NEVERMORE project.

At an ontological level, and hence at the level of what is, we embrace a vision of embeddedness. In this sense, we consider economic activities as social activities happening within society, which in turn is embedded in biophysical and physical environments (see Figure 1). This view, in turn, implies that whatever happens in the biophysical environment might influence all the other embedded systems and vice versa (Spash, 2012).

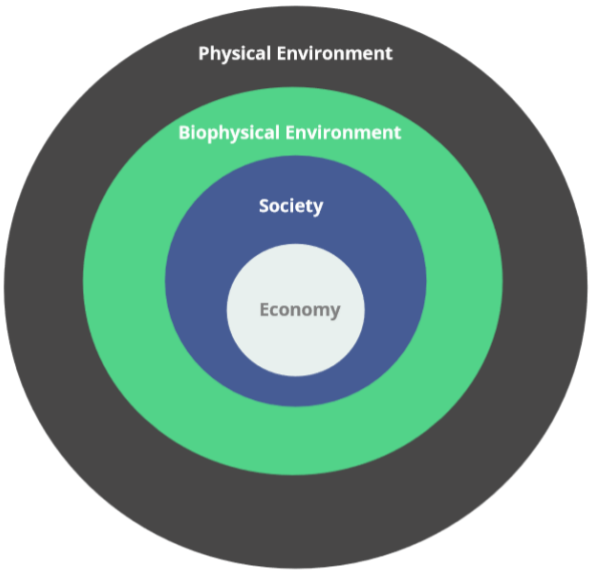

Figure 1. Ontology of hierarchical systems, design by the authors.

Such defined ontological presuppositions also bear epistemological consequences and influence the way knowledge can be gained about all domains (Pollini, 2013). Our approach is holistic in the sense that parts cannot be understood apart from their wholes, which are in themselves more than just the mere sum of parts. In this vein, our approach additionally seeks to contextualise, i.e., consider specific contexts related to time and place, rather than pursuing a one-fits-all-approach (which would be universalism). Our approach is further shaped by our own standpoint as European, white, non-disabled, middle-class social scientists.[1] On this basis, we have selected a mixed-methods approach of qualitative and quantitative methodologies to inform our analytical framework, which is described in the next section.

3. Methodology

The methodology of this report is based on a **comprehensive literature review** drawing from psychology, sociology, and political science while considering the state of the art in climate change modelling. The literature review revealed six key themes, which in turn form the basis for this analytic framework: behaviour change, political system, resilience and vulnerability, social priorities, social provisioning, and finally, social innovation. Subsequently, we developed **three research guidelines**, each designed to tap into specific aspects of the key themes, support their investigation in the context of the NEVERMORE project, and inform the modelling approaches.

For the **literature review**, we used a combination of keyword searches in research databases and expertise from the authors' previous work and research in the realm of climate change and the environment. We included peer-reviewed articles, preprints, conference contributions, and book chapters in our search and collected the literature in a shared Zotero database. Reading and analysing the literature was shared between the authors contingent on their expertise and synthesised into the six main themes presented in chapter 5.

The **first research guideline** proposes a set of 59 quantitative indicators to be included in the climate change models, which result from the literature review presented in chapter 5. This compiled list was iteratively discussed with NEVERMORE partners and revised several times to meet the project's needs

[1] For an elaboration of these premises see for example (Norgaard, 2006).

and requirements. The indicators were further linked to existing international data sources to allow their inclusion without the need for additional data collection processes.

The **second research guideline** supports investigating the locally specific contexts and different actors' perspectives on climate change and, in particular, their role in adaptation and mitigation measures and efforts. Taking a decidedly qualitative and critical perspective, we adopt recent literature on power and agency to better understand how climate change actors negotiate their different interests and how to characterise the social structure they are embedded in. For this purpose, a topic-centred qualitative interview process was set up to engage local policy-makers and persons active in combatting and facing climate change at case study level. This approach allows for understanding the local specificities which cannot be captured by the quantitative indicators proposed in research guideline #1 and puts the experiences of local actors in the focus of the research interest. The research guideline is designed as a detailed handbook containing descriptions of the interview implementation and examples for the NEVERMORE case studies to carry out themselves. Moreover, the process and materials (i.e., the interview guidelines) were already tested by the authors of this report.

The **third research guideline** puts social innovations at the centre, which contribute to solving the manifold challenges arising from the climate crisis from a bottom-up perspective. Based on the literature distilled in chapter 5.6 as well as a complementary review of social innovation measurement approaches, we developed research guideline #3 consisting of three main strategies to investigate social innovation (initiatives) in a local context. The guideline uses a mix of qualitative and quantitative approaches and largely (but not exclusively) relies on secondary data sources, such as databases and documents. This guideline should equip NEVERMORE case study leaders and supporters with the tools to investigate social innovation in their local context to better understand their potentials and barriers and gain a complete picture of the ecosystem of actors in their region.

4. Assessment of social and behavioural aspects in existing climate change models – a research gap

The climate crisis affects human and natural systems with varying impacts on regions, sectors and time. The specific impacts thereby do not only rely on physical and biophysical realms but also depend on related social and economic developments (van Vuuren *et al.*, 2014). Accordingly, climate change models should seek to integrate insights from social sciences "to improve the model representations of societal transformations, such as behaviour of various actors, transformation dynamics in time, and heterogeneities within and across societies." (Trutnevyte *et al.*, 2019, p. 431).

According to van Vuuren and colleagues (2014), one can distinguish three key climate research communities:

(1) Climate and energy system modelling (ESM), which studies low-carbon transitions and optimal designs of energy systems (Vagero & Zeyringer, 2023).
(2) Impacts, adaptation, and vulnerabilities assessments (IAV), which study the impact and response to climate change events and hazards (Carter *et al.*, 2021).
(3) Integrated assessment modelling (IAM), which seeks to understand both drivers of climate change and efficient mitigation policies (van Vuuren *et al.*, 2014).

The NEVERMORE project works with IAMs and IAVs modelling approaches. In the following, both approaches are elaborated in more detail.

Integrated Assessment Models (IAMs) are tools widely used for generating global emissions pathways and supporting climate policy (Workman *et al.*, 2020). However, these tools usually provide a relatively simple scheme for addressing the climate change problem, providing a simplified representation of complex technical and socio-economic systems. IAMs contain several assumptions that sometimes are

very unrealistic or simplistic and can introduce systemic bias, for instance, favouring some mitigation approaches over others. I.e., most IAMs assume abundance of both fossil fuels and renewable energy sources, which implies not considering the technical and physical limits to some technologies (Capellán-Pérez *et al.,* 2020). Another example is the reliance on assumptions regarding the feasibility of some technologies that have proven not to be as viable as they are currently, such as carbon dioxide removal (Workman et al, 2020). Furthermore, policy evaluation is usually carried out using economic cost-benefit approaches, putting on the back burner the assessment of ecological impacts.

IAMs have historically tended to represent society and economy from a neoclassical framework, which misrepresents the dynamic, socially determined nature of technical change (Ackerman *et al.*, 2009). This has resulted in the lack of representation of social and behavioural aspects in integrated assessment models in general.

According to Asefi-Najafabady et al. (2021), IAMs have six key inadequacies that hinder IAMs from being adequate tools for assessing the climate emergency and ecological breakdowns. These are:

- The rational expectations assumption, IAMs usually represent economy as a system in which there are optimising agents with full information. As real behaviour in human societies is quite diverse and different individuals face limited knowledge, diverse information and motivations, this assumption is deemed problematic.
- Lack of real complexity; IAMs are limited in incorporating complexity, non-linearity and uncertainties. Also, modellers have great leeway in choosing functional forms and parameters, which can radically affect the conclusions though these key assumptions are often not clearly communicated.
- 'Integrated' as part of IAM does not mean comprehensive. Some complex feedback processes, such as climate change impacts, are sometimes not reflected in the models. Instead, they depend on exogenous projections that feed the models. The non-consideration of relevant feedback processes makes these models unable to represent realistic challenges and appropriate human responses.
- The use of a 'representative agent' in the economic model; Economy is usually modelled such that a kind of generic economic agent represents all peoples' interests. This involves that societal and institutional contexts, as well as government decisions, are almost rendered irrelevant. Furthermore, inequality, heterogeneity and conflicts are left out. The representative agents usually are consumers and producers 'rationally' optimising their decisions.
- The economic agent as a consumer; "discounts that should not count" (Asefi-Najafabady *et al.*, 2021, p. 1182). The representative consumer maximises their welfare through the value placed on current consumption. When making decisions with inter-generational consequences, discount rates are used. Discount rates are a way to 'distribute' the generational wealth gap, and it relies on many assumptions that are philosophically related to utilitarianism and individualism. According to Asefi-Najafabady et al. (2021, p. 1183), this agent is "*an amoral unit making calculations in an amoral economy".*

  The economic agent as producer; "the damage done by damage functions" (Asefi-Najafabady *et al.*, 2021, p. 1184). As another problematic simplification, the producer usually produces goods and services by using capital and labour and a given technology. This is given by the production function. Usually, climate damages and environmental degradation affect this production function through the damage functions. Damage functions are generally conceptually dubious and have been heavily criticised for their lack of theoretical and empirical foundations (Keen, 2021).

On the basis of this analysis, the NEVERMORE Project, and specifically the WP4, aims at providing inputs based on social science that help to enhance the WILIAM IAM.

The WILIAM IAM, which is currently under development and planned to be finished by Autum 2023, is a System Dynamics model that was built under the scope of the LOCOMOTION H2020 Project. Since its origins, WILIAM has attempted to be a model that overcomes some of the inadequacies found in other IAMs, especially with regard to the representation of ecological boundaries and inequality. For instance, WILIAM has heterogeneous agents (different regions, different industries, different institutional sectors) and great detail in the representation of economic and biophysical processes, with a high level of links, feedback loops (it is based on system dynamics) and disaggregation. Some of the social and behavioural elements that have been identified for improvement of WILIAM in the NEVERMORE project are:

- The representation of behavioural change, incorporating lifestyle change either endogenously (through the representation of drivers and barriers) or exogenously (through the representation of storylines of social change, instead of only focusing on technical innovations).
- The representation of mitigation and adaptation policies, considering a broad catalogue of policies.
- The representation of climate change impacts, considering not only economically aggregated damage functions but also complex causal chains representing social impacts such as those on health, critical infrastructure or migrations.
- The representation of inequality, with all the previous elements disaggregated with different criteria, in order to capture the unequal distribution of policy and climate impacts and decision-making.

While at the global scale the WILIAM Integrated Assessment Model will be developed, at the local scale a risk assessment framework will be defined based on three basic components: hazard, exposure and vulnerability. The first step is the definition of specific key concepts to understand the local methodology:

- **Hazard**: the potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources. This is normally quantified through a probability of occurrence.
- **Exposure**: the presence of people, livelihoods, species, ecosystems, environmental functions, services, infrastructures, and economic, social, or cultural assets in places and settings that could be adversely affected.
- **Asset**: element exposed at risk. Starting from the sectors defined at the global scale, for the local scale, a set of relevant assets is defined (buildings, schools, hospitals, people, etc.)
- **Vulnerability**: the propensity or predisposition of the asset to be adversely affected by a specified type of hazard. Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.
- **Impacts**: a hazardous event's total effects (e.g., economic losses). The term includes economic, human and environmental impacts and may include death, injuries, disease and other negative effects on human physical, mental and social well-being.
- **Risk**: the combination of the consequences of an event or hazard and the associated likelihood of its occurrence, considering in the analysis also the asset vulnerability.
- **Probabilistic Risk Approach**: The consideration of all possible events, their likelihood, and associated impacts. This method contains the idea of uncertainty because it incorporates the concept of randomness. The probabilistic risk is quantified from a series of historical or synthetic events spanning a time period long enough to be statistically representative of all possible disastrous events that can occur in a territory.
- **Current Scenario**: A hazard or risk scenario using the historical baseline or current data for the current conditions.

- **Future Scenario**: A hazard or risk scenario using the historical baseline or current data, and/or modelled climate change metrics presented in the future (after the present day), for example, for 2050 or 2080.
- **Resilience**: is defined as the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management (UNISDR, 2012). Resilience is seen as a cyclical process of continuous improvement of all its phases, which are prevention, absorption, recovery and adaptation. The term resilience is often used in relation to critical infrastructure as the resilience of critical infrastructure. By critical infrastructure is meant an asset, system or part thereof which is essential for the maintenance of vital societal functions, health, safety, security, economic or social well-being of people, and the disruption or destruction of which would have a significant impact as a result of the failure to maintain those functions (Council of the European Union, 2008). In this context resilience is seen as the ability of a critical infrastructure element to reduce the magnitude, impact, or duration of a disruption.

Due to the flexibility that this methodology demands in order to be feasible for implementation to different assets and against various hazards, the methodology is setting some standard steps toward risk assessment. The procedure is described in Figure 2. .

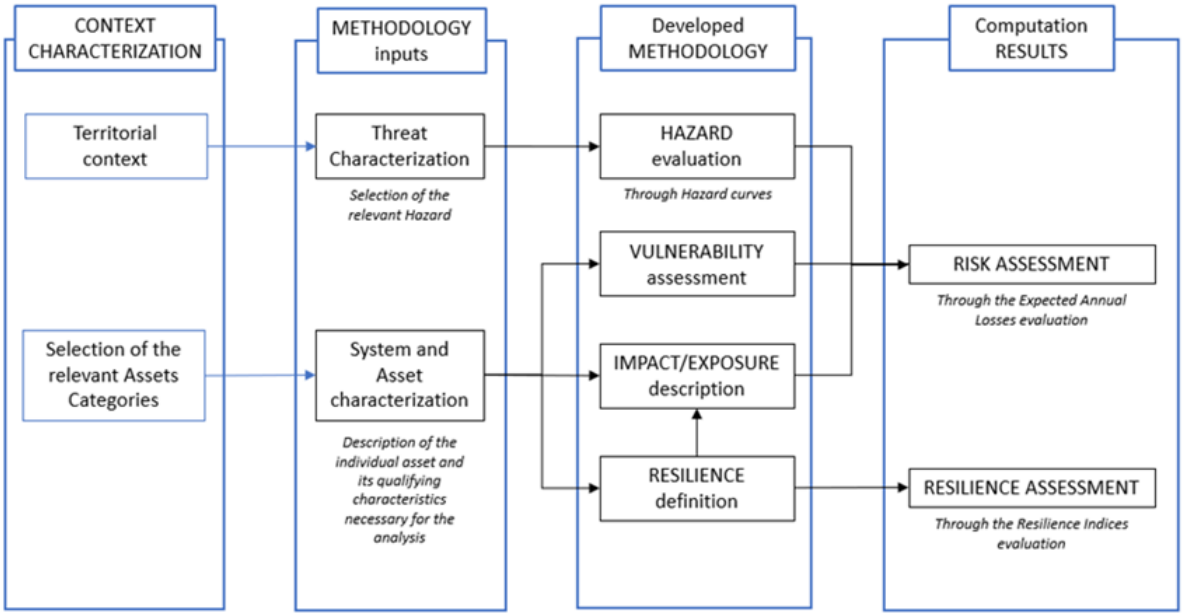

Figure 2. Schematic representation of the methodology at the local scale.

Risk assessment is the process of combining the risk components of hazard, exposure, and vulnerability to determine the level of risk. First, the identification of potential threats and hazards is carried out after evaluating the disruptive event's magnitude and criticality and defining the relevant hazard scenarios taking place. Briefly, the hazard component estimates the probability that the parameters that define the hazard will exceed various levels. Next, the model characterises the inventory of properties at risk as accurately as possible. One of the most important parameters used to characterise the assets is the location of each property at risk. A process called geocoding is normally used to assign geographic coordinates such as latitude and longitude to each asset. With a property's location in spatial terms, other factors that could aid in estimating the vulnerability of a property are added to its characterisation. For a building, these parameters include such features as its construction type, the

number of stories and its age. Lastly, the vulnerability of the asset shall be determined as well using a structural assessment. In essence, this step in the model quantifies the physical impact of the natural hazard phenomenon on the property at risk. How this vulnerability is quantified differs from model to model. For instance, the HAZUS model (FEMA, 2013) classifies a structure as being in a Slight, Moderate, Extensive, or Complete damage state.

The impact could be evaluated for different assets as well as for different kinds of targets. The impact is defined as the presence of people, livelihoods, species or ecosystems, environmental functions, services, resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected by a hazard. Therefore, it can be seen as the scale of the consequences of a hazard. The impact is normally quantified in the determination of damages and losses caused to stakeholders, the environment and human life. In this study case, the analysis of the impact is based on the analysis of three different categories, according to Sousa et al. 2019:

- impacts on People (fatalities/injuries);
- impacts on the Physical System/Infrastructure (damages on the structures);
- impacts on Service continuity (interruptions/downtime).

The evaluation of each component is provided in economic terms; in such a way that the combination of them provides a unique impact value.

Finally, the loss module translates damage into monetary loss and estimates the probability of exceeding various levels of loss through the risk curve.

Risk is calculated as the convolution of the damage caused by all events, considering their associated likelihood (probabilistic risk approach).

The risk assessment can be either qualitative, semi-quantitative, or quantitative. In the NEVERMORE project at the local scale, a quantitative risk assessment is suggested and adopted.

Based on the asset characterisation, the definition of the resilience goals and the objectives for planning resilience will be set. The objectives will serve as the baseline for assessing the actual current level of resilience as well as possible measures to improve the “to be” condition. The assigned objectives will provide an assessment of the level of awareness of the user on the topic of resilience, the risks associated with the user’s current level of awareness and the resilience actions or plans which have already been implemented. The resilience, beyond the assignment of the so-called resilience indicator, is also used to affect the impact analysis.

The resilience assessment will be carried out in a quantitative form, specifically via a resilience matrix based on specific indicators. The resilience matrix contains the robustness, rapidity, resourcefulness, and redundancy sections. From an operational point of view, a resilient approach can be defined as the ability of a system to withstand an unexpected harmful change or a disruptive event by reducing the initial negative impacts, adapting itself to them, and recovering from them in a timely and cost-effective way.

Social vulnerability and resilience have emerged as core concepts to describe the capacity of social systems to prepare, absorb, adapt and recover from the effects of natural hazards (Ran *et al.*, 2020). The severity of these effects can be disproportionally larger for some population groups (e.g., certain communities within a region). In addition, the underlying socio-economic and demographic characteristics (e.g., gender, age, income, access to education and health services) of a community influence their social vulnerability. However, traditional risk-quantification methods often do not assess people’s vulnerability or assume a homogeneous vulnerability of the entire population. The inclusion of social vulnerability in natural-hazard risk assessment can be beneficial for policy-makers in developing tailored risk reduction strategies, particularly targeting the most vulnerable and marginalised. Different methods can be employed to quantify social vulnerability to natural hazards.

The most frequently used methods are based on composite indicators, such as the Human Development Index, the Prevalent Vulnerability Index, or the Social Vulnerability Index. These indicators are quantitative metrics that enable places to be compared and their corresponding vulnerability trajectories to be tracked. Additionally, these indicators are relatively easy to interpret for non-experts. (Mesta *et al.*, 2022). The detailed analysis of the social vulnerability will be described in deliverables D6.2 "Risk assessment and risk maps of the case studies" and D6.3 "Report on case studies A&M measures and vulnerable areas". The most critical aspect behind the NEVERMORE project is its applicability towards scalable spatial levels, beginning from a single building/structure and extending to a whole province or country.

At the local scale, community resilience is currently determined by indicators that include economic and physical assets, education, health and economic capacity, social and institutional protection, but also cognitive and subjective factors such as risk perception, civic engagement, cultural norms, and values. Many socio-economic factors that influence community resilience are locally embedded and depend on a community's ability to share a mutual goal, to learn, self-govern and self-organise.

This resilience, beyond the assignment of the so-called resilience indicator, is also used to affect the impact analysis. Here the resilience questions are briefly listed:

- **Preparation (planning in advance):**
    - Existence and status of emergency plans.
    - Frequency of training courses/exercise.
    - Insurance cover.
    - Existence of backup systems.
    - Did the community around the asset has already experienced a significant hazardous event?
    - Warning time before the hazardous event.
- **Internal resourcefulness (effectiveness and availability of resources):**
    - Available Early Warning System and/or specific countermeasures.
    - Existence of available material to offset the loss.
    - Coord with facilities/department of Hospital.
- **External resourcefulness (external agreement and coordination plants with other subjects):**
    - Mutual agreements and exercises with relevant institutions and organisations.
    - Coordination with public units and local government institutions.
    - Coordination with Provincial Health Directorate institutions in the region.
    - Coordination with hospitals with special treatment units.

The local model will analyse the current scenario that is obtained using the historical baseline or current data, for the current conditions to evaluate the level of risk. If the level of risk is not acceptable, then the mitigation options to improve resilience and lower vulnerability and/or exposure should be considered, including the development of short-, medium- and long-term mitigation interventions to improve resilience and vulnerability indicators. Finally, future projections of climate and development variables will be considered to run future scenarios and to evaluate how the mitigation interventions may affect a range of indicators. These interventions are intended to improve the current level of resilience and/or to maintain the level of resilience in view of future events, such as those exacerbated by Climate Change. The acceptable level of risk is not a univocally determined value, but this can be defined with the stakeholders and depends on the specific context. The option of accepting the losses and letting the effects of climate change happen without intervention should be considered and is an appropriate option in some circumstances. The option is best suited to areas where human lives are not at risk, where impacts on infrastructure are minor, or even where inhabitants are willing to accept the risk. If this option is selected, there needs to be information provided to stakeholders about likely

changes, potential losses and associated timing, and whether this option needs to be augmented with any other options such as minor relocation of infrastructure. This is likely to be an important consideration for many adaptation planners because of the expense of implementing many adaptation options.

5. Psychological, societal, and socioeconomic factors relevant to climate change research

The following sections present the results of the comprehensive literature review which forms the bulk of this deliverable and the main foundation for the three research guidelines; together, the review and the guidelines provide the analytical framework necessary to understand relevant socio-economic factors in the modelling framework and the NEVERMORE project at large. The literature review considers diverse psychological, societal, political, and socioeconomic factors relevant in the context of climate change. In the course of reviewing and synthesising the extensive literature, we identified six main themes which structure this chapter: behaviour change, which focuses primarily on psychological aspects of three main types of behaviours; political system, which describes relationships between a country's political system and its climate change policies as well as environmental quality; resilience and vulnerability, a chapter describing social vulnerability and resilience to adverse climate change impacts; social priorities, covering necessary material and social conditions which need to be maintained to enable a decent life; social provisioning, a strand of research aiming to understand resource use and social conditions in the context of climate change; and finally, social innovation and its potential for sustainable societal transformation.

5.1. Behaviour change

This section presents indicators relevant for understanding behaviour change in the environment and climate change context. We cover indicators that have emerged as relevant for different classes of behaviours rather than specific behaviours. As such, this overview provides a general account of factors relevant to environmental behaviour change. The behaviour change indicators are grouped along four main themes: understanding behaviour, demographic factors, society and politics, and relationship with environment and climate.

The following sections describe the indicators associated with each of those four themes, which are also listed in the NEVERMORE list of indicators - see Research guideline #1: Collecting data on the socio-economic situation and structure of the case-study regions (a secondary-data analysis). In addition to researching and defining indicators as well as providing a comprehensive overview of the list of indicators, we have compiled information about data availability, mostly stemming from international surveys. Based on the authors' expertise in the field of environmental psychology and a comparison with measurement instruments used in previous research, specific items used in international surveys were chosen as measures for a given indicator. The indicators described in this section were also used to inform activities in T2.1 (*Social science for climate action and setting the basis*) and are therefore partly included in D2.1. (*Society and climate change links and lifestyle changes measures*)

In the literature review, we consider single studies, meta-analyses, and (systematic) reviews looking at outcome variables capturing environmental and climate activism, support for environmental and climate policies, and everyday environmentally-friendly or pro-environmental behaviour. These types of behaviours are described in the following subsection.

5.1.1. Understanding Behaviour

This section describes our understanding of behaviour as well as three main behavioural antecedents assumed to be necessary for any kind of behaviour. First, we define what we mean when we refer to

"behaviour" or "behaviour change". In the environment and climate context, social and psychological sciences use different classifications of behaviours. Stern (2000) defines four main types of behaviours, which have been widely adopted: (1) environmental activism, which includes being actively involved in initiatives, organisations, or protests with an environmental focus; (2) behaviours visible in public, which are not per se activist, for instance, policy support or environmental citizenship (e.g., signing petitions); (3) behaviours in the private domain, consisting of more everyday behaviours, like consumption and lifestyle choices; and (4), the category of "other" environmental behaviours, like actions within one's workplace.

We loosely follow this classification by investigating factors specifically relevant for a) environmental activism (which many studies also conceptualise as including environmental citizenship behaviours); b) policy support; and c) private-sphere behaviours, which we call everyday pro-environmental behaviours in this report. Furthermore, we suggest also including these three behavioural types in the NEVERMORE list of indicators, as they are also relevant for modelling climate change impacts on different levels. Oftentimes, these behaviours are interrelated. For instance, climate protesters also report lifestyle changes and everyday pro-environmental behaviours, such as reducing flying and car use, changing to a vegetarian diet, or engaging in recycling and resource conservation (Martiskainen *et al.*, 2020).

First, **everyday pro-environmental behaviours** subsume different consumption or lifestyle behaviours, such as buying organic food, sustainable clothing, or using renewable energy. It also involves behaviours such as recycling, conserving energy or water, or using public transport rather than a car. Pro-environmental behaviours are often measured as self-reports, i.e., individuals report on a frequency scale how often they perform specific behaviours (Lange & Dewitte, 2019). Some studies also measure observations by trained observers or household members. Furthermore, device measurements are often used as outcome variables, as they provide an objective measure of the product of behaviour, though not the behaviour itself. For instance, device measurements can capture the CO_2 emissions of a household (usually not of the individual). These variables provide additional perspectives and results, which cannot be obtained with the predominantly self-report-based measures of other behaviours.

Second, **environmental policy support** captures the extent to which individuals support a range of different climate and environmental policies and whether and how much they would be willing to pay for their implementation. Understanding and explaining why individuals support environmental or climate policies, and in turn, increasing support, is crucial for implementing a sustainable, societal transformation (Drews & van den Bergh, 2016). For instance, individuals are often asked to indicate their support for carbon or fuel taxes or investment in green energy infrastructure. As such, it is not directly an individual behaviour, but rather captures positive attitudes as well as a tendency to accept, adhere to, or vote for a specific policy.

Third, **environmental activism** consists of behaviours in the political or public sphere, and is often used interchangeably with the terms collective action or political participation (Ballew *et al.*, 2019; Lubell *et al.*, 2007; Schulte *et al.*, 2020; Sparks, 2021). Typical behaviours that are measured under the concept of environmental activism are contacting government officials about global warming, being engaged in movements or initiatives, participating in protests, demonstrations, or strikes, donating money or signing petitions.

At this point, it should be noted that the measures of behaviour commonly used in the social sciences and psychology have several limitations. Usually, behaviour is measured with methods that have some degree of inaccuracy, as a meta-analysis comparing self-reported and objective measures of the same behaviour amongst the same group of people indicates: accordingly, the measures are correlated with each other only to a medium extent (21% of explained variance), which is surprising given that the measurements should be capturing the same construct (Kormos & Gifford, 2014). One explanation for

this difference between behavioural measures might be the inaccuracy of self-report questionnaires due to social desirability of the behaviour or priming effects, though all types of measurements can show some degree of inaccuracy (Koller *et al.*, 2023). In addition, different behavioural outcome measures are often correlated with very different factors and indicators, for instance when social identity predicts behaviour measured with self-reports, but not behaviour measured with electricity meters (for an overview, see Moser & Kleinhückelkotten, 2018; Nielsen *et al.*, 2022).

Many studies on pro-environmental behaviour rest on the assumption that an individual's performance of any behaviour is determined by three main beliefs; **self-efficacy**, **locus of control**, and **perceived behavioural control** (Ajzen, 2002). Perceived behavioural control describes the individuals' perception of how easy or difficult performing the behaviour is considered. Self-efficacy describes the confidence in one's own capabilities to perform a behaviour and achieve a given outcome (Bandura, 1997). It is often measured regarding a specific behaviour or domain of behaviours. Locus of control describes an individual's general belief about whether they can influence decisions, changes, or events in their life, indicating an internal locus of control, or whether these decisions, changes, or events are due to external factors they cannot control, suggesting an external locus of control (Galvin *et al.*, 2018). Previous research suggests that in the environmental and climate context, these three factors (self-efficacy, locus of control & perceived behavioural control) are also relevant for understanding and explaining behaviour.

First, **environmental self-efficacy,** which we use as an umbrella term in this report for subsuming research on different behaviours within the environmental domain, as it is usually measured as domain- or task-specific. For instance, a person who feels stronger self-efficacy is more willing to volunteer for an environmental initiative or organisation, engage in climate activism, support climate policies, and perform everyday pro-environmental behaviours (Gulliver *et al.*, 2022; Lubell *et al.*, 2007).

Moreover, a strong internal **locus of control** generally promotes everyday pro-environmental behaviours, such as energy conservation or recycling (Frederiks *et al.*, 2015; Hornik *et al.*, 1995). Individuals with an external locus of control are less likely to enact pro-environmental behaviours, though this depends on the specific external actor the responsibility for the environment is assigned to. Individuals who believe that powerful actors (i.e., governments, corporations) are responsible for environmental degradation are more likely to engage in everyday pro-environmental behaviours and activism, whereas those individuals who believe that climate change is due to fate, chance, or any god, are less likely to engage in any behaviour to benefit the environment (Kalamas *et al.*, 2014).

Lastly, **perceived behavioural control** is a relevant facilitator of behaviour change, though not consistently. For instance, a person is more likely to participate in a local environmental initiative if they judge their participation as being easy and effortless given their current life situation (Bamberg *et al.*, 2015). Likewise, a systematic review suggests that the convenience and perceived difficulty of a behaviour, in this case, recycling, influences whether a person actually engages in that behaviour: the easier it is, the more likely a person will do it (Fogt Jacobsen *et al.*, 2022). However, when also controlling for factors such as situational aspects or norms, perceived behavioural control sometimes loses relevance as a predictor of behaviour, specifically for recycling and environmental volunteering (Gulliver *et al.*, 2022; Tonglet *et al.*, 2004).

5.1.2. Demographic factors

We suggest including a range of demographic factors pertaining to an individual or their household, specifically income, formal education, household size, homeownership, dwelling size, length of residence, as well as their area of residence.

A person's **income** and **formal education** (as well as their composite indicator socioeconomic status) are among the most examined factors for explaining behaviour in the environmental and climate

context. However, depending on the type and measurement of behaviour and which other variables are considered, the role of income and education varies.

Many studies have found positive relationships between **income** and engaging in everyday pro-environmental behaviours. Income is positively associated with participation in a premium-priced green electricity programme, however, with a relatively small effect size (Clark *et al.*, 2003). Relatedly, those individuals who perceive themselves as wealthy report to be engaged in more daily pro-environmental behaviours, such as recycling, eating locally, or purchasing eco-friendly products (Ertz *et al.*, 2016). Importantly, investigating household emissions as a behavioural product presents a more complex picture: households with larger available incomes generally emit more CO_2, particularly in the domains of goods and services, clothing consumption, transport, energy, vehicle use, and flying (Ala-Mantila *et al.*, 2014; Boucher, 2016; Büchs & Schnepf, 2013; Lévay *et al.*, 2021; Nielsen *et al.*, 2022). These findings suggest that even though high-income individuals report to behave more environmentally friendly, they actually emit more CO_2. It seems that behaviours in the domain of environmental consumption and lifestyle behaviours are largely determined by available resources. Fittingly, individuals with lower income more often show those behaviours labelled as environmentally friendly that also save money, specifically using public transport and reduced heating, suggesting that financial resources possibly play a larger role than pro-environmental intent (Blankenberg & Alhusen, 2018). High-income households additionally have the option of investing in energy-saving appliances and other energy-efficient technologies to curb their use of resources (Frederiks *et al.*, 2015). Moreover, individuals who become unemployed afterwards show more pro-environmental behaviours requiring more time and effort, suggesting that not only financial but also temporal resources play an important role in promoting behaviour. A study comparing solar panel adopters from high-income households with low-to-moderate income households, who received the solar panel for free, suggests that the two groups are rather similar in key psychological constructs usually predicting solar adoption, showing that income is the most important barrier in this case (Wolske, 2020). In fact, low-to-moderate income households showed stronger environmental norms and a stronger motivation to use green technology. In sum, research on income as determining factor of pro-environmental behaviour should be critically evaluated with regards to the required financial and temporal resources the behaviour requires as well as how much it impacts the environment.

In the domain of environmental and climate policy support, income plays only a negligible role. Though Kotchen *et al.* (2013) find that households with higher income are also more willing to pay for implementing climate policies, income plays no relevant role when asking about general support for climate policies or when considering other variables like beliefs, worry, norms, or risk perception (Davidovic & Harring, 2020; Goldberg *et al.*, 2021; Harring & Jagers, 2013; Mayer *et al.*, 2017).

A study investigating values in relation to climate policy support, climate activism, and everyday pro-environmental behaviours at the same time found that the role of income for policy support is negligible when other variables are controlled for, whereas there are very small positive correlations for activism and everyday behaviours (Lubell *et al.*, 2007). In contrast, Sparks (2021) found no evidence of a relationship between climate activism and income.

Similar to income, **formal education,** i.e., education obtained in schools and other educational institutions such as training centres or universities, potentially influences behaviours. **Households** with higher formal education, particularly with tertiary education, emit more CO_2 in general as well as in the domains of transport, flying, as well as goods and services (Boucher, 2016; Büchs & Schnepf, 2013; Lévay *et al.*, 2021). Possibly, households with different levels of education also show different ways of consuming and spending free time, thereby accounting for the differences in emissions. Systematic reviews suggest that the influence of formal education on specific everyday behaviours varies depending on the behaviour type. Individuals with higher formal education are more likely to perform

lifestyle behaviours based on energy saving or energy efficiency, technology, and leisure time, such as participating in environmental groups or reading about environmental topics (Blankenberg & Alhusen, 2018). Formal education bears no influence on the extent of energy use (Frederiks *et al.*, 2015).

Furthermore, households with a higher level of formal education tend towards stronger support for different environmental and climate policies and are willing to pay more for policies that reduce CO_2 emissions (Adaman *et al.*, 2011; Davidovic & Harring, 2020; Lubell *et al.*, 2007; Mayer *et al.*, 2017). In contrast, support for building local energy infrastructure was higher among those with lower formal education (Devine-Wright & Batel, 2013). When considering other factors such as climate change beliefs, trust, norms, worry, or risk perception, formal education, however, loses its relevance in explaining climate policy support (Goldberg *et al.*, 2021; Harring & Jagers, 2013).

There is little evidence for a relationship between formal education and climate activism. Formal education seems to increase climate activism slightly in the form of contacting a government official about global warming, signing petitions, donating money or belonging to an environmental organisation (Ballew *et al.*, 2019; Lubell *et al.*, 2007). In contrast, Sparks (2021) found no evidence of a relationship between climate activism and education.

Next, we propose to include **household size**, or the number of people living in a given household, in the NEVERMORE list of indicators. The relationship between household size and CO_2 emissions varies depending on the domain under investigation. Larger households emit more CO_2 in the domains of purchased products and services, transport, and food, specifically eating meat (Ala-Mantila *et al.*, 2014; Boucher, 2016; Ivanova & Büchs, 2020; Lévay *et al.*, 2021). Larger households overall emit more CO_2 due to energy use, but this is reversed when looking at the per capita use (Frederiks et al., 2015). Overall, smaller households, particularly single households, demonstrate more CO_2 emissions in general as well as when it comes to electricity and housing, vehicle use and flying (Ala-Mantila *et al.*, 2014; Boucher, 2016; Ivanova & Büchs, 2020). Smaller households are also more likely to invest in a pricey green electricity programme (Clark *et al.*, 2003).

We also suggest including **homeownership** in the NEVERMORE list of indicators. Owning a home, particularly a detached house, is associated with more energy use. At the same time, homeowners are more likely to be able to invest in energy saving, e.g., with energy-efficient technology (Frederiks *et al.*, 2015). Households living in detached houses also show greater CO_2 emissions, particularly in the domains of energy use (Lévay *et al.*, 2021).

Relatedly, **dwelling size** is positively related to energy consumption: the more floor space or the number of rooms available to a household, the more energy they consume and the higher their CO_2 emissions (Frederiks *et al.*, 2015; Lévay *et al.*, 2021).

The **length of residence** in one's home area positively predicts the extent of engagement with climate change (Scannell & Gifford, 2013). It is also associated with support for new energy infrastructure in the area, such that people who live longer in the respective area show less support for building new infrastructure (Devine-Wright, 2013).

Finally, we suggest including a person's **area of residence** in the NEVERMORE list of indicators. Overall, there are three dimensions of areas relevant to behaviour. First, living in a colder climate zone is associated with higher energy consumption compared to warmer climate zones (Frederiks *et al.*, 2015). Second, living in a coastal area is associated with more support for climate policies (Mayer *et al.*, 2017). Third, individuals living in rural areas emit more CO_2, particularly in the domains of energy consumption, transport and fuel, and housing (Ala-Mantila *et al.*, 2014; Büchs & Schnepf, 2013; Frederiks *et al.*, 2015). Only the emissions due to the demand for services are larger for individuals residing in urban areas. Furthermore, individuals living in a city are more likely to support climate policies (Harring & Jagers, 2013).

5.1.3. Society and Politics

Within the theme of society and politics, we suggest four indicators that describe an individual's relationship with political and societal institutions.

Political trust is often conceptualised as the level of trust towards different political institutions, including government, parliament, politicians, or the legal system (Levi & Stoker, 2000). A relationship of trust implies that an individual is willing to make themselves vulnerable to an institution that might do harm or betray them, but do not feel the need or worry to monitor the institution's behaviour. Political trust is an important determinant of environmental policy support, such as taxes on fossil fuels or subsidies, and willingness to pay for environmental policies (Davidovic & Harring, 2020; Fairbrother, 2019; Fairbrother *et al.*, 2019; Harring & Jagers, 2013; Kulin & Johansson Sevä, 2021; Lim & Moon, 2020; E. K. Smith & Mayer, 2018). If political trust is low, individuals are less willing to pay to achieve reductions in CO_2 emissions (Adaman *et al.*, 2011). In addition, political trust works as an enabling factor, since people concerned and aware of climate change are only more likely to support environmental policy if they trust their political institutions (Fairbrother *et al.*, 2019). One study suggests that political trust is only an important factor for support of those policies in which governments are the responsible actors for implementation, such as carbon taxes (Rhodes *et al.*, 2017). Moreover, political trust strengthens the relationship between civic morality and support for environmental policy (Lim & Moon, 2020). A subdimension of political trust is **political cynicism**. Low political cynicism refers to the perception that a government is honest and keeps promises. In contrast, high political cynicism tends to reduce policy support, as people do not trust their government to actually keep their promise (Fairbrother, 2019). In addition to environmental policy support, political trust also fosters everyday pro-environmental behaviours, such as recycling or energy conservation, as individuals are more willing to adhere to related regulations or government programs (Irwin, 2020; Knickmeyer, 2020; Nguyen-Van *et al.*, 2021). A recent meta-analysis suggests that political trust is more relevant for explaining public behaviours, such as policy support, than private pro-environmental behaviours (Cologna & Siegrist, 2020). However, people who engage in climate activism or show the willingness to take action to fight climate change tend to be less trusting towards political institutions (Knops & De Vydt, 2023), though this is not a robust relationship, as one study found no relationship between activism and political trust (Smith & Mayer, 2018)**.**

Social trust – capturing trust in relations with one's social groups, community, or society at large – predicts the willingness to take action against climate change (Smith & Mayer, 2018). Furthermore, individuals with high social trust are also more likely to contribute to community adaptation measures (e.g., by contributing money) or to perform everyday pro-environmental behaviours such as recycling, using sustainable transport, or conservation efforts (Cologna & Siegrist, 2020; Gür, 2020; Irwin, 2020; Knickmeyer, 2020; Paul *et al.*, 2016). However, a recent meta-analysis suggests that compared to indicators such as political trust or social norms, social trust exerts a relatively small influence on everyday pro-environmental behaviour (Nguyen-Van *et al.*, 2021). Individuals who show higher levels of social trust also report more support for climate policies, albeit this association tends to be comparatively small (Davidovic & Harring, 2020; Harring & Jagers, 2013; Irwin, 2020). Moreover, individuals with little social trust are less willing to pay more to achieve reductions in CO_2 emissions (Adaman *et al.*, 2011). Also, the level of social trust in a given country is seemingly unrelated to the actual adoption of climate policies (Lamb & Minx, 2020). Notably, people that show higher social trust are also more trusting towards political institutions (Jackob, 2012).

Additional conceptualisations of trust include trust relations with the institutions of science. **Trust in science** or (climate) scientists positively impacts support for climate policies, even across different policy types such as market-based, regulatory or voluntary (Rhodes *et al.*, 2017). Indeed, as a recent meta-analysis points out, trust in scientists is more strongly correlated with public behaviours such as

policy support than private pro-environmental behaviours (Cologna & Siegrist, 2020). Trust in science can promote pro-environmental behaviours and policy support by increasing climate change concern as well as the certainty that climate change is happening (Hmielowski *et al.*, 2014; Visschers, 2018). Importantly, trust in scientists mediates the relationship between media use and climate change belief, such that liberal outlets increase trust in scientists, which in turn increases the belief that climate change is happening, whereas conservative outlets decrease trust in scientists and climate change beliefs (Visschers, 2018).

Lastly, **political interest** is a correlate of several relevant societal and political factors. It moderates the relationship between political orientation and climate change denial, such that only those right-wing respondents who also have a high political interest are engaged climate change deniers (Carrus *et al.*, 2018). Moreover, people, who indicate to be more interested in politics tend to be more supportive of climate policy (Fairbrother, 2019; Fairbrother *et al.*, 2019).

5.1.4. Relationship with Environment and Climate Change

We propose including several factors that describe an individual's perspective and relationship with the environment and climate change, mostly from psychology. These include norms and values, both personal and with regards to the environment; identity; engagement with climate change on a cognitive and affective level; the experience of risk through climate change, both on the level of personally experiencing risk and perceiving climate change risk more generally; and finally, the individual's quality of life.

First, we suggest including **personal norms and values**, specifically the manifestation of altruistic values and egoistic values. Following Stern et al. (1999), personal values form the foundation based on which more specific environmental norms are formed, which in turn promote environmental behaviours. Individuals with strong altruistic values towards both humans and other species emphasise social justice, peace, and equality, and care for others. They tend towards stronger support for climate policies, show more motivation to participate in a premium-priced green electricity programme, and are more interested in installing photovoltaic at their homes (Clark *et al.*, 2003; Harring & Jagers, 2013; Stern *et al.*, 1999; Wolske *et al.*, 2017). In contrast, individuals who hold egoistic values emphasise power, dominance, influence, material possessions and control, and are less likely to support climate policies (Harring & Jagers, 2013; Stern *et al.*, 1999).

In addition to personal values, we suggest including **environmental norms and values** as an indicator in the NEVERMORE list. We propose to use this indicator in a broader sense than usually applied in psychological research and subsume research on four different dimensions under **environmental norms and values**, which are discussed in the following.

The first dimension covers personal environmental and biospheric values, which describe the extent to which a person considers costs and benefits for the environment rather than exclusively their own, personally values environmental protection, and considers nature to have an intrinsic value (Davidovic & Harring, 2020; Kácha *et al.*, 2022; Lubell *et al.*, 2007; Rhodes *et al.*, 2017; Steg *et al.*, 2005; Wolske *et al.*, 2017). Strong personal environmental and biospheric values are associated with support for climate policies, for example, for taxes, bans, subsidies, supply-focussed regulations, or energy policies, as well as climate activism and, to a lesser extent, everyday pro-environmental behaviours, such as installing solar panels. Personal environmental and biospheric values also guide decision-makers in organisations and companies contributing to adverse climate change impacts, as a stronger endorsement of environmental protection as a value increases support for measures to reduce climate change impacts within the organisation (Nilsson *et a*l., 2004; Nilsson & Biel, 2008). Relatedly, perceived moral obligations to behave pro-environmentally due to personal values increase the tendency to engage in energy conservation behaviour as well as support for energy policies (Frederiks *et al.*, 2015; Steg *et al.*, 2005).

The second dimension comprises perceived social norms, which capture what a person thinks other people, such as friends, family, or their community, think and which behaviours they endorse. For instance, if a person considers the norm being little support for climate policies, i.e., only few people endorse such policies, the person also tends to report less support themselves (Bolsen *et al.*, 2014). Meta-analyses and systematic reviews have confirmed the influence of social norms on many different types of behaviours, including energy use, recycling, use of pesticides, volunteering in environmental organisations, clothing consumption, or water conservation (Farrow *et al.*, 2017; Hornik *et al.*, 1995; Nguyen-Van *et al.*, 2021). Stronger perceived social norms can also promote support for different climate policies, climate change activism, as well as the tendency to engage in pro-environmental behaviour (Ballew *et al.*, 2019; Frederiks *et al.,* 2015; Goldberg *et al.*, 2021; Harring & Jagers, 2013). However, there is research indicating that social norms predict only pro-environmental intentions but not actual impacts resulting from the behaviour (Nielsen *et al.*, 2022).

With the indicator **environmental identity**, we subsume two distinct concepts of identity: self-identity and social identity. Self-identity describes to which extent a person sees themselves as someone who acts pro-environmentally, which positively predicts different self-reported pro-environmental behaviours, such as owning energy-saving household appliances, eating less meat, or trying to use little natural resources (Moser & Kleinhückelkotten, 2018; Nielsen *et al.*, 2022). Social identity describes the identification with a social group, which can be an environmental organisation, environmental activists or volunteers. Relatedly, individuals with a strong identity towards one of those groups are more likely to participate in an environmental movement, engage in regular meetings of an environmental initiative, or support environmental protection policies (Bamberg *et al.*, 2015; Haugestad *et al.*, 2021; Owen *et al.*, 2012; Schulte *et al.*, 2020).

We suggest including engagement with climate change on an affective or cognitive level in the NEVERMORE list of indicators, covering the extent to which a person thinks and feels about climate change (Lorenzoni *et al.*, 2007). Within the concept of **climate change engagement**, we subsume several concepts that are usually treated as distinct measures in the environmental psychology literature but which we consider as too specific and somewhat inaccessible for the purpose of the interdisciplinary work setting the basis for NEVERMORE and integrated assessment modelling. Therefore, we also discuss the concepts **concern for climate change and the environment**, **belief in climate change**, and **climate change knowledge** as being part of climate change engagement in the following, but only include engagement in the NEVERMORE list of indicators.

First, concern and worry describe an affective component of climate change engagement. The more concerned a person is about climate change, the more likely they are to support climate policy, such as taxes on fossil fuels, perform pro-environmental behaviour or engage in climate activism (Kácha et al., 2022; Kulin & Johansson Sevä, 2021). In fact, climate change activists or protesters often articulate worry about climate change and its effects as important motivators for them to take action (Boucher et al., 2021; Martiskainen *et al.*, 2020). In addition, the analysis by Goldberg et al. (2021) shows that worry about climate change is among the strongest predictors of climate policy support after belief in climate change, i.e., that it is real and really taking place. Other studies have similarly shown that the certainty that climate change is really taking place and caused by human activity is an important predictor for support of climate change policies as well as willingness to pay for a climate policy to be implemented (Kotchen *et al.*, 2013; Sibley & Kurz, 2013).

Knowledge about climate change can increase the willingness to participate in several different types of environmental behaviours. More knowledge about climate change and its effects promote activism and protests, especially among young people (Haugestad *et al.*, 2021; Martiskainen *et al.*, 2020; Sparks, 2021). Knowing about the environment and climate change promotes the willingness to pay more to achieve reductions in CO_2 emissions (Adaman *et al.*, 2011). Different everyday pro-environmental behaviours such as energy conservation can be promoted by providing knowledge about how to save energy, feedback about the household's energy use, or information about which behaviours reduce

emissions (Abrahamse *et al.*, 2007; Cappa *et al.*, 2020). This effect is also confirmed by a meta-analysis, showing that providing knowledge in the form of real-time feedback on energy consumption can significantly reduce energy use (Delmas *et al.*, 2013). In contrast, limited knowledge or confusion about climate change regarding its causes and consequences as well as lacking understanding and awareness pose barriers to engaging with climate change (Lorenzoni *et al.*, 2007).

The indicator **risk exposure** describes the extent to which an individual personally experiences climate change effects. Studies on risk exposure distinguish between actual and perceived risk exposure. For instance, Xia et al. (2022) found that experiencing floods, droughts, general temperature anomalies and other natural hazards promotes belief in human-made climate change and support for climate policies. However, this relationship is stronger when individuals report their own perceptions of exposure than when actual occurrence of these events is measured in their area. Nevertheless, similar studies indicate that the extent of CO_2 emissions, heat waves, and droughts in one's area of residence increase support for climate and environmental protection policies (Mayer *et al.*, 2017; Owen *et al.*, 2012). In contrast, those individuals who experienced relatively cool weather showed less support for environmental protection policies.

Broadly, the indicator of **risk perception** covers the extent to which climate change is perceived as a risk, threat, or hazard to a person, their social environment (e.g., family, friends) or community, their local area, region, country, continent, or the world at large (van der Linden, 2015, 2017). In contrast to the indicator of risk exposure, risk perception depends upon individual perspectives that are not necessarily related to their own experience of climate change impacts (Akerlof *et al.*, 2013). Nevertheless, individuals tend to have a stronger risk perception if they personally experience the effects of global warming (Akerlof *et al.*, 2013).

Individuals with a strong risk perception of climate change are also more likely to support climate policies and to take action against climate change, which is supported by strong social trust (Goldberg *et al.*, 2021; Mayer *et al.*, 2017; E. K. Smith & Mayer, 2018). An individual who perceives climate change as a risk to themselves and others, or to health, natural resources, and economic development similarly tends to be more engaged in climate activism and to a smaller extent, everyday pro-environmental behaviours (Ballew *et al.*, 2019; Lubell *et al.*, 2007). A qualitative field study among young climate activists similarly suggests that their perception of climate change as an imminent risk and a threat is an important determinant of their actions and activism (Haugestad *et al.*, 2021). However, if people perceive climate change as a risk that cannot be resolved, they are less likely to perform pro-environmental actions (Xiang *et al.*, 2019).

Notably, the extent to which climate change is seen as a risk or a threat depends on the person's perception of distance. In the spatial sense, it seems that risks stemming from climate change are perceived to be more extreme on a global level, but perceived as a lesser threat on a personal level (Tvinnereim *et al.*, 2020). Similarly, environmental problems or adverse impacts from climate change are experienced as more severe when discussed on the level of a whole country, whereas they seem a lesser threat when talking about a person's region on the sub-national level (Milfont & Thomson, 2020). In turn, reducing the experienced geographical distance between a person and climate change, for instance by perceiving it as an issue on the local level, can promote engagement with climate change and climate activism (Scannell & Gifford, 2013; Sparks, 2021). In addition to the perceived spatial distance, experiencing temporal distance (i.e., climate change is an issue of a distant future) as well as social distance (i.e., climate change does not impact the individual or people they know personally) reduce pro-environmental behaviours and climate change engagement (Jones *et al.*, 2017; Lorenzoni *et al.*, 2007).

On a more general level, a person's perceived **quality of life** can be affected by climate change. On the one hand, this can include life satisfaction; in fact, the perception that a specific behaviour change will have negative consequences for a person's quality of life, as it might be as costly or inconvenient, reduces their willingness to perform this behaviour (Frederiks *et al.*, 2015; Lorenzoni *et al.*, 2007). On

the other hand, experiencing climate change and related events can have adverse effects for a person's general wellbeing and mental health (E. Lawrance *et al.*, 2021). For instance, extreme weather events increase psychological distress and PTSD symptoms, whereas high temperatures and heatwaves pose a risk for both physical and psychological wellbeing. Recently, the concept of climate anxiety has been described to capture psychological responses – such as anxiety and depression – to the climate crisis without personally experiencing adverse impacts (Clayton, 2020).

5.2. Political System

In the following, we provide a brief overview of literature on the relationship between a country's political system and its environmental policies and environmental quality. We suggest that indicators capturing different manifestations of policy (focussing on content dimensions) and polity (focussing on structures related to policy making) should be considered in modelling, and present two large-scale projects conceptualising democracy a) in general and b) specifically regarding the environment. Each of the projects provides tangible and rigorous measurement in addition to both indicators and datasets. These indicators are included in the NEVERMORE list of indicators, as they constitute the framework in which decision-making and policy processes occur and as such determine their implementation and impacts. Related research on political systems and their environmental quality or policies can be distinguished based on their levels of comparison, which we outline in this section.

First, studies using older data have compared different political systems, namely democracies and autocracies, and investigated their relationship with environmental degradation and environmental measures (Li & Reuveny, 2006; Ward, 2008). Accordingly, the more autocratic a political system, the worse is its environmental quality. In contrast, stronger manifestations of democracy reduce environmental degradation, for instance measured as CO_2 and NO_x emissions, land degradation, deforestation, and water pollution.

Second, previous studies have compared different democratic systems and found that parliamentary democracies implement stricter environmental policies whereas presidential-congressional systems implement less stricter policies and resemble autocracies in that respect (Fredriksson & Wollscheid, 2007). Electoral systems further influence environmental outcomes in different ways: consensus-based and proportional electoral democracies to a larger extent reduce CO_2 emissions and support everyday environmental policy efforts (e.g., policies for recycling or lead-free fuel; Poloni-Staudinger, 2008). In contrast, democracies with majoritarian party systems are more effective in implementing conservation policies (i.e., for protecting land and wildlife).

Third, more recent studies have examined the influence of specific aspects of democracy, considering factors such as the manifestation of different democratic types or the quality of democratic institutions. Accordingly, democracies with stronger deliberative aspects, i.e., a stronger role of civil society in political decision-making, implement more climate mitigation policies and laws (Povitkina & Jagers, 2022). Furthermore, stronger liberal (more important role of market and businesses) or social-liberal aspects (stronger focus on equality and welfare) implement more stringent policies and laws, in addition to larger reduction in CO_2 emissions. However, stronger egalitarian democracies show more CO_2 emissions, which the authors explain with lower levels of economic inequality, which leads to more consumption of basic goods in the population (Selseng *et al.*, 2022). The quality of different democratic institutions is also associated with environmental degradation, mostly measured as CO_2 emissions (Haldar & Sethi, 2021; Kim *et al.*, 2019; Lægreid & Povitkina, 2018; Povitkina & Jagers, 2022; Wawrzyniak & Doryń, 2020). Specifically, higher government effectiveness, high manifestation of political culture and civil liberties as well as civil society participation go along with reduced emissions. In contrast, high corruption increases emissions and reduces stringency of environmental policies.

Lastly, another strand of research investigates the impact of environmental democracy and related democratic rights. Standards and compliance processes for environmental democracy were

established in the Aarhus Convention by the UN Economic Commission for Europe in 1998 *(Ahmadi et al.*, 2019; Worker & De Silva, 2015). Environmental democratic rights were further institutionalised in the context of the Bali Guidelines in 2010, which concentrate on establishing national legislation on access to information and justice as well as public participation in environmental matters. More specifically, environmental democracy captures "the right and ability of the public to freely access relevant and timely information, provide input and scrutiny into decision making, and to challenge decisions made by public or private actors which may harm the environment or violate their rights before an accessible, independent, and fair legal authority" (Worker und De Silva, 2015, p. 2). According to related research, countries that have established environmental rights in their constitution show better environmental quality, covering indicators such as emissions, toxic waste, or global warming potential (Ahmadi *et al.*, 2019; Gellers & Jeffords, 2018). Moreover, existing environmental democratic rights facilitate environmental justice and basic human rights, such as access to improved water sources and sanitation facilities (see also the chapter 5.4 Social Priorities - Basic Needs).

We conclude this brief review by pointing out gaps in the literature, as reported in a recent synthesis by Dasgupta & De Cian (2018). Accordingly, the scope of previous research is somewhat limited to explaining physical environmental indicators, such as pollution and emissions, whereas aspects like policy adoption, the role of public opinion or lobbying are scarcely researched. These limitations are mostly due to gaps in data availability. The interaction between different domains, i.e. economic, cultural, societal, political, and institutions, is similarly under-researched; here, the NEVERMORE project aims to contribute with its consideration of multiple sectors, impacts, and policies. In addition to these gaps, we would like to point out that the definition of democracy as well as democratic and institutional quality varies. For instance, Haldar and Sethi (2021) understand the quality of political institutions in terms of guaranteeing economic freedom of individuals and businesses, which we refuse in favour of understanding quality as promoting participation, welfare, and equality.

Based on this brief overview of relevant research on political systems and the environment, we suggest using two main sets of indicators in the NEVERMORE modelling approach and provide information and related data sources in the NEVERMORE list of indicators. The remainder of this section briefly describes these two sets of indicators and their application.

First, the **Varieties of Democracy (V-Dem)** indicators provide a new, multi-dimensional approach to conceptualise and measure democracy in the form of five main varieties (Coppedge, 2023). Instead of measuring "democracy" as one overarching concept, the V-Dem approach conceptualises democracy along five main components: electoral, liberal, participatory, egalitarian, and deliberative (see Coppedge, 2023 for a current discussion of V-Dem). Each of those components consists of several subcomponents, which in turn consist of indicators rated by experts. The different components and subcomponents are aggregated into scores and indices based on mathematical equations, which can then be used in analysis and modelling. V-Dem provides data for 182 countries from the year 1900 onwards (Coppedge *et al.*, 2023).

For the purpose of the NEVERMORE indicator list, we decided to include a total of 7 V-Dem indicators based on the literature review above (see Coppedge *et al.*, 2021 for details). We include the five main components covering electoral, liberal, participatory, egalitarian, and deliberative aspects of democracy. Furthermore, we chose 2 subcomponents reflecting a more detailed understanding of democratic political systems and their relationship with environment and environmental policies for modelling. First, we include the civil society participation index, which is part of the participatory democracy dimension and captures aspects such as to which extent civil society representatives are consulted by policy-makers or whether citizens can freely and autonomously work towards their political and civic goals. Second, we suggest the political corruption index, covering six different types of corruption in the public, executive, legislative, and judicial domain. Corruption includes activities

such as bribery, embezzlement, theft, and with different aims, for instance affecting law making or affecting law implementation.

Second, the **Environmental Democracy Index** (EDI) covers the extent to which democratic rights of access to information, justice, and public participation in the context of environmental issues are established in a given country and is based on the Bali Guidelines discussed above (Worker & De Silva, 2015). Here, established refers to being realised in the form of laws and regulations, which are perceived as necessary for sustainable development. The EDI indicator framework constitutes three main pillars of environmental democracy, each of which consists of further guidelines, measured by legal indicators and practice indicators. Legal indicators assess all national legally binding and enforceable rules related to each pillar, such as laws, constitutions, and regulations. The practice indicators supplement the legal indicators by assessing evidence that these rules are actually implemented. The indicators were scored by experts and researchers in 2014.

We suggest to include the three main pillars of environmental democracy in the NEVERMORE list of indicators, which are obtained by averaging the related guideline scores (see Worker & De Silva, 2015; World Resources Institute, 2015 for more details on guidelines and measurement). The first pillar covers access to information or the right to freely access information on environmental quality and problems. The second pillar is public participation, which covers the right to participate meaningfully in decision-making processes when deciding environmental matters. The third pillar comprises access to justice, including the right to seek enforcement of environmental laws or compensation for harm.

5.3. Resilience and Vulnerability

Human beings are – as is the environment – vulnerable to the climate crisis. Since the beginning of the 21st century, the IPCC reports consider vulnerability as "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change." (McCarthy *et al.*, 2001, p. 6). On the basis of this definition, not all environmental systems or members of societies are equally vulnerable to the climate crisis. Vulnerability can differ with regard to exposure and sensitivity to critical situations as well as adaptive capacity to deal with critical situations (Thomas *et al.*, 2019).

Resilience, in turn, refers to the ability to cope with difficult situations, which also includes the consequences of the climate crisis. Vulnerability and resilience are inversely linked– the more resilient members of societies are, the less vulnerable they are to critical events (Kehler & Birchall, 2021).

Even though resilience and vulnerability are located and measured on the individual level, the historic and social context of a person influences their capacity to be resilient (Adams *et al.*, 2021). Therefore, resilience and vulnerability are strongly related to social inequalities. Marginalised and discriminated against groups in societies are likely to be less resilient and most vulnerable to be adversely affected by climate change (Pörtner *et al.*, 2022).

Marginalisation and discrimination on the ground of gender, disability, race, ethnicity, class, religious believes, age, sexual orientation and intersections thereof structure individual living realities. Climate change mitigation and adaptation policies need to address these inequalities purposefully, "not only from a social justice and moral perspective, but also because the ability to plan for, survive and be resilient to climate change depends on it." (Kehler & Birchall, 2021, p. 473)

To account for vulnerabilities in the realm of climate change and hence, the exposure, the sensitivity and adaptive capacity to specific consequences and events, Kimberley Thomas and colleagues (2019) have identified four crosscutting themes which need to be considered:

(1) Access to tangible and intangible, public and private resources is key to resilience. In relation to climate change, the accessibility of emergency response, insurance, or alternative housing are examples of key dimensions that mediate individual and communal vulnerabilities. The accessibility of these goods and services is mediated by power structures and social

relationships, varies with location (urban/rural) and is context dependent. Importantly, theoretical availability does not equal access (Thomas *et al.*, 2019).

(2) Representation of different groups in governance processes is key to ensure that heterogeneous needs are considered in climate change mitigation and adaptation policies (Thomas et al., 2019).

(3) The dominant culture and social status influences how and which risks related to climate change are identified, and correspondingly how they are acted upon. Respective structures can reproduce vulnerabilities and prevent community action (Thomas *et al.*, 2019).

(4) The socio-cultural context is an important factor when it comes to transmission of information and knowledge. Its non-consideration can have detrimental effects on specific communities (Thomas *et al.*, 2019).

Indicators to measure resilience and vulnerability have been specifically developed to capture the ability and capacity of people and communities to handle disasters arising from natural hazards and other forms of adversity. In the context of climate change, this captures available resources to deal with climate change impacts and natural disasters.

The indicators described in the following (

Table 2) are largely based on the World Risk Poll (Lloyd's Register Foundation & Gallup, 2022) and capture individuals' vulnerability and resilience to risks by assessing their availability of resources on individual, household, community, and societal level.

Table 2. Dimensions of Global Resilience Index (based on Lloyd's Register Foundation & Gallup, 2022).

Dimension	World Risk Poll Indicator
Individual	Agency
	Educational Attainment
Household	Financial Asset
	Planning
	Access to communication
Community	Social capital
	Local infrastructure
Society	Discrimination
	Government support
	National institutions index

These indicators can be combined into a global resilience index (Lloyd's Register Foundation & Gallup, 2022). The index is built using all the listed indicators and was created in two steps:

(1) An average score per dimension was calculated (individual, household, community, society).

(2) The total global resilience index value is calculated as the arithmetic mean of the four averaged scores derived from step 1.

Thus, these indicators allow for conclusions regarding a person's and, by aggregating, a country's available resilience in the face of risks such as extreme weather events caused by climate change or pandemics. Moreover, comparing indicator scores allows determining the most vulnerable groups, with the least available resources.

The following section describes the individual indicators and the ways they are related to resilience, what they mean in the context of climate change adaptation and mitigation, and discussing how intersectionality of marginalised identities can exacerbate climate vulnerability.

Discrimination based on social processes of differentiation and devaluation influence individual and communal vulnerabilities (Pörtner *et al.*, 2022; Thomas *et al.*, 2019). A corresponding indicator in the World Risk Poll asks for the experience of discrimination based on one's nationality, religion, skin colour, sex or disability (Lloyd's Register Foundation & Gallup, 2022). In general and across different social identities, the experience of discrimination can increase the extent of exposure to danger during a disaster (i.e., seeing how houses are damaged) as well as experienced psychological distress and PTSD symptoms (Weems *et al.*, 2007). Those individuals identifying as female and as having minority status as well as those with less income experienced more discrimination. In particular, people identifying as queer can experience discrimination when accessing support and resources for coping with risks (Dominey-Howes *et al.*, 2014).

Discrimination mediates and influences the access to social, financial and material resources necessary to build resilience. For instance, in Nepal women were at higher risk after a devastating earthquake as they were often not accepted for government relief and support programmes and also at higher risk of (sexual) violence (K.C. & Hilhorst, 2022). Also, queer and trans people were shown to be at higher risk due to discriminatory policies excluding them of disaster relief support (Dominey-Howes *et al.*, 2014; Gorman-Murray *et al.*, 2014). These processes exacerbate when dimensions of inequality intersect (Kaijser & Kronsell, 2014). Most marginalised groups are, for example, particularly likely to live in poverty and are thereby again more vulnerable to the negative impacts of climate change. But also disabled women were shown to be disproportionally affected by the negative effects of climate change (in Cambodia) (Gartrell *et al.*, 2020).

Experiences of discrimination reduce a person's wellbeing, inhibit the sense of belonging, and can additionally increase the risk for depression (Florez *et al.*, 2020; Mowat, 2015). At a societal level, discrimination negatively impacts social trust, social cohesion and thereby decreases societal resilience as a whole (Florez *et al.*, 2020). At a peer group level, however, discriminated against groups also tend to find resources and support in self-organised communities (Gartrell *et al.*, 2020; Handlovsky *et al.*, 2018; McCann & Brown, 2017).

Individual resources are crucial to deal with risks and disasters. The **sense of agency** is one of the resources which supports resilience and reduces vulnerability. The concept relates to whether an individual feels capable of actively influencing something. Evidence suggests that a sustained sense of agency through a crisis can potentially improve resilience (E. L. Lawrance *et al.*, 2022). In turn, limited levels of sensed agency also seem correlated with higher vulnerability, as they might hinder the development of individual coping strategies. For instance, in their study, Laurie Yung and colleagues (2015) find that farmers exhibiting a limited sense of agency also show worse coping strategies for climate change weather events, such as short-term planning, or no planning at all and hoping for the best instead of devising effective long-term strategies (Yung *et al.*, 2015). Distress alone, however, is not necessarily limiting levels of agency – as e.g. adolescents and young adults, who experience distress to climate change also tend to exhibit a high sense of agency (Lawrance *et al.*, 2022). Already among ten- to twelve-year-old children, a strong sense of agency is related with climate awareness and the motivation to act in favour of climate change mitigation (Trott, 2020).

Financial security is another important indicator relating to someone's individual resilience and vice versa their vulnerability. In relation to climate change, several critical events can cause people to lose their livelihoods. The indicator of financial security as applied in the World Risk Monitor 2021 therefore indicates whether an individual could cover all of their basic needs with only their savings, when all other sources of income were lost (Lloyd's Register Foundation & Gallup, 2022). Several studies indicate that people already living in financial poverty are most vulnerable to natural disasters, as they tend to be living in lower-quality housing, be more dependent on their direct environment for making a living in rural areas, have fewer food stocks and less resources for rebuilding after a disaster (Pörtner *et al.*, 2022; Thomas *et al.*, 2019; Hossain, 2015; Rodima-Taylor, 2012). Financial insecurity also makes

people more dependent from access to non-commodified resources, such as for example public emergency shelters (Thomas *et al.*, 2019).

When in crisis, **access to a mobile phone and the internet** (Lloyd's Register Foundation & Gallup, 2022) are key resources increasing individual resilience as they can be used for gaining information about potential risks as well as support structures such as shelter or evacuation. The access to knowledge and information and respective transmission is key to maintain an individual sense of agency or to maintain social relations and find emotional support, maintaining a sense of agency (Hossain, 2015; Thomas *et al.*, 2019).

Individuals, who **plan for disasters**, and have strategy for their household in case of a natural disaster might be more resilient in case of emergencies (Lloyd's Register Foundation & Gallup, 2022). As one study conducted in Poland indicates, those with better disaster planning (in this case, for floods), show a high sense of agency (Działek *et al.*, 2016). People with **higher formal education** who have social networks they can rely on (i.e. social capital), are more likely to have disaster plans in place *(Działek et al.*, 2016). In case of an emergency evacuation, large households and especially children and people with disabilities are at risk (Hossain, 2015).

Social support can notably strengthen individual and community resilience to climate-induced risks. The related concept of **social capital** is defined in the World Risk Poll as (a) whether an individual's neighbours care about them and their wellbeing, and b) whether they have helped someone they had not known in their community in the past month (Lloyd's Register Foundation & Gallup, 2022). As a systematic review suggests, social capital in the form of strong interpersonal relationships contributes to resilience by providing psychological and limited material support when faced with a risk or crisis and thus supports a household's coping capabilities (Carmen *et al.*, 2022; Jordan, 2015). Importantly, social capital is not sufficient to foster resilience among marginalised or socially excluded groups. When competition for accessing and gaining resources is strong, relationships within networks are weakened and social capital decreases as a result (Carmen *et al.*, 2022). Thus, the extent to which social capital can be sustained after a disaster depends on provided infrastructures and resources (Thomas *et al.*, 2019).

Moreover, social capital in the form of extended networks and hierarchical and horizontal networks and contacts can help gaining access to new information and resources, which is especially important directly after a crisis or disaster (Thomas *et al.*, 2019). The type of social capital seems to determine information-seeking behaviour (regarding climate change adaptation): those people with larger networks and contacts are more willing to learn about adaption behaviour than those with stronger interpersonal relationships, yet smaller networks (J. W. Smith *et al.*, 2012).

Individual and communal resilience are further dependent on the provision of infrastructures that possibly improve the agency to deal with climate induced crises. The 2021 World Risk Poll suggests an indicator measuring **satisfaction with local infrastructure** in the realms of education, healthcare, and transportation. Insufficient transport systems can hinder reaching shelter, evacuation, and post disaster relief in case of a disaster (Hossain, 2015).

In case of a crises, not only the provision of infrastructures, but also trust in the provisioning institutions can strengthen societal resilience. The World Risk Poll hence uses the indicator **trust in institutions** defined is the perception whether the government cares about the respondent as well as their confidence in national institutions, specifically the government, military, judiciary, and honesty of elections (Lloyd's Register Foundation & Gallup, 2022).

5.4. Social Priorities - Basic Needs

What is needed for living a decent life? This was and still is an important philosophical question. Basic needs approaches of the 1990s, with Max-Neef (1991), and Doyal and Gough (1991) investigating questions of material presuppositions necessary for human lives, laid out some theoretical notions

which are still deemed relevant today. Amartya Sen's (1987) work introduces the capability approach to conceptualise needs and desires from a different perspective, a work which was further developed e.g. by Martha Nussbaum (2000). From a postcolonial feminist perspective, the critical question remains whether any universal basic needs or desires rooted therein can be formulated, as a universal attempt necessarily disregards the "disparate historical configurations of family, community, society, and state that differently frame practices, vulnerability, as well as agency, in the postcolonial world" (Dhawan, 2018, p. 106).

Others argue, that while the ways needs are perceived and met vary socio-culturally, certain material conditions can be perceived as universal in our globalised world:

> We see the DLS [Decent living standards] as a set of material conditions that people everywhere ought to have, no matter what their intentions or conception of a good life, or what other rights they may claim. These material requirements have no intrinsic value of their own. They are justified as entitlements only to the extent they are essential preconditions to meet basic needs or provide central capabilities (Rao & Min, 2018a, p. 226).

Whether necessary material conditions can be considered without relations to specific socio-historical configurations remains an important open question, which becomes even more pertinent when working with marginalised communities in both the Global South as well as the Global North. While the question of universal basic persists as a contested one, the climate crisis and globally growing inequalities provide evidence of people overconsuming, appropriating too much space, energy and resources, hindering others at an *intra*generational (within one generation) and *inter*generational (between different generations) level to get a just share. This suggests that there are limits to consumption, just as there are biophysical limits to resources and sinks. This is the approach Kate Raworth (2013) took when formulating the Safe- and just-Space (SJS) concept. Inspired by the concept of planetary boundaries by Rockström J. et al. (2009) - the safe space - which formulates thresholds in the earth's biophysical capacity to absorb emissions, Raworth analysed the national and regional government submissions to the Rio+20 Conference (UN Conference on Sustainable Development) in 2012. On this basis, she identified 11 social issues, which were reported by more than 50% of the submissions, as lower social boundaries (Raworth, 2013). The Safe-and-Just-Space conceptually lies above the defined lower boundary, which in Raworth case is defined as 'no deprivation', but also within the biophysical limits of planetary boundaries. This idea has further been conceptualised as consumption corridors, as defining the space where sustainable consumption is possible (Di Giulio & Fuchs, 2014; Pirgmaier, 2020).

Raworth's framework is closely aligned with the Sustainable Development Goals (SDGs), which were adopted in 2015 with the Agenda 2030 for Sustainable Development by all UN member states, building on the Rio+ Conference as well as the UN Millennium Development Goals of 2000 (O'Neill *et al.*, 2018).

Following Raworth's theoretical conceptualisations, several authors attempted to empirically use the Safe-and-just-Space framework (Cole *et al.*, 2014 in South Africa; Dearing *et al.*, 2014 for Chinese provinces; O'Neill *et al.*, 2018 at a global level) by linking the defined priorities to regionally relevant and/or available quantitative indicators. The research provides empirical evidence that basic social priorities can be globally achieved within planetary boundaries. Similarly, papers of *(Baltruszewicz et al.*, 2021; Vogel *et al.*, 2021) investigate possibilities to cater for social needs at low levels of energy consumption to stay within planetary boundaries.

As the SJS-framework shares many commonalities with the SDGs, we closely matched the definitions and data sources for the selected indicators of social priorities with already existing SDG-indicators. Table 3 presents the SDGs matched with the social priorities as defined in Raworth (2013).

Table 3. Sustainable development goals & Raworth's (2013) Safe-and-just-space social priorities. Matched by authors.

UN SDGs (2015). 17 goals	Raworth's SJS (2013). 11 social priorities
Goal 1. End poverty in all its forms everywhere	No deprivation in income
Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture	No deprivations in food
Goal 3. Ensure healthy lives and promote well-being for all at all ages	No deprivation in health care
Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	No deprivation in education
Goal 5. Achieve gender equality and empower all women and girls	No deprivation in gender equality
Goal 6. Ensure availability and sustainable management of water and sanitation for all	No deprivations in water and sanitation
Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all	No deprivation in energy
Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	No deprivation in jobs
Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation	No deprivation in resilience to shocks (also relates to Goal 11)
Goal 10. Reduce inequality within and among countries	No deprivation in social equity (also relates to Goal 16)
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable	(No deprivation in resilience to shocks)
Goal 12. Ensure sustainable consumption and production patterns	-
Goal 13. Take urgent action to combat climate change and its impacts	-
Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development	-
Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	-
Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	No deprivation in voice; (No deprivation in social equity)
Goal 17. Strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development	-

The following section elaborates on the social priorities indicators that have been selected for the NEVERMORE project and their relevance with regard to the climate crisis as well as mitigation and adaptation measures. Access to clean drinking water, safe sanitation and sufficient nourishment can all be considered as key determinants to human health and needs. While these factors are key-dimensions of the SDGs (Goal 6 and 2) and often discussed for countries in the Global South, it is important that – in light of existing inequalities and the climate crisis – they are also considered for countries of the Global North. On this basis, they have been selected as indicators to be considered in NEVERMORE when assessing climate change adaptation and mitigation measures as well as general developments related to climate change. **Access to drinking water** can be assessed by referring to data by the World Bank's World Development Indicators, which collect data on people using safely managed drinking water services per country and measures the percentage of population using safely managed drinking water services country. **Access to safe sanitation facilities** is equally assessed by the World Banks' World Development Indicators and measured as the share of people using safely managed

sanitation services per country. **Sufficient nourishment** is most commonly defined in relation to a specific dietary energy requirement, measured in kilocalories. For measuring sufficient nourishment at EU-level, the calculation of the inverse of the indicator prevalence of undernourishment, which is provided by the World Bank World Development Indicators has been selected.

Healthy life expectancy is commonly defined as the number of years a person at birth is expected to live in a healthy condition, i.e. in the absence of limitations in functioning or a disability. Living expectancy, and particularly healthy living expectancy strongly depend on many different factors, such as clean air, access to clean drinking water and sanitation, nutrition – most of which are considered as social priorities in this section – as well as the provisioning systems related to these areas (Barrett *et al.*, 2015; Vogel *et al.*, 2021; see also section 5.5). Healthy life expectancy has further shown to be strongly linked to inequalities, with persons with a low socio-economic status, i.e. a low status relating to their level of educational attainment, field of employment and income, have been shown to have a lower expectance of both years they spent healthy as well as years they are alive in total (Assari, 2018). Further dimensions of inequalities, such as gender and race, equally need to be considered in this regard (Assari, 2018; see also section 5.3). Both the factors leading to climate change as well as its foreseen consequences can strongly impact the amount of years people live a healthy life (Bardi & Perini, 2013; Barrett *et al.*, 2015). Data for healthy life expectancy is provided by Eurostat and available at country level.

Energy poverty describes the phenomenon of people not having access to modern energy services that help guarantee their health i.e., heating, cooling, lightning, or cooking activities. This can be related to financial poverty and other dimensions of possibly intervening inequalities, such as age, gender, race, disability and origin, which should be considered in an intersectional manner (Jessel *et al.*, 2019; see also section 5.3). In addition, energy insecurity can be related to lacking access to energy sources, related to provisioning, but also in relation to environmental hazards or conflicts (Jessel *et al.*, 2019). Importantly, the need to keep one's home adequately warm is also related to the climate zone of living, as well as conditions and insulation of the building or shelter (Rao & Min, 2018b). As social priority, **the absence of energy poverty,** i.e. being able to keep one's home adequately warm**,** was selected as indicator for NEVERMORE. Corresponding data is provided by the EU-SILC dataset, which is available at Eurostat.

The last two factors included as indicators for the realm of social priorities encompass a basic level of education as well as the absence of financial poverty. As has been elaborated already, both are decisive factors when it comes to individual behaviours (see section 5.1) and are related to inequalities and resulting vulnerabilities (see section 5.3).

The definition of **basic education** needs to be specified in a context-sensitive manner and can be assessed with a focus on different aspects of education. The Human-Development-Index for example includes the mean year of schooling as indicator for formal basic education. In the context of NEVERMORE, the following two indicators, which are part of the EU SDG 4 reporting, have been selected to represent basic education:

(1) The share of the population having successfully completed at least primary education as highest level of education. Corresponding data can be calculated as the inverse of the share of population whose highest education is primary education and is provided for 20- to 64-year-olds by the EU labour force survey (EU-LFS) and available at Eurostat by NUTS2 region and gender.
(2) A basic educational attainment can also be defined as not leaving school and training early. Corresponding data describes the share of population, aged between 18 to 24, who have

attained no education, primary education or secondary education as highest education and who are not enrolled in further education or training. Corresponding data is provided by the EU-LFS at NUTS2-regional level and can be adjusted by gender.

In parallel with basic education, there are also multiple ways to define the **absence of financial poverty**, depending on the underlying interest. The measurement selected in the context of NEVERMORE is the inverse of the share of people who are at risk of poverty and social exclusion. This index (see section 6.1 for the explanation of an index) is composed of the following three dimensions and represents the share of those members of the population who are affected by more than one of the following dimensions:

- At-risk-of-poverty rate indicates the share of people whose equivalised disposable income (including social transfers), undercuts 60% of the national median equivalised disposable income.
- The severe material and social deprived rate indicate the share of individuals in a population, who cannot afford necessary and desirable goods, services or social activities to lead an adequate life. People are listed as severely materially and socially deprived, if they meet 7 of 13 defined criteria for household (e.g. the capacity to face unplanned expenses) and individual related items (e.g. having two pairs of shoes, which fit properly). All items are listed here.
- Living in a household with low work intensity is defined as share of persons living in a household where all those members aged 18-64, who are not in education or training, together have only worked 20% or less, compared to full-time equivalents, during the previous year.

5.5. Social Provisioning

The nation state, the market, neighbourhoods or other communities and families/households structure the ways people provide for others and themselves (Narotzky, 2005). The provisioning approach emphasises the role of institutions for organising flows of goods and services. In forms of networks, techniques, material stocks, and manufacturing, institutions mediate the ways biophysical resources are used and transformed into material and cultural means that contribute to human needs satisfaction (Fanning *et al.*, 2020; O'Neill *et al.*, 2018). Globally, prevailing capitalist economic structures have led to a commodification of provisioning (Pirgmaier, 2020). The way these institutions have formed is shaped by socio-cultural, economic and historic processes, which is why the specific configurations of provisioning systems vary across societies (Fanning *et al.*, 2020). In any society, however, there are several possible pathways for the provision of similar goods and services (Narotzky, 2005).

Consider the individual need for getting from point A to point B. The way an individual can move depends, amongst their (dis-)ability to walk, or drive a specific vehicle, on the availability of means, such as an individually or collectively owned car or a bike, public transport systems such as trains or busses as well as infrastructure such as rails, streets or biking lanes for using specific means. In the context of these, the individual can decide how to get from A to B. In this vein, Susana Narotzky (2005) emphasises the complexity of provisioning. Underlying processes of production, distribution, appropriation and consumption interfere with social relations, processes of social differentiation, identity creation and meaning-making (Narotzky, 2005). In relation to the introduced example of the individual needing to get from A to B, an individual, who identifies as environmentally conscious might make a different choice than one who prioritises the comfort of individual car mobility. A single-mother, who needs to bring her child to the kindergarten and do chores and errands on the way to her

workplace, might have different time-constrains and potentially different space requirements for moving from A to B.

In the context of the climate crisis, provisioning systems have emerged as useful lens to understand levels of resource use and social conditions, as they configure the ways social priorities or needs can be met individually and at a societal level (O'Neill *et al.*, 2018, 2018; Vogel *et al.*, 2021). A provisioning system is considered efficient if a high level of human well-being can be achieved with using little resources (Fanning *et al.*, 2020). On the basis of interconnected relationships amongst their manifold social and physical elements, these systems can be considered complex. They exhibit feedback mechanisms and tend to reproduce unequal relations of power. The latter is, according to Andrew L. Fanning, Daniel W. O'Neill and Milena Büchs (2020), related to appropriating sub-systems, which are currently part of provisioning systems. These appropriating and hence rent-extracting systems satisfy the *wants* of a few, rather than the *needs* of a small section of society at the expense of efficient provisioning for all. An example thereof are the rising costs of renting a privately-owned or corporation-owned flat, which come at the expense of those who need housing. Simultaneously, these rising rents generate profits for the asset owner(s) that exceed the proportionate compensation of labour related to their house ownership.

Alternating the configuration of provisioning systems therefore bears potential for transformative changes. Rather than modifying its elements, a transformation of the relations amongst existing elements is considered more efficient, with the most effective change, however, being a redefinition of the purpose of a provisioning system (Fanning *et al.*, 2020; Meadows, 1999).

Current research of provisioning systems in the context of the climate crisis asks for the role of provisioning systems in facilitating sustainable individual behaviour and practices (Wiedmann et al., 2020). In this vein, Diana Ivanova and Milena Büchs (2022) argue for the social and environmental potential of sharing and cooperation practices in the provisioning of goods and services. Katharina Bohnenberger (2020) investigates the role of welfare states as historically specific structures of public provisioning systems of the Global North. In their empirical study of globally available data, Jefim Vogel and colleagues (2021) use the concept of provisioning factors as a characterisation of provisioning systems. In consideration of extraction, production, distribution, consumption and disposal, they identify provisioning factors, which are positively related to higher need satisfaction at lower energy use. These so called beneficial factors comprise public service quality, income equality, democracy, and access to electricity (Vogel *et al.*, 2021). In contrast, some provisioning factors increase the needed energy for need satisfaction and are hence considered detrimental from a social-ecological perspective. This concerns for example economic growth and extractivism[2] (Vogel *et al.*, 2021).

Our selection of indicators related to social provisioning and provisioning systems mainly build on the work of Vogel and colleagues (2021), as they used provisioning factors as a means to characterise and quantify key-characteristics of provisioning systems. Additionally, indicators used in the framework of decent living standards (DLS Rao & Min, 2018a), as well as dimensions of the Sustainable Development Goals (SDGs) not yet covered amongst the social priorities indicators (section 5.4) were included. Importantly, and in contrast to section 5.4, our indicators of provisioning systems or factors suggested for this section are not per se indicators of human need satisfaction, but intermediaries structuring individual and societal practices and related needs for energy and resource flows.

The indicator **sustainable communities** has been selected in relation to SDG 11 (Make cities and human settlements inclusive, safe, resilient and sustainable). Inclusive and sustainable settlements are more resilient to climate change (see section 5.3) and hence beneficial for both climate change adaptation and mitigation policies. Sustainable communities can, however, represent a

[2] Extractivism relates to the practices of removing large amounts of natural resources specifically for the purpose of export and is particularly related to (neo-)colonial practices in the Global South (Acosta, 2013).

multidimensional concept, which is why they are best included as an index, summarising important aspects in one common score (see section 6.1). For NEVERMORE, three dimensions of sustainable communities are described in more detail:

(1) Housing deprivation. A severe deprivation thereof is defined as population living in overcrowded dwellings with at least one of the following issues: leaking roof, no bath/shower, no indoor toilet, too dark for living. Corresponding data is available at EUROSTAT at country level.
(2) The Soil sealing index compares the increase in sealed soil through construction to the share of sealed soil in 2006 as base year. Data is provided by EUROSTAT at country level.
(3) Victims in road accidents. Road safety is strongly linked to making settlements safe as a whole. The corresponding indicator is therefore used by EUROSTAT to monitor progress for SDG11. Corresponding data is available at NUTS2 and hence at regional level.

When using energy, individuals largely depend on the locally available energy sources as well as corresponding public and private infrastructures. In case nationally provided systems largely depend on fossil fuels, also the individual energy use is likely to be have a larger footprint (Rao & Min, 2018a; Suranovic, 2013). Therefore, Vogel and colleagues (2021) considered access to clean energy an important provisioning factor, which statistically proved to support meeting social needs with lower energy consumption. In combination with SDG 7 (Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all), the indicator of **renewables**, which signifies the share of renewable energy in gross final energy consumption was chosen for the NEVERMORE project. Corresponding data is provided by EUROSTAT at country level.

The organisation of mobility can also be considered as a provisioning factor as it determines how individuals and communities move and how much energy and resources they need while doing so (Ivanova & Wood, 2020; Wiedmann et al., 2020). The indicator selected to capture this dimension for NEVERMORE is the **share of collective transport** in total transport. Data is provided by EUROSTAT at country level, whereas the modes of collective transport considered only extend to busses and trains, as data collection for trams and metros is not yet harmonised. This dimension further relates to SDG 9 (Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation).

Similarly, local waste management systems influence individual as well as societal waste-related practices. Rao an Min (2018a) list safe waste disposal as a key indicator for decent living standards. In relation with SDG 11 (Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable) the indicator for **municipal recycling** was chosen for NEVERMORE. This indicator measures the share of recycled municipal waste amongst all the waste generated by households as well as small businesses and public institutions that has been collected by the municipality. Corresponding data is provided by EUROSTAT at country level.

In light of persisting inequalities, the provision of public services is an important factor for sustainable welfare (Bohnenberger, 2020). The way services are provided influences how and by whom they can be used. Therefore, **public service quality** was considered as provisioning factor, which also statistically decreased the resources needed for meeting social needs (Vogel *et al.*, 2021). Further, public service quality also relates to SDG 16 (Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels). Similar to the sustainable communities' indicator, public service quality is a multidimensional concept, which is therefore best represented as an index, capturing multiple dimensions thereof (see section 6.1). Vogel and colleagues (2021) created an additive index based on quality of public services, civil service and policy implementation, which was then rescaled from 1 to 6.

Corresponding data is available for all three dimensions at the World Bank's Worldwide Governance Indicators at country level.

The organisation of the health system influences whether health care is only available to those who can afford it, or to everyone, who is in need. **Public health coverage** has empirically improved a population's health and has been shown to be particularly beneficial for financially deprived members of societies (Moreno-Serra & Smith, 2012). As provisioning factor, public health coverage also beneficially decreased the necessary energy use for meeting individual needs in the statistical model by Vogel and colleagues (2021). This factor further relates to SDG 3 (Ensure healthy lives and promote well-being for all at all ages) and is related to the DLS-Framework (Rao & Min, 2018a). As possible measurement of public health coverage data provided by EUROSTAT on self-reported unmet needs for health care have been selected. Public health coverage might therefore be calculated as the inverse of the unmet needs for health care. The available dataset provides data for these unmet needs at country level and includes data on gender, age and location of living for further disaggregation.

Also the **democratic quality** of a country can be considered as provisioning factor (Vogel *et al*., 2021). For this sector, both indicators already listed in the section 5.1.3 (Society and Politics) as well as 5.2 (Political System) can be used.

Whether and how people are employed is strongly correlated with their possibilities for making a living and social security and hence the way they can sustain their livelihoods. On this basis, the indicator of **decent work** has been selected in relation to SDG 8 (Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all). According to the ILO's Decent Work agenda, decent work "involves opportunities for work that is productive and delivers a fair income, security in the workplace and social protection for all, better prospects for personal development and social integration, freedom for people to express their concerns, organise and participate in the decisions that affect their lives and equality of opportunity and treatment for all [persons of all genders]" (ILO, 2023). Decent work is hence a multidimensional concept, which might again be best captured as an index summarising several dimensions. For NEVERMORE, three indicators capturing relevant aspects have been selected:

(1) The share of NEETS, i.e. young people aged 15 to 29 years, who are neither in employment, nor in education nor training. Corresponding data is provided by EUROSTAT at NUTS2-regional level.
(2) The long-term unemployment rate, which measures the share of the population aged between 15 to 74 years who is not in education and unemployed for more than a year. Corresponding data is provided by EUROSTAT at country level and can also be split by age, gender and educational attainment.
(3) Employment rate by citizenship. This indicator measures the share of persons aged between 20 and 64 who are currently employed, i.e. they worked at least for one paid hour in the week of reference, by EU and Non-EU citizenship. Corresponding data is available at EUROSTAT at country level.

Social inequalities interfere with the ways needs are considered and met at a societal level and therefore have to be considered as provisioning factors according to Vogel and colleagues (2021). Correspondingly, SDG 10 calls for the reduction of 'inequality within and among countries.). In this regard, two indicators have been selected for NEVERMORE to represent dimensions of inequalities: inequalities of income and gender equality.

Inequality of income strongly mediates access to resources as well as individual capabilities (Thomas *et al.*, 2019; Vogel *et al.*, 2021). **Income equality** can be measured using different approaches, whereas three have been selected for the context of NEVERMORE:

(1) The Gini coefficient is one of the most commonly used indicators of income inequality and – since it is a measure of dispersion – it can take on values amongst 0 (perfect equality) to 1

(perfect inequality). Data for the Gini coefficient of equivalised disposable income is provided in the EU-SILC survey at country level.

(2) The ratio of total income received by the 20% of population who earn the most to the 20% of population who earn the least. Total income is defined as equivalised disposable income. Corresponding data is provided by EU-SILC at a country level, with disaggregation options for age groups and different genders.

(3) Purchasing power adjusted to GDP per capita indicates the GDP-harmonised purchasing power standards per NUTS2 region, as corresponding data is equally provided by the EU-SILC survey.

As further important category of social differentiation and inequality **gender equality** has been selected as provisioning factor to be considered in the NEVERMORE project – relating to both SDG 5 (Achieve gender equality and empower all women and girls) as well as the SJS-framework. Unequal gender relations influence multiple dimensions of individual living realities, which is why gender equality is necessarily measured with a multidimensional index. The European Institute for Gender Equality (EIGE) regularly assesses an index based on 31 items covering areas of gender equality in the realms of work, money, knowledge, time, power and health. Unfortunately, the corresponding indicator only covers a binary understanding of gender, i.e. relates to men and women only, excluding inter or non-binary persons, as well as relevant differentiations between cis and transgender persons. For the year 2022 however, the indicator tries to consider at least other intersecting dimensions of inequalities such as disabilities, age, level of education, country of birth and family type, which are included in the data set provided.

5.6. The role of social innovation for sustainable transformation

In this section, we present the concept of social innovation and explore its role in societal transformation towards sustainable climate futures as well as adaptation and mitigation scenarios. We first explain how social innovation can be conceptualised and its possible contribution to the NEVERMORE project. Then, we outline different approaches to investigating and understanding social innovation for characterising the NEVERMORE case studies, thus setting the basis for research guideline #2 and research guideline #3.

Research on social innovation has considerably increased in recent years, which has also been accompanied by a multitude of different definitions and conceptualisations (Mihci, 2020). For this report, we focus on a general **definition of social innovation** that has been developed and applied to different (policy) areas in the context of the SI-DRIVE project (https://www.si-drive.eu/). Accordingly, social innovation is "a new combination or figuration of practices in areas of social action, prompted by certain actors or constellations of actors with the goal of better coping with needs and problems than is possible by using existing practices. An innovation is therefore social to the extent that it varies social action and is socially accepted and diffused in society" (Howaldt *et al.*, 2014, p. 122; see also Schuch & Šalamon, 2021). Thus, social innovations consist of several dimensions: they **address and aim to improve social or societal issues** – such as climate change –; they include some kind of **novel aspect** to qualify as innovative, for instance by applying solutions in a new context or with new actors; social innovations are **intentionally developed and initiated by actors or groups of actors**, whereby "actors" is understood broadly and might encompass NPOs, citizens, or social businesses; and finally, social innovations **provide solutions** which address the respective issue and **lead to change**, in attitudes, knowledge, behaviours, or social practices. Changed social practices refer to a change of routinised behaviour and the activities, knowledge, and materials involved in this behaviour (Strengers, 2014).

In addition to changed social practices, social innovations might also lead to change on a larger scale by contributing to the development of new institutions or even changes in a socio-economic system, such as systems of governance and decision-making (Castro-Arce & Vanclay, 2020; Kluvankova *et al.*,

2021). Changes on the level of systems can be understood as **(societal) transformation or transitions**. In the context of climate change, the role of social innovation for **sustainability transitions** has become a focal point of research, as the transition towards a sustainable and climate-neutral society necessitates changes not only in practices, but more importantly in socio-economic systems and their institutions.

To make the idea of social innovation and how it contributes to transitions and transformations more tangible, we provide some examples of research on social innovations in the sustainability context. Suitner et al. (2022) investigated the role of social innovation for energy transitions in two rural regions in Austria. They scrutinised the relationships between actors, tracing how the regions' energy sectors changed, and which new actors, practices, and products had been developed and implemented. Angelidou and Psaltoglou (2017) investigated 29 social innovation initiatives for sustainable urban development to better understand the role of citizens and social businesses in these initiatives. The social innovation initiatives were involved in activities such as self-organising the distribution of recycling bins, citizen science projects, providing a platform for restaurants to donate leftovers, or setting up a community farm. Another study focused on an organisational network in rural Brazil that transformed the agricultural system as well as how food is produced and sold as a case study of social innovation (Rover *et al.*, 2016). Specifically, the authors examined the actors (in this case, NGOs) involved in the network and their dynamic, their intentions and motivations to participate, and how they were embedded in and interacted with the regional system of policies and regulations and the socio-economic system. These examples demonstrate that researching social innovation can help to better understand regional efforts towards climate mitigation and adaptation as well as sustainable futures.

We suggest investigating the potential for social innovation and transformation in the NEVERMORE case studies to better understand the local actors, their relationships, and the societal, political, and socio-economic systems they are embedded in. Social innovations are always embedded within social structures and develop over time; therefore, social innovation should be approached from different levels (i.e., a micro, meso, and macro level), considered at different stages in its development and within its context (Krlev & Terstriep, 2022; Unceta *et al.*, 2020). To acknowledge this complexity, we develop two different but complementary research guidelines.

Research guideline #2 takes on an actor-centred perspective and focusses on local climate change actors, how they are embedded within their social and policy system, and their perspective on regional transformation. Thus, this research guideline provides an understanding of the regions' social structures and ongoing work on climate change and climate action. Moreover, it aims to understand how the local actors negotiate and enact different interests, which challenges they observe, and how access to resources and power is distributed. Thus, guideline #2 follows scholars such as Avelino (2017) and Avelino et al. (2017) in considering that the actors involved in climate change have different degrees of power over decisions and outcomes, that power influences the relationships between actors and the potential for transformations, and should hence be considered for understanding processes of change. Here, we understand power as the "(in)capacity of actors to mobilise resources and institutions to achieve a goal" (Avelino, 2017, p. 515). For instance, actors who represent existing institutions such as local governments or agencies might have more power than a local citizen initiative because they can utilise the resources available in their institution and are part of political and professional networks. These different levels of power should be considered to better understand who is involved in a given climate action, who is excluded, and why this might be the case. Hence, a power-sensitive perspective provides a more comprehensive picture of a region's potential for social innovation and transformation that cannot be gained by studying already successful social innovation initiatives. Furthermore, processes of social innovation and transformation can also reduce power of some of the involved actors when social structures shift and new groups get involved (Avelino *et al.*, 2017). In sum, research guideline #2 proposes to investigate local climate actors, specifically policy

representatives on the one hand and representatives from social movements and initiatives or activists on the other hand, to better understand the regional social structures, relations and dynamics between these actors, the distribution of power, and the perspectives on climate change and necessary climate actions. Thereby, the research guideline #2 sets the basis for researching social innovation in research guideline #3, which focusses on the macro and meso level.

In social innovation research, the macro level usually refers to "society" manifested at the national or country level and tries to define a status quo of social innovation, which can then be measured with indicators and compared across societies or countries (Krlev *et al.*, 2014). As social innovation can be influenced by a variety of different factors and actors, macro level analysis allows a top-down view to grasp the interrelations between these different factors and actors, though without in-depth information. In this view, we follow the conceptualisation by Krlev et al. (2014) and Bund et al. (2015), who define an input – throughput – output model of social innovation on the national level. The **input** dimension captures the framework in which social innovation takes place and includes available financial and human resources, infrastructure, prevalent social norms such as solidarity, the regulative and legislative framework, cultural institutions, the political environment and awareness about social innovation, and the social needs and demands. The **throughput** represents social innovation activities, referring to activities by businesses, NGOs, or networks, or other types of collaboration in the social, political, cultural, economic, or ecological area. Social innovation activities encompass developing ideas or knowledge, mobilising resources to realise these ideas, and the implementation. Finally, the **output** dimension refers to positive social outcomes assumed to be the results of social innovation activities, which might be better access to health care or preserving biodiversity. To conclude, the macro level approach towards social innovation allows for a comprehensive snapshot of the status quo in a given country as well as for comparison across countries. However, it does not allow for an in-depth understanding of contexts, actors, drivers, and solutions in the field of social innovation; this understanding requires further research activities. To characterise the NEVERMORE case studies with regards to their frameworks, activities, and outcomes, gain an overview of the state of social innovation, and provide a basis for further investigations, we propose to apply the indicator framework by Krlev et al. (2014) and Bund et al. (2015) to the case studies using national or, if available, regional secondary data.

The meso level usually comprises organisations, institutions, networks, or communities and their relationships. To understand social innovation on the meso level, we follow the approach of social innovation ecosystems (see Sgaragli, 2014). Social innovation ecosystems expand the focus on actors as agents of social innovation to their environments and networks (Domanski, 2018). Particularly common in researching urban contexts, social innovation ecosystems as a theoretical framework capture the cooperation between actors from different sectors, how their relationships develop and change, and how they are governed (Domanski *et al.*, 2020). Relatedly, social innovation on the meso level has often been investigated using social network analysis, in which actors engaged in social innovation activities are represented as being part of a social network and their relationships are visualised (Kolleck, 2013; Lombardi *et al.*, 2020). These networks can then be further examined regarding their structures and links, collaboration and cooperation between network actors, which actors or types of actors are central to the network and connect with other networks, or its flows of information. Networks can be compared across communities or regions and over time. However, network analysis of social innovation is limited to a structural understanding whereas motivations, experiences, and perceptions of the network actors themselves are not in the focus. As such, the social innovation ecosystem framework expands the social network approach by not only considering actors and relationships, but also their resources, barriers, and capabilities within the ecosystem (Domanski, 2018). Moreover, social innovation ecosystems emphasise that not only social businesses are considered as relevant innovation actors, but that social innovation can take place in all sectors, including civil society, public authorities and governments, or academia (Domanski, 2018). The relationships and collaborations between actors from different sectors should also be considered for

understanding social innovation. Following the idea of ecosystems, we suggest to investigate the meso level of social innovation in the NEVERMORE case studies by collecting and mapping existing social innovation actors from different sectors. We do not necessarily advise to create a network, as capturing the relations between the actors can be very time-consuming error-prone; we refer interested readers to Kolleck (2013) and Lombardi et al. (2020) for more information on social innovation networks. Instead, we suggest to use the mapping of actors a) as a more detailed overview of social innovation activities in the region not gained with indicators alone, and b) as a starting point for inviting actors to the focus group interview discussed in research guideline #3.

6. Research Guidelines

6.1. Research guideline #1: Collecting data on the socio-economic situation and structure of the case-study regions (a secondary-data analysis)

One of the most common methods to collect quantitative data in the social sciences are surveys. Surveys present a set of questions to individuals, households, or experts and ask for responses to a pre-defined set of answers. In order to create a survey, the research objective is turned into multiple questions, so-called items. Items are also called indicators and operationalise the research questions by turning them into measurable entities (Gray *et al.*, 2007). Questionnaires often contain closely related items to measure a complex concept in slightly different ways and gain a more comprehensive picture of the concept. Thus, the overall pattern of responses to these related questions produces multiple measures of one concept and may be more accurate than one indicator (Gray *et al.*, 2007). To conclude, one indicator measures one dimension of a concept and provides the respondent with several answers to choose from. Usually, the answer options are labelled for better understanding, e.g., on a scale from “Agree not at all” to “Agree completely”. For the analysis, the answers are transformed into numbers, whereby the numbers represent how strong the concept is endorsed by the participant. For instance, the answer “Agree not at all” would be transformed into the number one, whereas “Agree completely” might be transformed into the number 5 to represent stronger agreement.

Indexing and scaling are techniques for measuring complex phenomena in social science. These include behaviour and attitudes – such as “political trust” or “perceived behavioural control”. The validity and reliability of these constructs can be increased by operationalising them using multiple indicators. Thus, several indicators can be combined into a single composite measure of a behaviour, attitude, or any other concept, which is called index. An index, which consists of several indicators, represents a greater range of the concept’s dimensions and hence reflects complex concepts more accurately (Gray *et al.*, 2007).

Before the operationalisation, these indicators must be logically related to the measured concept. An index consists of multiple indicators which measure a common, hence unidimensional construct. At the same time, an index might contain questions designed to measure different domains of a concept. Major criteria for the selection of these items are conceptual balance (i.e. they measure all important dimensions), validity (they measure aspects of the measured concept), and statistical relationship (they correlate with each other).

Depending on the type of scale that was used in the survey, the concept that was measured, or the research objective, indicators can be summated, multiplied, or weighted. For additive indices, the values of all individual items are added n these, the questions asked in certain surveys are designed to tap different domains of concepts but no item is considered more important than the other. The most comprehensible scale in additive ratings is the Likert format, in which answers are assigned numbers,

most commonly from 1 to 5. (Gray *et al.*, 2007) Importantly, all added items need to follow the same scale (e.g. a Likert scale ranging from 1 to 5).

An average score index can be a continuation from added indices, with the value of the index representing the average score of the composing indicators, rather than their sum. An example of averaged indices, the measurement of political trust, is shown below in Figure 3.

Items	Response on a scale from 1 - 5
How much confidence do you have in the parliament?	2
How much confidence do you have in the European Union?	3
How much confidence do you have in political parties?	3
How much confidence do you have in the government?	1

Figure 3. Example of an averaged index. Source: Questionnaire European Values Study 2017[3].

Indices can also be built by multiplying or weighting the items. In weighted indices, the weights are chosen based on theory or prior estimated and multiplied by the value of the individual item. For example, when creating an index for socioeconomic status, questions regarding income, occupation, and education are asked. One might think of income as being more important than occupation and thus weighing it when building an index. In conclusion, the decision whether to add, multiply or weigh an item to build an index is dependent on theoretical assumptions and scales used in the conducted research.

The indicator collection by ZSI (Table 4) provides indicators for different concepts which are relevant for understanding environmental behaviour change, policy change and climate change impacts on society or societies' resources to deal with adverse climate change impacts. Overall, five topics with 59 quantitative indicators were derived from extensive research of relevant literature. The indicators have been selected in relation to already available datasets and are available on different levels, i.e., some provide for regional data (NUTS-2), while others provide for data at a country level. When using the indicator compilation, individual indicators of the table can be selected depending on the research focus. In addition, the indicators relating to the Political System (V-Dem & Environmental Democracy Index, see section 5.2) and Resilience & Vulnerability (Global Resilience Index, see section 5.3) can be used as indices.

[3] https://europeanvaluesstudy.eu/methodology-data-documentation/survey-2017/full-release-evs2017/participating-countries-and-country-information-survey-2017/

Table 4. Full indicator table.

Topic	Indicator	Description of indicator	Accessible Data Sources	Level of data availability	Link to Data Sources
The topic the indicator relates to	*The name of the indicator*	*What the indicator captures and how the indicator can be assessed in the context of NEVERMORE*	*Names of already existing data sources collecting related data*	*Indicates the granularity of data available (country/NUTS2)*	*Lists accessible links to data sources named in the tab Accessible Data Source*
Behaviour Change	Area of residence	Characterisation of area in which a person lives. Usually asked on a continuum from rural to urban area (that's how it's measured in the corresponding item); however, coastal areas are also relevant.	European Social Survey 2020; European Values Study 2017	European Social Survey 2020: Individuals; countries. NUTS 1 NUTS 2 regions, NUTS 3 regions not yet available. European Values Study 2017: Individuals; NUTS 1, NUTS 2, NUTS 3, country.	https://www.europeansocialsurvey.org/docs/round10/questionnaire/ESS-Round-10-Source-Questionnaire_FINAL_Alert-06.pdf
Behaviour Change	Climate Change Engagement	The extent to which a person thinks about and (cognitively) engages with climate change. This indicator also covers the concept of "climate change belief", a person's belief in human-made climate change; the concept of "climate change knowledge", knowledge about climate change causes, effects, and impacts; and "concern for climate change and environment", worry and concern about climate change and its effects and on topics regarding the environment at large.	European Social Survey 2016; International Social Survey Programme: Environment IV - 2020; European Values Study 2017	European Social Survey 2016: Individuals; NUTS 1, NUTS 2, NUTS 3, country. International Social Survey Programme: Environment IV - 2020: Individuals; Region (not clear which specification, perhaps NUTS 2); country European Values Study 2017: Individuals; NUTS 1, NUTS 2, NUTS 3, country."	several sources; see sheet "items"
Behaviour Change	Dwelling Size	The space available to household members	/	Household	
Behaviour Change	Environmental activism	Extent to which a person participates in forms of activism or political participation with relation to climate change and environment	International Social Survey Programme: Environment IV - 2020	Individuals; Region (not clear which specification, perhaps NUTS 2); country	several sources; see sheet "items"
Behaviour Change	Environmental Identity	This indicator describes to which extent a person identifies as someone	/		

Topic	Indicator	Description of indicator	Accessible Data Sources	Level of data availability	Link to Data Sources
		environmentally-friendly or with the social group of environmentalists.			
Behaviour Change	Environmental Norms and Values	Environmental norms and values as an indicator cover different manifestation of morals, social norms, and values related to the environment. Under this indicator, we subsume different dimensions of norms and values often treated as different concepts in research: biospheric value orientation – the extent to which a person considers costs and benefits for the environment (ecosphere, biosphere); environmental identity - whether a person identifies as an environmental person and feels like they belong to other people or to the group of pro-environmentalists because identity determines behaviours; personal moral obligations to behave pro-environmentally; and perceived environmental norms - Whether a person thinks that the people around them endorse pro-environmental norms. The datasource linked in this row only covers biospheric value orientation.	European Social Survey 2016	Individuals; NUTS 1, NUTS 2, NUTS 3, country.	https://ess-search.nsd.no/en/study/f8e11f55-0c14-4ab3-abde-96d3f14d3c766
Behaviour Change	Environmental Policy Support	Being in favour of policies like emission taxes, government investments in renewable energies, etc.	European Social Survey 2016; International Social Survey Programme: Environment IV - 2020; European Values Study 2017; Life in Transition Survey III 2016	European Social Survey 2016: Individuals; NUTS 1, NUTS 2, NUTS 3, country. International Social Survey Programme: Environment IV - 2020: Individuals; Region (not clear which specification, perhaps NUTS 2); country European Values Study	several sources; see sheet "items"

Topic	Indicator	Description of indicator	Accessible Data Sources	Level of data availability	Link to Data Sources
				2017: Individuals; NUTS 1, NUTS 2, NUTS 3, country. Life in Transition Survey III 2016: Individuals, countries	
Behaviour Change	Environmental Self-Efficacy	Extent to which a person thinks that they are capable and that their actions make a difference	International Social Survey Programme: Environment IV - 2020; European Values Study 2017	International Social Survey Programme: Environment IV - 2020: Individuals; Region (not clear which specification, perhaps NUTS 2); country European Values Study 2017: Individuals; NUTS 1, NUTS 2, NUTS 3, country.	several sources; see sheet "items"
Behaviour Change	Everyday pro-environmental behaviours	Reports of or intentions to perform a behaviour positive for the environment that can be integrated in one's everyday life, such as consumption, lifestyle, resource use.	European Social Survey 2016; International Social Survey Programme: Environment IV - 2020	European Values Study 2017: Individuals; NUTS 1, NUTS 2, NUTS 3, country. European Social Survey 2016: Individuals; NUTS 1, NUTS 2, NUTS 3, country.	several sources; see sheet "items"
Behaviour Change	Formal education	Level of formal education / educational attainment	European Social Survey 2020; European Values Study 2017	European Social Survey 2020: Individuals; countries. NUTS 1 NUTS 2 regions, NUTS 3 regions not yet available. European Values Study 2017: Individuals; NUTS 1, NUTS 2, NUTS 3, country.	
Behaviour Change	Homeownership	The share of a population living in homes owned by themselves.	/	Household	
Behaviour Change	Household Size	The number of people living in the household	European Social Survey 2020; European Values Study 2017	European Social Survey 2020: Individuals; countries. NUTS 1 NUTS 2	

Topic	Indicator	Description of indicator	Accessible Data Sources	Level of data availability	Link to Data Sources
				regions, NUTS 3 regions not yet available. European Values Study 2017: Individuals; NUTS 1, NUTS 2, NUTS 3, country.	
Behaviour Change	Income	The money earned by all household members in a given period (weekly/monthly/yearly) in relation to a country's income levels.	European Social Survey 2020; European Values Study 2017	European Social Survey 2020: Individuals; countries. NUTS 1 NUTS 2 regions, NUTS 3 regions not yet available. European Values Study 2017: Individuals; NUTS 1, NUTS 2, NUTS 3, country.	https://www.europeansocialsurvey.org/docs/round10/questionnaire/ESS-Round-10-Source-Questionnaire_FINAL_Alert-06.pdf
Behaviour Change	Length of residence	How long people have lived in their current place of residence	/	Individual	
Behaviour Change	Locus of Control	Extent to which a person think they can control what happens to them and what happens around them	European Values Study 2017	Individuals; NUTS 1, NUTS 2, NUTS 3, country.	https://europeanvaluesstudy.eu/methodology-data-documentation/survey-2017/full-release-evs2017/participating-countries-and-country-information-survey-2017/
Behaviour Change	Perceived Behavioural Control	How easy or hard a person perceives a behaviour to be	/	Individual	
Behaviour Change	Personal Norms and Values	"This indicator covers a person's values and considerations when making decisions. High values indicate caring personal values. It subsumes altrustic values (extent to which a person considers costs and benefits for others when making decisions),) when making decisions), and egoistic values (Extent to which a person	European Social Survey 2016	Individuals; NUTS 1, NUTS 2, NUTS 3, country.	https://ess-search.nsd.no/en/study/f8e11f55-0c14-4ab3-abde-96d3f14d3c76

Topic	Indicator	Description of indicator	Accessible Data Sources	Level of data availability	Link to Data Sources
		considers costs and benefits for themselves when making decisions), as well as "			
Behaviour Change	Political Interest	Interest in politics, following politicis and political news	European Values Study 2017	Individuals; NUTS 1, NUTS 2, NUTS 3, country.	https://europeanvaluesstudy.eu/methodology-data-documentation/survey-2017/full-release-evs2017/participating-countries-and-country-information-survey-2017/
Behaviour Change	Political Trust	Trust in political institutions and political actors	International Social Survey Programme: Environment IV - ISSP 2020; European Values Study 2017; European Social Survey 2016	International Social Survey Programme: Environment IV - 2020: Individuals; Region (not clear which specification, perhaps NUTS 2); country European Values Study 2017: Individuals; NUTS 1, NUTS 2, NUTS 3, country. European Social Survey 2016: Individuals; NUTS 1, NUTS 2, NUTS 3, country.	several sources; see sheet "items"
Behaviour Change	Quality of Life	Quality of life a person perceives to have; subsumes the dimensions life satisfaction and wellbeing/happiness.	European Social Survey 2020; European Values Study 2017	European Social Survey 2020: Individuals; countries. NUTS 1 NUTS 2 regions, NUTS 3 regions not yet available. European Values Study 2017: Individuals; NUTS 1, NUTS 2, NUTS 3, country.	several; see Tab "Items"

Topic	Indicator	Description of indicator	Accessible Data Sources	Level of data availability	Link to Data Sources
Behaviour Change	Risk exposure	A person's actual or perceived exposure to environmental hazards, such as noise or pollution.	International Social Survey Programme: Environment IV - 2020 for perceived risk exposure	International Social Survey Programme: Environment IV - 2020: Individuals; Region (not clear which specification, perhaps NUTS 2); country	https://search.gesis.org/research_data/ZA7650
Behaviour Change	Risk perception	Perceptions about threats through climate change and environmental catastrophes and how likely they are or will be prevented	European Social Survey 2016; International Social Survey Programme: Environment IV - 2020; Attitudes of Europeans towards Biodiversity. Special Eurobarometer 481, 2018	European Social Survey 2016: Individuals; NUTS 1, NUTS 2, NUTS 3, country. International Social Survey Programme: Environment IV - 2020: Individuals; Region (not clear which specification, perhaps NUTS 2); country Attitudes of Europeans towards Biodiversity. Special Eurobarometer 481, 2018: Individuals; NUTS 1, NUTS 2, NUTS 3, country.	several sources; see sheet "items"
Behaviour Change	Social trust	Trusting other people in society / social environment	International Social Survey Programme: Environment IV - ISSP 2020; European Values Study 2017; European Social Survey 2016; Life in Transition Survey III 2016	European Social Survey 2016: Individuals; NUTS 1, NUTS 2, NUTS 3, country. International Social Survey Programme: Environment IV - 2020: Individuals; Region (not clear which specification, perhaps NUTS 2); country European Values Study 2017: Individuals; NUTS 1, NUTS 2, NUTS 3, country. Life in Transition Survey III	several sources; see sheet "items"

Topic	Indicator	Description of indicator	Accessible Data Sources	Level of data availability	Link to Data Sources
				2016: Individuals, countries	
Behaviour Change	Trust in Science	Trust in researchers and research institution	International Social Survey Programme: Environment IV - 2020	Individuals; Region (not clear which specification, perhaps NUTS 2); country	https://search.gesis.org/research_data/ZA7650
Political System	Access to environmental information	"Pillar 1 of the indicators to measure environmental democracy. Captures assessments of the right to freely access information on environmental quality and problems"	Environmental Democracy Index (2014)	Country	https://environmentaldemocracyindex.org/node/13967.html
Political System	Access to justice	"Pillar 3 of the indicators to measure environmental democracy. Captures assessment of the right to seek enforcement of environmental laws or compensation for harm. "	Environmental Democracy Index (2014)	Country	https://environmentaldemocracyindex.org/node/13967.html
Political System	Civil Society Participation	Measured with the civil society participation index; this aspect is also represented in participatory democracy. Is part of Asks whether major CSOs routinely consulted by policy-makers; how large is the involvement of people in CSOs; are women prevented from participating; and is legislative candidate nomination within party organisation highly decentralised or made through party primaries? The core civil society index CCSI is designed to provide a measure of a robust civil society, understood as one that enjoys autonomy from the state and in which citizens freely and actively pursue their political and civic goals, however conceived.	V-Dem (Varieties of Democracy)	Country	https://www.v-dem.net/data/the-v-dem-dataset/

Topic	Indicator	Description of indicator	Accessible Data Sources	Level of data availability	Link to Data Sources
Political System	Deliberative democracy	Measured with deliberative democracy index. Indicates to which extent the deal of deliberative democracy is achieved.	V-Dem (Varieties of Democracy)	Country	https://www.v-dem.net/data/the-v-dem-dataset/
Political System	Egalitarian democracy	Measured with the Egalitarian democracy index. Egalitarian democracy is achieved when 1 rights and freedoms of individuals are protected equally across all social groups; and 2 resources are distributed equally across all social groups; 3 groups and individuals enjoy equal access to power.	V-Dem (Varieties of Democracy)	Country	https://www.v-dem.net/data/the-v-dem-dataset/
Political System	Electoral democracy	Measured with electoral democracy index. Indicates to which extent the ideal of electoral democracy in its fullest sense is achieved.	V-Dem (Varieties of Democracy)	Country	https://www.v-dem.net/data/the-v-dem-dataset/
Political System	Liberal democracy	Measured with liberal democracy index. Indicates to which extent the ideal of liberal democracy is achieved.	V-Dem (Varieties of Democracy)	Country	https://www.v-dem.net/data/the-v-dem-dataset/
Political System	Participatory democracy	Measured with participatory democracy index. Indicates to which extent the deal of participatory democracy achieved.	V-Dem (Varieties of Democracy)	Country	https://www.v-dem.net/data/the-v-dem-dataset/
Political System	Political corruption	Measured with the political corruption index. Indicates the extent of corruption in the public, executive, legislative, and judicial sphere. Higher values indicate higher corruption.	V-Dem (Varieties of Democracy)	Country	https://www.v-dem.net/data/the-v-dem-dataset/
Political System	Public participation in deciding environmental matters	Pillar 2 of the indicators to measure environmental democracy. Captures assessments of the right to participate meaningfully in decision-making.	Environmental Democracy Index (2014)	Country	https://environmentaldemocracyindex.org/node/13967.html
Provisioning Factor	Decent work	SDG 8 (1) NEETS = people (age 15-29) neither in employment nor in education nor training by gender (2) longterm	Eurostat SDGs (SDG 8_30)	NUTS2 Country	(1)https://ec.europa.eu/eurostat/databrowser/view/EDAT_LFSE_22__custom_1855971/bookmar

Topic	Indicator	Description of indicator	Accessible Data Sources	Level of data availability	Link to Data Sources
		unemployment rate (>=12 months) age: 15-74; (3) employment-rate by citizenship (EU/non-EU) age (20 – 64)			k/table?lang=en&bookmarkId=2caf2f62-54dd-4b37-8202-acdfa18b7e1a (2)https://ec.europa.eu/eurostat/databrowser/view/LFST_R_LFU2LTU__custom_1677772/bookmark/table?lang=en&bookmarkId=ca0d453e-4c2d-4aa4-bb2f-9231c2bc993e (3)https://ec.europa.eu/eurostat/databrowser/view/sdg_08_30a/default/table?lang=en
Provisioning Factor	Gender equality	SDG 5 + SJS EIGE gender equality index based on 31 gender equality indicators in the realms of work, money, knowledge, time, power and health	EIGE	Country	https://eige.europa.eu/gender-equality-index/2022/compare-countries/index/table
Provisioning Factor	Income equality	SDG 10 + considered as provisioning factor by Vogel et al. 2021 (1) Gini coefficient of equivalised disposable income (2) The ratio of total income received by the highest-earning 20% of the population to lowest-earning 20% (3) purchasing power adjusted to GDP per capita by NUTS2 region	EU SILC 2021	EU SILC: Country SDG 10: NUTS2	(1) https://ec.europa.eu/eurostat/databrowser/view/tessi190/default/table?lang=en (2)https://ec.europa.eu/eurostat/databrowser/view/ilc_pns4/bookmark/table?lang=en&bookmarkId=b3eb6354-e22a-428e-9110-480571a7ae90 (3)https://ec.europa.eu/eurostat/databrowser/view/NAMA_10R_2GDP__

Topic	Indicator	Description of indicator	Accessible Data Sources	Level of data availability	Link to Data Sources
					custom_1855694/bookmark/table?lang=en&bookmarkId=3da27295-9429-4a5c-acb1-dd7d465feba9
Provisioning Factor	Municipal recycling	SDG 11 + related to waste management as part of DLS (Rao & Min 2018); Share of recycled waste in total municipal waste	Eurostats SDG (SDG 11_60)	Country	https://ec.europa.eu/eurostat/databrowser/view/sdg_11_60/default/table?lang=en
Provisioning Factor	Public health coverage	SDG 3 + considered as provisioning factor by Vogel et al. 2021 inverse of self-reported unmet needs for health	Eurostat 2019	Country	https://ec.europa.eu/eurostat/databrowser/view/hlth_ehis_un1u/default/table?lang=en
Provisioning Factor	Public service quality	SDG 16 & considered as provisioning factor by Vogel et al. 2021 quality of public services, civil service, and policy implementation (score), calculated as Government effectiveness (rescaled to 1-6)	WB WGI 2021	Country	https://databank.worldbank.org/source/worldwide-governance-indicators
Provisioning Factor	Renewables	SDG 7 + considered as provisioning factor by Vogel et al. 2021 Share of renewable energy in gross final energy consumption	Eurostat	Country	https://ec.europa.eu/eurostat/databrowser/view/sdg_07_40/default/table?lang=en
Provisioning Factor	Share of collective transport	SDG 9 + related to DLS (Rao & Min 2018); measures the share of collective transport modes in total inland passenger transport performance, expressed in passenger-kilometres (pkm), incl. busses and trains, excluding trams and metros.	Eurostats SDGs (SDG9_50)	Country	https://ec.europa.eu/eurostat/databrowser/view/sdg_09_50/default/table?lang=en
Provisioning Factor	Sustainable communities	SDG11 (1) Severe housing deprivation (2) Soil sealing index (SDG 15) (3) victims in road accidents by region (NUTS2)	Eurostat SDGs (SDG 11); European Environment Agency 2018	Country NUTS2	(1) https://ec.europa.eu/eurostat/databrowser/view/sdg_11_11/default/table?lang=en (2) https://ec.europa.eu/eurostat/databrowser/

Topic	Indicator	Description of indicator	Accessible Data Sources	Level of data availability	Link to Data Sources
					view/sdg_15_41/default/table?lang=en (3) https://ec.europa.eu/eurostat/databrowser/view/TRAN_R_ACCI__custom_1855853/bookmark/table?lang=en&bookmarkId=eea85d1e-c9cd-4a67-826b-155eb57198d9
Resilience and Vulnerability	Access to communication	Whether people have access to a mobile phone or the internet (through mobile phone, a computer, or other device)	World Risk Poll 2021	Individuals; regions (not clear which classification); countries; continental region (in Europe: Eastern Europe; Northern/Western Europe; Southern Europe)	https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_data.csv; https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_methods.pdf
Resilience and Vulnerability	Confidence in national institutions	A person's confidence in national political and state institutions	World Risk Poll 2021	Individuals; regions (not clear which classification); countries; continental region (in Europe: Eastern Europe; Northern/Western Europe; Southern Europe)	https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_data.csv; https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_methods.pdf
Resilience and Vulnerability	Disaster planning	Whether people have a plan for what to do that all household members know about, when a disaster occurs	World Risk Poll 2021	Individuals; regions (not clear which classification); countries; continental region (in Europe: Eastern Europe; Northern/Western Europe; Southern Europe)	https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_data.csv; https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_methods.pdf
Resilience and Vulnerability	Discrimination	Experience of discrimination due to belonging to different social groups	World Risk Poll 2021	Individuals; regions (not clear which classification); countries; continental	https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_data.csv;

Topic	Indicator	Description of indicator	Accessible Data Sources	Level of data availability	Link to Data Sources
				region (in Europe: Eastern Europe; Northern/Western Europe; Southern Europe)	https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_methods.pdf
Resilience and Vulnerability	Financial security	How long people could cover basic needs if they suddenly lost all income and had to survive on their savings and things that could be sold.	World Risk Poll 2021	Individuals; regions (not clear which classification); countries; continental region (in Europe: Eastern Europe; Northern/Western Europe; Southern Europe)	https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_data.csv; https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_methods.pdf
Resilience and Vulnerability	Local infrastructure	People's access to infrastructure that improves their capacity to manage disasters	World Risk Poll 2021	Individuals; regions (not clear which classification); countries; continental region (in Europe: Eastern Europe; Northern/Western Europe; Southern Europe)	https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_data.csv; https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_methods.pdf
Resilience and Vulnerability	Perceptions of government support	Perception how much government/country cares about a person's wellbeing	World Risk Poll 2021	Individuals; regions (not clear which classification); countries; continental region (in Europe: Eastern Europe; Northern/Western Europe; Southern Europe)	https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_data.csv; https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_methods.pdf
Resilience and Vulnerability	Sense of agency	Whether people feel empowered to take action in the case of a disaster	World Risk Poll 2021	Individuals; regions (not clear which classification); countries; continental region (in Europe: Eastern Europe; Northern/Western Europe; Southern Europe)	https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_data.csv; https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_methods.pdf

Topic	Indicator	Description of indicator	Accessible Data Sources	Level of data availability	Link to Data Sources
Resilience and Vulnerability	Social Capital	How much a person can rely on social networks and relationships	World Risk Poll 2021	Individuals; regions (not clear which classification); countries; continental region (in Europe: Eastern Europe; Northern/Western Europe; Southern Europe)	https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_data.csv; https://wrp.lrfoundation.org.uk/lrf_wrp_2021_full_methods.pdf
Social Priorities	Absence of energy poverty	SDG 7 + SJS inverse of population with poverty status unable to keep household adequately warm	Eurostats SDGs (SDG7_60) - EU SILC	Country	https://ec.europa.eu/eurostat/databrowser/view/sdg_07_60/default/table?lang=en
Social Priorities	Absence of financial poverty	SDG 1&10 + SJS inverse of people at risk of poverty or social exclusion as share of the population (index)	Eurostats SDGs (SDG1) - EU SILC	NUTS2	https://ec.europa.eu/eurostat/databrowser/view/ILC_PEPS11__custom_1855164/bookmark/table?lang=en&bookmarkId=e25f70fd-572e-4835-b17b-5ab0d0e89ebc
Social Priorities	Basic education	SDG 4 + SJS (1) early leavers from school and training (2) share of population with primary education as highest level of educational attainment	Eurostat SDGs (SDG 4)	NUTS2	(1) https://ec.europa.eu/eurostat/databrowser/view/EDAT_LFSE_04__custom_5833730/default/table?lang=en (2) https://ec.europa.eu/eurostat/databrowser/bookmark/f5d7b63f-369b-4cbe-8cd1-83573f1e13f9?lang=en
Social Priorities	Drinking water access	SDG 6 + SJS share of people using safely managed drinking water services	WB WDI 2020	Country	https://databank.worldbank.org/reports.aspx?source=World-Development-Indicators
Social Priorities	Healthy life expectancy	SDG 3 + SJS number of years that a person at birth is expected to live in a healthy condition	Eurostat (2020)	Country	https://ec.europa.eu/eurostat/databrowser/vie

Topic	Indicator	Description of indicator	Accessible Data Sources	Level of data availability	Link to Data Sources
					w/tps00150/default/table?lang=en
Social Priorities	Safe sanitation access	SDG 6 + SJS spare of people using safely managed sanitation services	WB WDI 2020	NUTS2	https://databank.worldbank.org/reports.aspx?source=World-Development-Indicators
Social Priorities	Sufficient nourishment	SDG 2 + SJS reversed prevalence of undernourishment	WB WDI 2020	Country	https://databank.worldbank.org/reports.aspx?source=World-Development-Indicators

6.2. Research guideline #2: Researching the regions' configuration of climate-change-related stakeholders (a qualitative approach)

Qualitative interviews are one of the most used methods for qualitative data collection. All types of qualitative interviews represent some form of conversation between an interviewee, i.e., the person who is asked the questions, and the interviewer, the person asking the questions. The conversation is structured based on underlying research interests as well as specific methodological assumptions (Flick, 2012). The structure and formalisation of interviews vary on a continuum between standardised to unstandardised (for more details see for example Froschauer and Lueger 2003; Brüsemeister 2008; Berg and Lune 2017; Roulston and Choi 2018). **Structured interviews** are formally structured using a pre-scripted and chronologically ordered interview guide, which is similar to a quantitative survey that is conducted in a face-to-face situation. **Unstructured interviews** are also called open, in-depth or - having a biographical focus - narrative interviews. These are designed in openly and are guided by themes rather than pre-defined questions, with only the first question being prepared. Questions are generally openly formulated and adapt to the interviewee's explanations. Since the structure is dynamically evolving in the interview situation and guided by the interviewee rather than the interviewer, unstandardised interviews are often also referred to as narrative. These interviews are often affiliated with phenomenologic, ethnographic, symbolic-interactionist, grounded theory, or feminist research perspectives (Brüsemeister, 2008; Roulston & Choi, 2018). **Semi-structured interviews**, such as problem-centred interviews, occupy the middle ground between structured and unstructured interviews. They are guided by prepared questions, but sequencing is dynamically adapted to the interview situation; additional probing questions evolve during the interview situation and should be posed by the interviewer (Roulston & Choi, 2018).

In the context of NEVERMORE a qualitative research design using semi-structured interviews was set up to investigate the ways in which different climate actors across the five case studies negotiate different interests and evaluate climate change measures. Semi-structured interviews allow for adapting the interviews in a context-sensitive manner to the relevant structures of the interviewees and also facilitate cross-region comparability as stakeholders in all involved case studies are asked the same set of core questions.

The interview process set up for NEVERMORE is specifically designed to interview local policy-makers and climate activists. The number of interviews to be aimed for again depends on the theoretical framework of the testing.

ZSI is implementing the research design and engaging two stakeholders per case study, resulting in a total number of ten interviews. Being a qualitative approach, statistical representativeness is not an acclaimed goal, case study leaders and supporters are, however, encouraged to use the research guideline at hand to engage additional stakeholders in the process.

In the following, the necessary steps for (1) planning the interview, (2) conducting the interview and (3) analysing the interview are elaborated in more detail.

6.2.1. Interview Planning and Preparation

In the first step, the interview guideline, and hence the list of open-ended questions as well as the order they are to be asked in the interview, needs to be designed. Therefore, a list of topics and specific questions is created to investigate the research question at hand (Roulston & Choi, 2018). A literature review is recommended to identify core dimensions. The compiled list of questions is then put in chronological order, with broader questions being posed at the start of the interview (Roulston & Choi, 2018). In the context of NEVERMORE core dimensions relate to the perception of climate change amongst specific regional stakeholder groups.

ZSI developed the interview guideline based on a literature review on the topics of climate change perceptions, agency as well as social innovation and climate change. To address group specific needs, two partly adapted guidelines, one designed for policy-makers and one adapted to climate activists, were created.

Before its use in real interview settings, it is recommendable to test the interview guideline in an interview-like situation. Cognitive probing is a specific interviewing technique, which allows for investigating the cognitive processes used by a respondent to answer a question as well as the way questions are interpreted in specific linguistic and socio-cultural settings (Willis 1999; Miller 2014). The approach can therefore be used to test, evaluate, improve, and enrich the guideline questions (Willis 1999). As a specific form of interview, the process of cognitive interviewing varies with the scope of the testing. The two most popular techniques present in cognitive interviewing are the use of think-aloud techniques and verbal probing. **Think-aloud interviews** stem from psychological procedures and intend to unveil the "window into the mind" (Willis, 2015, p. 27). In think-aloud interviews, respondents are instructed and trained to spontaneously voice their thoughts when reading and answering a question. One disadvantage of this technique is that it significantly increases the burden on the test-interviewee (Prüfer & Rexroth, 2005; Willis, 1999).

Verbal probing represents an alternative approach, which attributes a more active role to the researcher involved in the cognitive interview. Verbal probes can either be scripted prepared and standardised to be used during all cognitive interviews conducted or might spontaneously come up during the interview situation (Willis, 2015). Depending on the scope of probing, different techniques can be used in the frame of cognitive interviews. Peter Prüfer and Margit Rexroth (2005, pp. 5–11) list different types of verbal probing techniques depending on the scope of the specific questions in the guideline:

- Comprehension probes elicit how the answered question has been understood
- Category selection probes investigate why a specific answer has been given
- Probes investigating the information needed to answer the question as intended by the researchers
- Information retrieval probing elicits the process of remembering in the context of retrospective questions
- General probing investigates the ease or difficulty to answer a question and the underlying reasoning patterns

The number of interviews to be aimed for depends on the theoretical framework of the testing. Being a qualitative approach, statistical representativeness is not an acclaimed goal of cognitive interviews. The documentation of the gathered material is crucially important for its further consideration. Therefore, most cognitive interview techniques operate with audio interview recordings, sometimes also video recordings, that are transcribed partly or fully according to the research in context (Willis, 2015).

The analysis of responses focuses on summarising the gathered information to condense the findings and to move from the level of individual cognitive interviews towards comparisons across respondents and subgroups, potentially identifying common patterns according to socio-cultural backgrounds, as well as issues arising in specific cases (Miller *et al.*, 2014; Willis, 2015). For doing so, text summaries, deductive coding, or inductive coding can be used. For a detailed description of these coding schemata, see for example Willis (2015). The results need to be carefully scrutinised in relation to individual questions as well as to the context of the whole guideline (Miller *et al.*, 2014).

The technique of cognitive probing interviews includes guided communication throughout the process of filling out the survey to get insights in cognitive and cultural processes underlying survey responses (Prüfer & Rexroth, 2005).

ZSI tested the developed interview guideline with the technique of cognitive probing. In total, four test interviews have been conducted and recorded. On this basis, the developed interview guideline was iteratively adjusted. Based on these results, the decision was taken to create two versions of the guideline to better capture the perspectives of policy-makers and climate activists respectively. These two versions are closely aligned and only deviate in a few probing questions. For example, people who participate in climate activism were asked about the goal of their organisation or movement while policy-makers were asked how climate change affects their work.

Since the problem-centred interview aspires to tap the personal perspectives of a diverse and international group of different stakeholders, language is a key dimension that should not be left out of sight. Doing the interviews only in English runs the risk of excluding interviewees, who might not feel comfortable expressing themselves in English (Resch & Enzenhofer, 2018). Therefore, it is recommendable to translate the English base guideline elaborated by ZSI into the local language(s) of the region. To ensure, that the translation corresponds to the English base survey and is simultaneously adapted to local requirements, another testing sequence is necessary (Resch & Enzenhofer, 2018). Cognitive interviews can again be used to test the translated guideline in different languages and/or cultural contexts (Schoua-Glusberg & Villar, 2014). In this specific setting differences in social desirability, levels of diction, and the naturalness of language can be evaluated (Miller *et al.*, 2014; Schoua-Glusberg & Villar, 2014). The translated guideline should be tested to discover problems, such as, e.g., a translation-induced shift of meaning, or unclear wordings upfront. A comparison of the received answers with the English original helps to identify possible incompatibilities. Based on these testing procedures, the translated guideline can then be adjusted and finalised.

In the next step, potential interviewees need to be identified. Qualitative research typically does not aim at statistically representative samples but usually works with small numbers of cases, which are then analysed in an in-depth and detailed manner (Schreier, 2018). The selection of interviewees is nevertheless guided by sampling strategies, which lay out the criteria for choosing participants. The recommended strategy for interviewee selection in the case of NEVERMORE entails purposive sampling, aspiring to interview stakeholders that can most likely provide a detailed answer to the research question (Schreier, 2018). To reach a heterogeneous sample, the strategy of maximum variation sampling between groups, i.e., these groups should represent diverging and contrasting views on the research question, is suggested. On this basis, the target group of the research design is limited to policy-makers and persons active in combatting and facing climate change at case study level, representing a diversity in sampling groups with diverging views. Policymakers are defined as persons in charge of taking political decisions or as a person who regularly participates in political decision-making processes (e.g., as a member of a local parliament). Climate actors are understood as persons active in (a) local climate movement(s) or initiative(s). A mapping process listing possible interview partners, their affiliations, a short description of their inclusion, as well as contact details is a helpful way to organise this step. Snowball sampling, where the engagement of interviewees starts with a small number of identified participants, who then recommend further persons for involvement, can be a recommendable strategy to involve hard-to-reach groups (Chamberlain & Hodgetts, 2018).

For the practical implementation, ZSI set up such a mapping process in collaboration with NEVERMORE Case Study Partners to identify relevant actors and groups in each region. Based on their knowledge of the local context, we trusted Case Study Partners to provide a detailed selection of possible interview partners. Due to accessibility of interviewees and resources in the project, a minimum of two interview partners, i.e., one policy maker and one climate actor per case study region were selected by ZSI using

maximum variation sampling, resulting in a minimum sample size of ten interviews. Further interview partners were identified using snowballing techniques.

In the third step, the persons need to be contacted and informed about the scope of the interview, its duration as well as purpose. Additionally, interviewees need to be informed about their rights and consent to the use of their answers for the attempted research (Roulston & Choi, 2018).

ZSI contacted possible interviewees beforehand and asked them to fill in a pre-registration form. The first part of the form ensured that the participant understands their rights and agrees with the use of their data. The second part of the form is analysed separately and covers basic socio-demographic dimensions such as the person's age, gender, ethnicity, and for how long they are already living in the case study region. The form was run using ZSI's self-hosted LimeSurvey tool, which ensured that the collected data was stored safely.

6.2.2. Conducting the Interview

The interviewer is in charge of sensitively guiding through the interview and ask additional questions, when new topics of relevance to the interviewee come up (so-called probing questions). The interviewer has the role of a moderator, keeping the discussion alive, yet being open to listening carefully and learning from their participants (Roulston & Choi, 2018). The semi-structured interview should centre the interviewee's opinions, perceptions, and relevance structures.

The interview process conceptualised for the NEVERMORE project is likely to take about one hour. Nevertheless, it is recommendable to allocate more time to allow for flexibility.

Materials needed for the interview involve the tested (and possibly translated) interview guideline and a device, which allows recording the interview. If the interview is conducted online, a stable internet connection and an online meeting tool are necessary. In case the interview is conducted in a face-to-face setting, the environment should provide a calm atmosphere that allows the participant to openly share their views (Roulston & Choi, 2018).

It is recommendable to start the interview with a short round of introduction and explanation and allow for questions about the process ahead, to establish a pleasant atmosphere for the interview. The interviewee should also be informed about the start of the recording process.

Taking notes throughout the interview allows for arranging the guideline, documenting core themes, and probing questions. The notes also provide additional materials, which might be considered for the analysis of the interview.

In case the interviewer does not speak the preferred language of the interviewee, the involvement of translators can be a useful method to allow for the interviewee's participation. In semi-structured interviews, interpreters can be directly involved in the interview situation, conducting the interview together with the interviewer (Resch & Enzenhofer, 2018). A recommended approach to assure the quality of the translated data is to involve more than one translator, resulting in a dual approach to the translation (Resch & Enzenhofer, 2018). The involvement of (a) translator(s) needs to be considered in the transcript as well as the following analysis.

Due to the different locations of all parties involved, ZSI conducted 10 interviews in an online setting in the timeframe from April to May 2023. Nine out of ten interviews were conducted in English. One interview was conducted with two simultaneous interpreters involved to allow the participant to express themselves in their preferred language. Importantly, two interpreters were involved, with one being part of the interviewee's community and knowing the interviewee beforehand. The involvement of two on-site interpreters ensured the quality of the interview. Furthermore, nine out of ten interviews were conducted with one person being interviewed. According to the wish of one contacted interviewee, one interview was conducted simultaneously with two persons from the same organisation. All interviews were fully recorded.

6.2.3. Debriefing and Analysis

Immediately after the interview, it is recommendable to check the recording and complete some more notes of the discussion. The latter is even more important in case the recording has not worked as planned. It can also be useful to include details of the interview situation, such as e.g., the exact timing and location, interruptions, and other difficulties or impressions during the interview process.

In the next step, it is highly recommended to fully transcribe the recorded interview (Roulston & Choi, 2018). This allows for a detailed analysis of verbatim statements. There are several possibilities to analyse the transcribed interview afterwards. Most qualitative methodologies use coding, i.e., the attribution of specific – either pre-specified or emerging – categories to specific statements of the interview. Methodologies range from analysing every single word (e.g., fine-grain-analysis in hermeneutics) to a broader analysis of full sentences or paragraphs (e.g., topic-centred analysis). The attributed codes help to identify the manifest and latent dimensions of the statements (Willig, 2014).

The involvement of translators must be considered in the analysis of the data. As the translation is the result of the interpretation of the translator, they become an interpreter, whose perception of the material is valuable (Resch & Enzenhofer, 2018). As they participate in the interview and translation process, they are involved in creating the meaning of what the interviewee says. In the process of analysing the interview, the different perceptions of the translators must be reflected.

It is important to match the analysis with the focus of the research. Thus, it is necessary to reflect on which qualitative method suits the research topic best. The analysis of the interviews conducted in NEVERMORE investigates the ways in which different climate actors across the five case studies negotiate different interests and evaluate climate change measures. We recommend a thematic analysis based on its accessibility and theoretically flexible approach. Thematic analysis is used for identifying, analysing, and reporting dominant themes in qualitative materials. Thematic analysis can be used in different ways – to report experiences, meanings and the reality of participants or to examine how experiences or events are affected by discourses. Further, thematic analysis can characterise how individuals derive meaning from their experiences. Before conducting the analysis, a clear focus should be chosen (Brown, Virginia & Clarke, Victoria, 2006).

A theme in thematic analysis captures important aspects related to the research questions and it represents a patterned response or meaning within the data set. It does not necessarily mean that aspects, which are discussed more often, are automatically a theme – the judgement of the researcher and the research question itself determine what a theme is. (Brown, Virginia & Clarke, Victoria, 2006).

Themes within data can be identified deductively or inductively. An inductive approach means that themes are identified through the data itself. This form is data-driven and themes are identified without trying to match a pre-existing coding frame. A deductive approach is instead driven by the theoretical or analytical research interest of the analyser. Based on existing research, a code set is created and then qualitative data is matched to this code set. Further, semantic or latent themes are relevant in analysing data. A semantic approach identifies explicit or surface meanings of the data. An analysis at the latent level goes beyond and strives to identify underlying concepts (Brown, Virginia & Clarke, Victoria, 2006). Inductive and deductive codes can be latent and semantic and these approaches add to one another.

The guiding themes present in the NEVERMORE interview guideline were the background of the interviewee, the perceived regional situation regarding climate change, perceived actions to tackle climate change in their region, and important climate change stakeholders in the region. In these themes, questions regarding barriers and incentives in the implementation process, the perceived development of the discourse regarding climate change, and the perceived accessibility of resources to tackle climate change were asked. These questions aim at an explorative approach to get to know the

person's background and perceived regional situation. These guiding themes entered the analysis as deductive codes to be enriched with inductive codes during the process of thematic analysis

In the following, we shortly describe the six steps usually taken when conducting a thematic analysis in more detail:

1. The first step in the applied thematic analysis is to familiarise yourself with the data by reading and re-reading the interviews and to generate an initial list of ideas of interest in the data (Nowell *et al.*, 2017).
2. In the second step, codes should be created that analyse the data on a latent or semantic level. The coded data differs from the themes, which are often broader than the codes. After working through the whole set systematically, the codes may form repeated patterns (themes) across the data set (Brown, Virginia & Clarke, Victoria, 2006).
3. In the third step, the codes generated in the second step are sorted into potential themes. It may be helpful to visualise the generated codes to come up with overarching themes.
4. Step four starts when this set of themes and codes is generated. You may find that some themes collapse into one another or some might need to be broken down into separate ones. It is necessary to review the data and themes, i.e., read the extracted data for each theme. Further, it is important to reflect on whether the themes represent the data set as a whole. To do this, the data set has to be read with a special emphasis on whether the themes work in relation to the set and to code additional data within themes that may have been missed earlier. Maybe you need to re-code some parts of the data, as it is an organic process (Savage, 2000).
5. The fifth step is to identify what the themes are about and determine what aspect of the data set it actually captures. It is important to know at the end of this step what your themes are about and clearly define them (Nowell *et al.*, 2017).
6. In the sixth and last step, a final analysis must be done. This means writing up the themes within the data and demonstrating the prevalence of the themes (Brown, Virginia & Clarke, Victoria, 2006). A special focus in the final analysis also lies on who speaks and which perspective is adopted – this can range from personal feelings to a political position.

Throughout the process of the analysis, it is important to acknowledge the position of the researcher in relation to the extracted topics, as their interests and values influence their analysis (Willig, 2014).

ZSI used the thematic analysis as an analytical lens for data interpretation to report experiences, meanings, and the reality of the participants in an open and explorative way. Concerning the interview guideline, a set of deductive codes was generated and enriched with an inductive approach identifying additional themes in the transcribed data. MaxQda, a software for qualitative data analysis, was used for coding and interpreting the interviews according to the six steps described earlier. Three people were involved in the process of coding and generating themes to ensure the quality of the analysis.

ZSI preregistered the approach for data collection and analysis on the Open Science Framework (accessible at https://osf.io/za7mr) using the template for preregistering qualitative research by Haven and Van Grootel (2019).

Preregistering research was originally developed for quantitative designs in light of the replication crisis in research and consists of publicly posting the plan for hypothesis testing, data collection, and analysis before conducting a study to reduce researchers' biases and improve transparency and rigor (Nosek *et al.*, 2018). Though originally developed for statistical hypothesis testing, preregistering also offers several benefits for qualitative (non-hypothesis testing) research (Haven & Van Grootel, 2019):

- Preregistration allows others to understand and scrutinise the research design of a given study, as it often goes beyond the polished and shortened methods and results sections in academic papers.
- It makes the researchers' original intentions and tools transparent.
- It improves the rigor of research by reflecting the flexibility inherent to qualitative studies.

- It motivates to make explicit the subjectivity, assumptions, and theoretical lens every researcher works with and promotes reflection before conducting the research.

Preregistration constitutes a plan of how to execute research, but it is perfectly acceptable to deviate from this plan as long as deviations are discussed openly and reflected on. Preregistrations contribute to fostering open, reproducible, and comprehensible research of all research traditions. The template provided by Haven and Van Grootel (2019) offers a blueprint for planning a rigorous qualitative study and can improve its design and execution, even without publishing it as preregistration.

6.2.4. The Interview Guidelines

The interview guidelines are split in two, to make it easier for the interviewers to distinguish between the two main target groups of interviewees, i.e. one for policy-makers (see Table 5) and the other one for climate activists (see Table 6). The two slightly differ to accommodate the different context within which each group acts, e.g. a professional setting vs. a setting of civil society organisations.

6.2.4.1. Interview guideline for policy-makers

Table 5. Interview guideline for policy-makers.

Investigated Dimension	Question	Aim of Question
Interviewee Background	Tell us about your background and your position at work. What is your role at work? In which position do you work?	Trying to know what position of power they might hold - power as de-individualised role in literature.
	For how long have you been working in this role?	Assessing the past (i.e., how long are they involved with climate change or policy making).
	How does climate change affect/pertain to your work? Are you active in movements regarding climate change outside your work?	Awareness of climate change in field of expertise and Second questions aimed at willingness to get active/tackle climate change.
Regional situation generally	How do you think climate change impacts [case study region]? How did the concept of climate change develop in [case study region]?	Aimed at a general view on climate change in the region and to get a sense of problems regarding climate change in each region (i.e., reindeer husbandry) and discourse in each region.
	What are the most important challenges in [case study]? How are the challenges tackled?	Referring to innovative power and observing problems and change.
Actions to combat climate change in region	What climate change actions have been implemented in [case study region] in the past? What was the result of these actions? What has changed because of these?	Access to discourse, trends and historic view on climate change in case study region.
	What actions are currently implemented? Who was involved in the process of developing these actions?	Access to present policy making processes and regional network.
	In the implementation process of the actions you just talked about - what	Who holds power over resources and how is the access to institutions

	resources were necessary for the implementation?	and capital; relation to regional conditions?
	If you think about [case study region], are there barriers in the implementation processes? Were there any incentives?	Aimed at relation and power effects.
	If you could decide, what actions regarding climate change in [case study region] would you like to see in the future?	Aimed at visions of interviewee also regards to one's role in region.
Climate changes actors in the region	Who are key players or movements in [case study region] that are connected to climate change? Why are they important and what is their role? Were you involved in actions regarding climate change?	Connect with networks and position of interviewee.
	How are the key players, movements and eventually firms working together? Do you perceive challenges within these groups? What positive aspects have you had in working or not working together?	Power transition framework and aimed at synergy of antagony effects within the region.
	When thinking about climate change and past and present actions - how do you see the future? What do you think is necessary to tackle them?	Radical or moderate perspective on climate change.

6.2.4.2. Interview guideline for climate activists

Table 6. Interview guideline for climate activists.

Investigated Dimension	Question	Aim of Question
Interviewee Background	What is your background and role in the [climate organisation/citizen initiative]?	Trying to know what position of power they might hold - power as de-individualised role in literature.
	For how long have you been active in this role?	Assessing the past (i.e., how long are they involved with climate change or policy making).
	What are the main goals in your movement/initiative? Does climate change impact your wage labour?	Awareness of climate change in field of expertise and Second questions aimed at willingness to get active/tackle climate change.
Regional situation generally	How do you think climate change impacts [case study region]? How did the concept of climate change develop in [case study]?	Aimed at a general view on climate change in the region and to get a sense of problems regarding climate change in each region (e.g., reindeer husbandry) and discourse in each region.
	What are the most important challenges in [case study region]? How are the challenges tackled?	Referring to innovative power and observing problems and change.
Actions to combat climate change in region	What climate change actions have been implemented in [case study region] in the past? What was the result of these actions? What has changed because of these?	Access to discourse, trends and historic view on climate change in case study region.
	What actions are currently implemented? Who was involved in the process of developing these actions?	Access to present policy making processes and regional network.
	Are you able to access resources in your region?	Who holds power over resources and how is the access to institutions and capital; relation to regional conditions?
	If you think about [case study region], are there barriers in the implementation processes? Were there any incentives?	Aimed at relation and power effects.
	If you could decide, what actions regarding climate change in [case study region] would you like to see in the future?	Aimed at visions of interviewee also regards to one's role in region.
Climate changes actors in the region	Who are key players or movements in [case study region] that are connected to climate change? Why are they important and what is their role? Were you involved in actions regarding climate change?	Connect with networks and position of interviewee.

	How are the key players, movements and eventually firms working together? Do you perceive challenges within these groups? What positive aspects have you had in working or not working together? What challenges do you face with your movement/initiative? What positive experiences have you made?	Power transition framework and aimed at synergy of antagony effects within the region.
	When thinking about climate change and past and present actions - how do you see the future? What do you think is necessary to tackle them?	Radical or moderate perspective on climate change.

6.3. Research guideline #3: Collecting data on social innovation initiatives in case study regions (a mixed-method approach)

The objective of this research guideline is to provide a framework and detailed description for researching social innovation initiatives in the NEVERMORE case study regions. Investigating local and regional social innovation initiatives will generate new insights into the regions' social structures and improve understanding of the local contexts, subsequently improving the validity of the NEVERMORE models.

Social innovation research distinguishes between the micro, meso, and macro level (see chapter 5.6 for a discussion of social innovation perspectives). For this guideline, we propose a mixed-methods approach focussing on the meso and macro level. We suggest **three research strategies** to investigate social innovation, combining **regional social innovation indicators** with a **mapping of each region's relevant actors to identify initiatives** and **in-depth exploration of these initiatives' experiences**. In the following sections, we provide detailed guidance on how this approach and each of these strategies can be implemented.

6.3.1. Strategy 1: National or Regional social innovation indicators

The first strategy towards understanding social innovation in the NEVERMORE case study regions **investigates regional indicators** or, if not available, indicators on the country level capturing aspects of social innovation. Using such indicators allows to describe the "status quo" of social innovation activity and capacity, draw conclusions on how specific initiatives might be embedded in the region and develop in the future, and compare social innovation across regions or countries (Krlev *et al.*, 2014).

Social innovation indicators can be fed with data from regional or country-wide databases, which are often freely available. Thus, social innovation indicators can be used for research without engaging in primary data collection and provide information about framework conditions for social innovation and related activities. Utilising social innovation indicators consists of several steps:

1. **Measurement approach**: Identify social innovation indicators relevant and applicable to the region or country.
2. **Data collection**: Identify secondary data sources to inform the indicators. If necessary, consider primary data collection.

3. **Analysis and conclusions**: Assign data and (if necessary) calculate indicators following the measurement approach. Draw conclusions about social innovation activity in the region of analysis and the framework conditions to further foster social innovation.

Defining a measurement approach to social innovation means defining one's conceptualisation of social innovation and how it should be operationalised, i.e., turned into measurable constructs and eventually, into numbers. Given the increased interest into social innovation in recent years, a number of social innovation measurement approaches and related indicator suites for regions and countries exist by now (EIU (Economist Intelligence Unit), 2016; Krlev *et al.*, 2014; Unceta *et al.*, 2016), though each of them has its own limitations (see Mihci, 2020 for a critical review).

For the purpose of this guideline, we suggest to use the measurement approach developed by Krlev et al. (2014) and Bund et al. (2015), which is based on a systematic review of both existing indicators and theories. This approach conceptualises social innovation as three connected levels: first, the framework conditions for social innovation, define the context and resources available for social innovation activities; second, entrepreneurial activities, though in this understanding, entrepreneurial is not limited to businesses, but also included NPOs and NGOs; and third, outputs and outcomes of these activities (see chapter 5.6 for more details). We suggest using this model as it provides a comprehensive picture of social innovation, capturing different states and dimensions, and combines different types of data, many of which should be accessible through secondary data sources.

The measurement model by Krlev et al. (2014) and Bund et al. (2015), including the specific indicators and possible data sources, is extensively described in the respective paper. Figure 4 presents a schematic representation of the main dimensions defined by the authors. The dimension of framework conditions covers resources (e.g., financial resources or infrastructure), institutions, political framework (e.g., the policy awareness about social innovation), and the societal climate framework, which comprise social needs and demands that inform social innovations as well as forms of social engagement. Entrepreneurial activities capture different activities assumed to promote social innovation, including investments, start-ups, and collaboration and networks. Lastly, the dimension of organisation output and societal outcome looks at the results of social innovation in different fields, of which environment is also a crucial part.

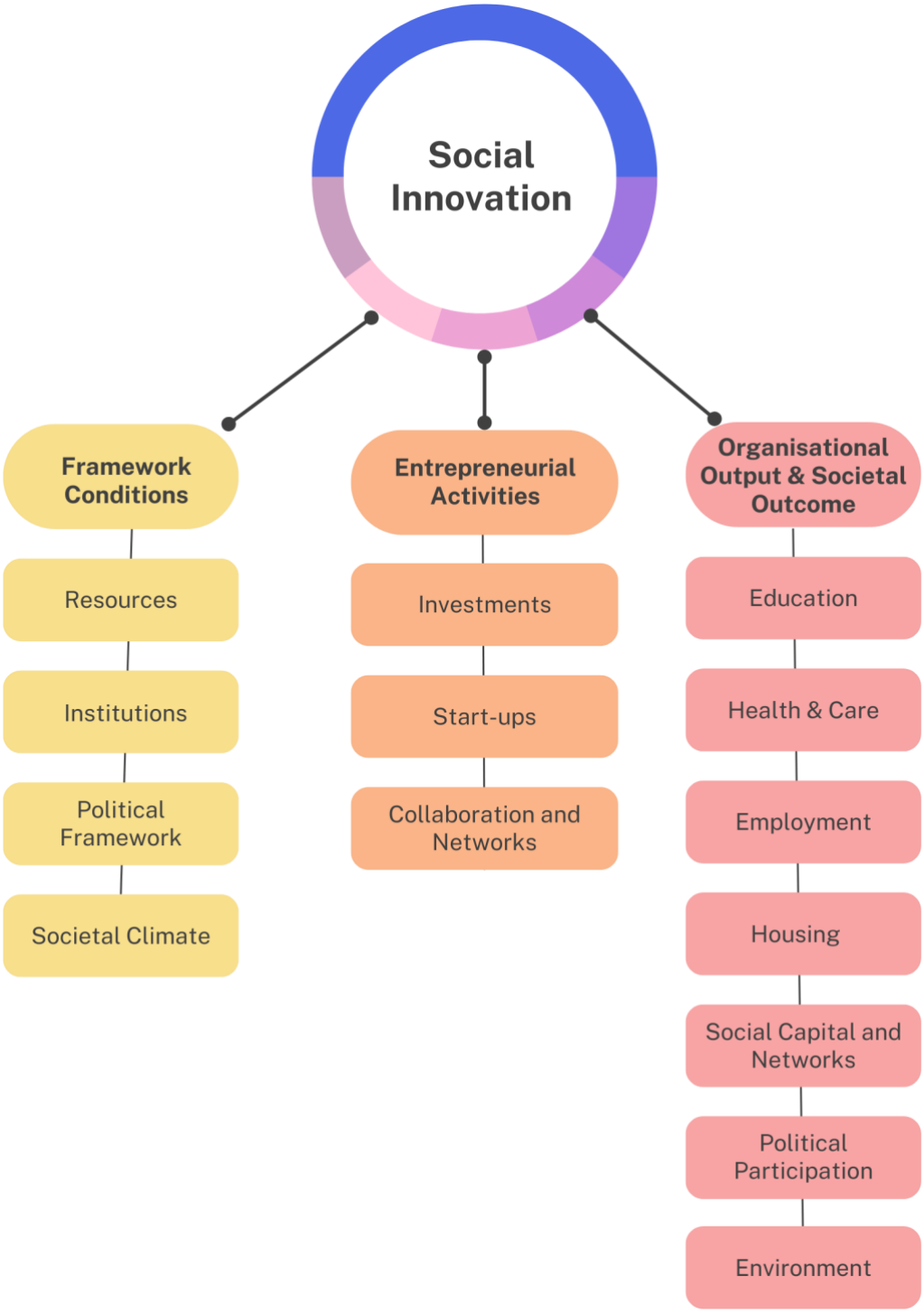

Figure 4. Schematic representation of the measurement model developed by Krlev et al.

After defining the measurement approach and related indicators, the next step consists of **collecting data** for calculating the indicators. The benefit of this macro-level approach lies in the availability of various regional and country-level databases that can be used to calculate indicators and describe the region or country. In their presentation of the indicator suite, Krlev et al. (2014) provide several potential data sources. Examples include the Community Innovation Survey implemented by Eurostat to capture investment activities or the total public social expenditure as percentage of the GDP as provided by the OCED statistics, to indicate financial resources within the resources framework conditions. If data is not available publicly, it might be possible to request information from regional authorities or other public institutions. In order to get an informed picture about social innovations in a given region or country, it is not necessary to find data for every single indicator in the measurement model. For instance, in the context of the NEVERMORE case studies, it might be sufficient to not consider every aspect of *organisational output and societal outcomes*, but to focus on environment and political participation.

In the final step, the **data is assigned** to each dimension and indicators are **calculated** and **analysed**. Oftentimes, descriptive statistics are computed and visualised to better understand the results. For meaningful conclusions, it makes sense to compare the descriptives with other regions or countries, to interpret and place into context the numbers on framework conditions, activities, and outputs and outcomes.

6.3.2. Strategy 2: Mapping of social innovation actors and initiatives

The second strategy for researching social innovation in the case study regions consists of mapping relevant actors for gaining a comprehensive view of activities and relationships in the region. While the first strategy focussed on social innovation in general, covering several different fields, we propose that the **mapping only focusses on climate-related and environmental actors**. Our usage of the term "actor" is intentionally broad and describes any stakeholder, who is concerned with the environment or climate change and works on achieving related goals, including active citizens, organisations, companies and businesses, projects, citizen-led initiatives, social movements, or activists. We also include institutional representatives such as policy-makers, politicians, or civil servants. We use this broad definition because a) research on social innovation in the specific NEVERMORE case studies is explorative and b) previous studies on social innovation have similarly investigated different entities, including entrepreneurs, projects, initiatives, or networks (see Pelka & Terstrip, 2016) (Figure 5), and we consider this diversity as fruitful for capturing different aspects of social innovation.

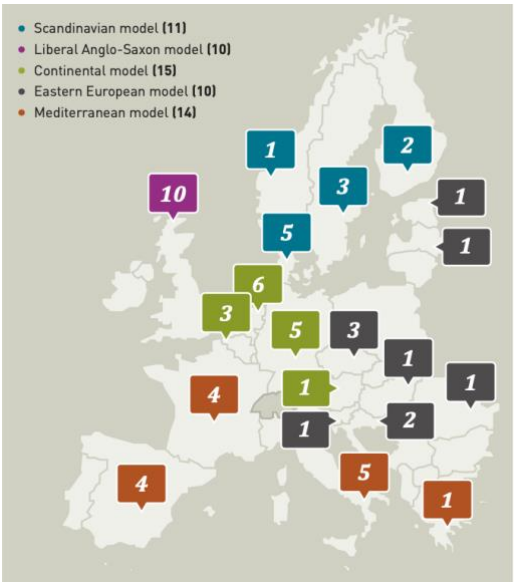

Figure 5. **Example of a social innovation map applied on a spatial scale (Terstriep *et al.*, 2015).**

Mapping social innovation initiatives has become an increasingly popular approach to gain an overview of the diverse forms and practices of social innovation, as Pelka & Terstrip (2016) suggest in their mapping of social innovation mapping approaches. Mapping consists of selecting cases based on an agreed-upon definition of social innovation (see chapter 5.6) in a given area and visualising these cases on a "map", which can be presented spatially or conceptually (Pelka & Terstrip, 2016). Further, these cases are often analysed in-depth using document research, interviews, or focus groups to gain a better understanding of the individual case and develop a coherent description or typology across cases. We provide two examples of social innovation maps in the figures below.

Error! Reference source not found. depicts a European map of 60 social innovation initiatives mapped by Terstriep et al. (2015), characterised based on the welfare regimes dominant in their regions. In addition to the map, the authors provide an ID card for each case, consisting of information on the problem the case addresses and which solution it proposes, main actors and partners involved, and the size of the organisation, to name a few examples. Data was collected using literature reviews, document analysis, and interviews. **Error! Reference source not found.** presents the knowledge map of ICT-enabled social innovation initiatives, which were collected in the course of the IESI project (Misuraca *et al.*, 2015). The initiatives were described using 44 quantitative and qualitative variables and visualised on a conceptual "knowledge map" (Misuraca *et al.*, 2015, p. 65) (Figure 6). The knowledge map places social innovation initiatives in a conceptual space divided by two axes and distinguishes different sectors.

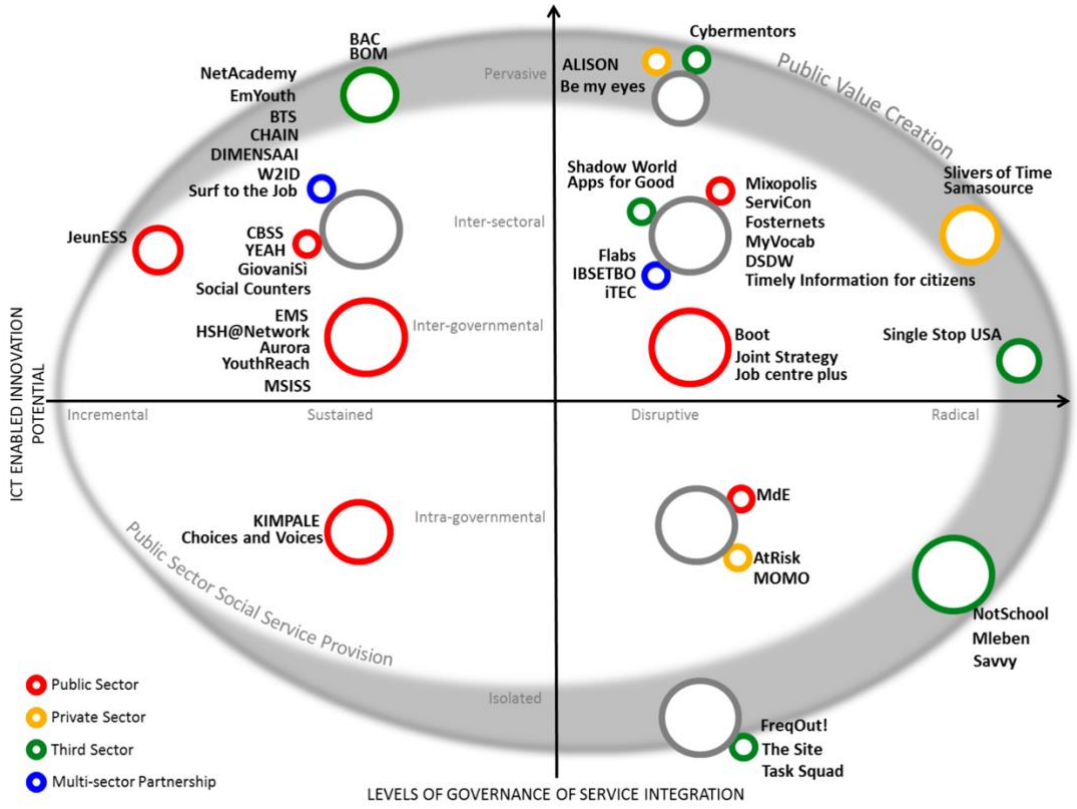

Figure 6. Example of a social innovation map applied on a conceptual scale (Misuraca *et al*., 2015).

In the context of the NEVERMORE project, we suggest conducting a mapping that primarily collects initiatives located in the respective case study region and lists only basic features, to reduce the workload of this task. The mapping will provide an overview of relevant actors in the region and describe them along several informative features, to inform both the research activities suggested in this deliverable (implementing strategy 3 in research guideline #2 as well as research guideline #3) and furthermore, future NEVERMORE activities such as the case study characterisation and stakeholder consultations.

The authors of this report have developed a template for the mapping (an Excel file called "mapping template deliverable 2.2.xlsx"), which will be shared with this deliverable. The template will support the collection of:

- Basic information on the climate actors.
- Analytic information which can be used to further compare and analyse the map.
- Contact information so that the collected actors can be engaged for focus groups or interviews. Contact information is sensible and should be kept secure, respecting the person's right to privacy.

A first version of the template has already been developed before finalising this deliverable and been filled by NEVERMORE partners with a first selection of relevant actors and the respective basic and contacts information. This file was used to prepare research guideline #2. A second and final version was developed also containing analytic information to represent social innovation aspects, which are based on existing mapping approaches (Howaldt *et al.*, 2016; Misuraca *et al.*, 2015; Terstriep *et al.*, 2015).

We propose the following steps to complete the social innovation mapping:

1. **Getting familiar with our proposed conceptualisations** of social innovation and climate actors.
2. **Getting familiar with the template**.

This includes the sheet "data collection" in which information should be included and the sheet "variable description & response" which describes how this information should be filled in.

3. **Collect information on climate actors** (sheet "data collection").
   We suggest to first collect as many different actors as possible and only filling the "basic information" part, as these contacts could be useful for other project activities. In the second step, collect data to fill the analytical information, then decide who you would like to interview or invite to a focus group. In the final step, collect contact information only for these actors. Data for completing the template can be collected using document research (i.e., internet and website search, reports, news articles, etc.) and by short written or verbal exchanges with the identified actors, which could ask for additional information or new contacts.
4. **Visualise and analyse.**
   In the final step, you can visualise the information you have collected using different charts (e.g., in Excel), such as bar charts, histograms, or map charts for further investigating those aspects relevant for the respective case study.

6.3.3. Strategy 3: In-depth exploration of social innovation initiatives

The third strategy for investigating social innovation consists of organising one focus group discussion with several relevant climate actors involved in social innovation initiatives or related activities, as identified in the mapping (strategy #2). A focus group is a qualitative interview setting, in which four to ten people (recommendations on the number of participants vary; see (Hennink, 2007; Nyumba *et al.*, 2018) are invited to collectively discuss a topic, guided by a moderator or facilitator. Unlike a single-person interview (explained in Research Guideline #2), a focus group gathers a variety of different views on a topic at the same time and attempts to use the dynamic of the group and the emerging discussion to synthesise the participants' perspectives. In the remainder of this section, we briefly discuss the goal of a focus group in the context of this research guideline, its implementation, and provide ideas for questions.

Focus group discussions aim to capture collective processes of thought, discussion, and reflection on a given topic, and allow to investigate spontaneous and authentic interactions between group members (Hennink, 2007). The exchange and group dynamics among different actors can spark new individual processes of thought as well as new ideas. Hence, focus group discussions provide for additional data that cannot be obtained in single-person interviews. More specifically, a focus group discussion with relevant climate actors can help characterising the regions' social innovation ecosystems and provide more information about available resources, the actors' capacities, but also barriers and restraints. It allows to put the actors' experiences, perceptions, and motivations into the focus while distilling collectively experienced issues and challenges in their work as well as necessary support measures for promoting social innovation in tackling challenges in the case study regions. Moreover, focus group discussions can provide insights into shared objectives of local climate actors and build bridges for mutual collaboration and cooperation. The focus group a method can enrich the characterisation of the NEVERMORE case study regions regarding the following aspects:

- Uncovering issues and ideas that emerge from the discussion between focus group participants of which the researchers were not aware of, and which would not have been asked in a single-person interview.
- Pinpointing topics that are unequivocally agreed on and identify topics with diverging viewpoints.
- Providing a broader context to single issues discussed.
- Better understand characteristics of the community in the respective case study region
- Identifying power imbalances in the discussion, which might mirror larger societal imbalances.

- Highlighting different approaches of addressing climate change and diverse experiences of its effects.

In the following, we briefly outline the most important aspects of focus group implementation. For further information on preparing, implementing, and analysing the focus group we refer to research guideline #2 on conducting interviews and to the handbook by Hennink (2007). The main differences that should be considered compared to a single-person interview (see 6.2 Research guideline #2: Researching the regions' configuration of climate-change-related stakeholders (a qualitative approach)) are a) the role of the moderator, b) the composition of the group, and c) content and usage of the discussion guideline.

The role of the moderator in a focus group differs from the interviewer role in a single-person interview. In a focus group, the moderator should facilitate the discussion with questions, but otherwise keep in the background so that participants can focus on the discussion among themselves (Hennink, 2007). Thus, the focus group participants talk with each other rather than to the interviewer. However, the moderator still needs to manage the discussion, in that they introduce new questions when saturation on a given issue is achieved and make sure the emphasis of the discussion is somewhat related to the overarching topic.

As a focus group comprises several individuals instead of one developing collective ideas, the composition of the group should be considered as it can influence the dynamic and development of the discussion (Hennink, 2007). Two main points to consider are how well focus group participants know each other (level of acquaintance) and to which extent the differ (level of homogeneity or heterogeneity). Both points depend on the research context as well as on the kind of stakeholders collected in the stakeholder mapping as well as their availability and have distinct benefits and disadvantages.

Some degree of acquaintance can provide a more familiar environment for participants to feel comfortable and includes shared knowledge and experiences participants can draw from in their collaborative discussion (Hennink, 2007). However, acquaintance can also include implicit power hierarchies restraining the discussion and implicit knowledge and information that is obvious to the participants but not the focus group moderator. If focus group participants are strangers, they might feel more comfortable due to anonymity and are more likely to thoroughly explain their thoughts; however, participants might need longer to warm up to the discussion. In the context of the NEVERMORE project, it is possible that the regional stakeholders collected in the mapping already know each other to some extent, as they are active in the area of climate change. In this case, it is important for the moderator to appraise the potential disadvantages of group acquaintance and try to address them, perhaps by stressing the confidentiality of the discussion or asking participants to explain their thoughts.

Group composition should also consider the extent to which participants have different socio-demographic characteristics or different experiences with regards to the discussion topic (Hennink, 2007). As the goal of the focus group research is to understand social innovation in the area of climate change in a given region, the participants invited to the focus group will share certain characteristics already, that is, they will be homogeneous at least to some extent. Hennink (2007) suggests to recruit homogeneous focus groups, firstly because this makes it more likely that participants identify with each other and collaborate well, and secondly, because it allows to compare focus groups that are homogeneous in different characteristics (e.g., compare a group of only young adults with a group of only seniors). If each case study region organises only one focus group as we suggest in this research guideline, then only the first aspect needs consideration. When compiling the group, Hennink (2007) proposes that participants should be homogeneous or comparable in these aspects: gender, power dynamics or social status, and level of knowledge or experience. We don't consider gender particularly relevant but would suggest to construct focus groups that share a similar level of knowledge and

experience in the domain of climate change and are not embedded in unequal power hierarchies, but otherwise aim for variety between participants.

Similar to a single-person interviewer, the moderator uses a guideline of questions, which have been developed beforehand and tested. This discussion guideline contains the key topics to be discussed by the group, and supports the moderator in keeping the balance between the research objectives and the discussion emerging in the group (Hennink, 2007). As a general structure, a focus group discussion guide can follow a funnel design, in which the first questions are posed in a more general manner, to open up and introduce the topic; followed by more specific questions covering the key issues of the research objective; then closing with somewhat broader questions for summarising and concluding the discussion. In the following, we provide a prototypical discussion guideline which can be adapted for the specific needs of each NEVERMORE case study. Results from research guideline #2 as well as results from analysing social innovation indicators and the social innovation mapping can also be incorporated. For the introduction and opening of the discussion, we suggest to follow the outline provided in Hennink (2007). Table 7 presents an exemplary discussion guideline, mostly based on Hennink (2007).

Table 7. Suggested structure of a discussion guideline for focus group interviews on social innovation.

Structure	Content	Example Questions
Introducing the setting	• Welcome participants and thank them for attending. • Explain the purpose of the focus group. • Reiterate why participants were invited and the importance of participating in the focus group. • Explain the code of conduct during the discussion, i.e. encourage participants to express their real opinions and feelings, that there are no wrong or right answers, that only one person should speak at a time to the group and that there is no particular order of speaking, that it is okay to disagree with each other and express diverging opinions, and explain the role of the moderator as facilitator of the discussion, not an expert. • Explain how information will be used and that it will be kept confidential and anonymous. • Explain the duration of the discussion. • Ask for consent for recording and start the recording.	
Opening up the discussion	Use an icebreaker question that every participant answers to, so that everyone has had a say and they feel more comfortable to contribute to the discussion later on.	As an introduction, I would ask everyone to tell us their name, pronouns, organisational background, and favourite hobby.
	After the icebreaker, proceed with the definition of social innovation: *We understand social innovation as the development of new solutions, products, or services that meet a social need or fulfil a social purpose. A social innovation is not only an idea, but needs to be implemented and*	• With regard to climate change, can you think of any "social innovations" in your region? • Why do you consider them to be a "social innovation"? • How are you affected by these social innovations?

Structure	Content	Example Questions

	results in some kind of change, for example changed awareness, norms, or behaviours.
	
	Proceed with open-ended questions introducing participants to the research topic (Hennink, 2007, p. 55):
	• Questions for capturing a "common knowledge base" as a foundation for the subsequent discussion.
	• Questions to know the participants relationship to the core theme.
		• Are you involved in any of these activities?
		  ○ How?
		  ○ If not: why?

Investigating the main research topic	After broadly introducing the research topic, proceed with a transition statement or a transition question towards the more specific questions directly related to the main research topic.	"Now that we have discussed existing social innovations in your area, I would be interested in your thoughts on implementing or realising different social innovation activities in your region. With social innovation activities, we mean any activities with the aim of developing, implementing, or sharing new solutions, products or services that address a social need. "

	The questions asking about the main research topic are called key questions (Hennink, 2007, p. 55). We suggest prompting the participants to discuss the following aspects:
	
	1. How actors experience the collaboration with others within the ecosystem.
	2. Which barriers and challenges regarding social innovation actors perceive in the region.
	3. The resources available to realise social innovations.
	4. Necessary measures to promote and push forward social innovation in the region.
		• When implementing activities related to any social innovation, with whom do you usually work together?
		  ○ How do you experience this collaboration?
		  ○ Who would you like to be more involved?
		• Which challenges or issues have you experienced when trying to realise activities related to social innovation?
		• How did you try to overcome these challenges or issues?
		  ○ And how did that work out?
		  ○ Which "best practices" of dealing with arising problems can you think of?
		• What do you think is necessary to support social innovation activities in the future?
		  ○ What would support you in your activities and goals?
		  ○ Who should be responsible for

Structure	Content	Example Questions
		supporting social innovation activities?
Summarising and concluding the discussion	Closing questions prompt participants to reflect on the discussion and important take-aways. 1. Asking about the relative importance of the issues that emerged during the discussion. 2. The moderator provides a brief summary of the discussion and asks participants whether the summary was accurate, and whether any important issues were missing or wrongly interpreted. Then, participants provide final inputs.	Considering all the issues discussed today, which do you feel are the most important ones when it comes to realising social innovation activities or initiatives?

The analysis of the focus group can follow a thematic analysis (see Research guideline #2 – Section 6.2.4). In contrast to individual person interviews, focus group interviews need to be interpreted with a stronger emphasis on the interaction amongst focus group participants and resulting micro-dynamics (Morgan & Hoffmann, 2018).

7. Conclusion and outlook

This document provides a comprehensive theoretical background and methodological considerations on the social science of climate change, which provides a foundation for an analytical framework for socio-economic factors and the uptake in climate change models. It also presents and elaborates in detail the three practical research guidelines:

- Research guideline #1: collecting data on the socio-economic situation and structure of the case-study regions – a secondary data analysis.
- Research guideline #2: researching the case study configuration of climate-change-related stakeholders – a qualitative approach.
- Research guideline #3: collecting data on social innovation initiatives in the case study areas – a mixed-method-approach.

The analytical framework and the corresponding research guidelines should inform further project work in NEVERMORE, specifically:

- The case study characterisation in WP6 (*Analysis of climate change impacts and risk at case studies*).
- The modelling activities going on regarding WILIAM in WP4 (*Design, modelling & integration of economic, environmental & social damages functions*) and regarding risk assessment and damage functions in WP6 (*Analysis of climate change impacts and risk at case studies*).
- The *climate change mitigation and adaptation policy analysis* in WP5.

Furthermore, the framework may guide the activities in WP2 which deals with the stakeholder engagement, the co-design of activities, and social sciences for climate action. The stakeholder engagement in particular is an ongoing process throughout the project duration that coordinates the projects activities which involve predominantly regional stakeholders, as well as the transnational council which consists of international experts. Here, the framework could provide ground for

additional research of factors or indicators that, for good reasons, cannot be adopted by one of the modelling approaches used by NEVERMORE.

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