



## Imprint

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### Abstract

This report elaborates an integrated vulnerability assessment concept, intended as a knowledge brokerage tool for decision-makers in the Baltic Sea Region. By developing an integrated vulnerability concept, in line with advances in regional and local vulnerability and adaptation research and based on the project's review of the scope and quality of current vulnerability assessments, the report supports discussions on what is needed for a systematic assessment of vulnerability in the region. The report rearticulates five critical challenges that potentially hamper realizing the full potential of vulnerability assessments to support and contribute to strategic decisions on climate adaptation: Adequate scope and goals; Ability to reflect the context; Inclusion of socio-economic stress; Clear connection between vulnerability assessment and decision-making on responses (and integrating knowledge and policies across sectors and levels); and Ability to merge top-down and bottom-up approaches. For each challenge, a principle has been formulated, which may serve as a guide in the development of the Baltic Sea Region Climate Change Adaptation Strategy.

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## 1 Introduction

This report entitled “Guideline on the system vulnerability: Analysis of the Baltic Sea Region vulnerability to the impact of climate change” elaborates an integrated vulnerability assessment concept, intended as a knowledge brokerage tool for decision-makers in the Baltic Sea Region, as part of Baltadapt task 4.5 “Integrated Vulnerability Assessment Concept”. The report was produced in parallel with the work to review national, regional or sectoral vulnerability assessments in Baltadapt, which was reported in Alberth et al (2012).

By developing an integrated vulnerability concept, based on the results from the evaluation of the current scope and quality of vulnerability assessments in the Baltadapt partner countries, the Baltadapt project intends to support the preparatory work with the Baltic Sea Region Climate Change Adaptation Strategy. Recent findings from research on regional and local vulnerability and adaptation to climate variability and change as well as practical vulnerability assessments have identified five critical challenges that potentially hamper realizing the full potential of vulnerability assessments to support and actively contribute to strategic decisions on climate adaptation. These are: 1. adequate scope and goals; 2. ability to reflect the context; 3. inclusion of socio-economic stress and change; 4. clear connection between vulnerability assessment and decision-making on responses (and integrating knowledge and policies across sectors and administrative levels); and 5. ability to merge top-down and bottom-up approaches. For each of these five challenges, a principle has been formulated, which may serve as a guide in the development of the Baltic Sea Region Climate Change Adaptation Strategy.

## 2 Aim and purpose of the report

The aim of Work Package 4.5 in Baltadapt is two-folded. Firstly, the Work Package aims to supply the transnational adaptation strategy with an overview about already known, homogenous and heterogeneous vulnerabilities in the BSR and their causes in order to facilitate discussion on how these should be addressed in the strategy. Secondly, the Work Package aims to support the transnational adaptation strategy conceptually, by providing a framework for thinking and acting on climate change vulnerability in the Baltic Sea region. This is referred to as the *Integrated Vulnerability Concept*. This concept intends to provide the basic elements for conducting integrated vulnerability assessments of climate change in the Baltic Sea Region. It should, thus, be seen as a means by which to gradually enhance both the knowledge base and the analytical and institutional capabilities to perform, assess and act on such knowledge. As such, the Integrated Vulnerability Concept strives to point out key elements and activities which might be prescribed in the strategy to become integrated parts of the adaptation action and follow up. In this report, we propose five major challenges for achieving integrated vulnerability, indicated above.

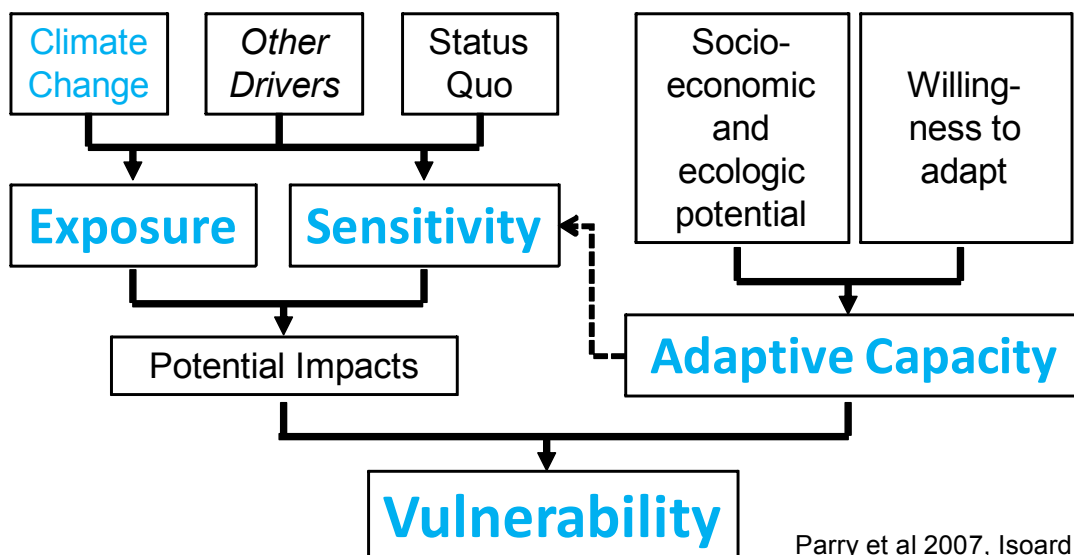
### 3 Integrated Vulnerability Definition

This section briefly presents the background and content of integrated vulnerability to climate variability and change and suggests basic elements of the approach to integrated vulnerability taken in the BaltAdapt project. We understand the integrated vulnerability concept as a framework that underlies and supports the development and implementation of the Baltic Sea region Climate Change Adaptation Strategy through emphasizing particular perspectives and phenomena over others.

Vulnerability is a widely used concept with different connotations across scientific communities and in practical application in various segments and administrative levels of society. In the climate change community, the Intergovernmental Panel on Climate Change, IPCC’s definition of the concept is perhaps the most prominent:

“Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity” (Parry et al 2007, p.883).

In other communities other definitions exist according to the context. For instance, the United Nations International Strategy for Disaster Reduction (UNISDR 2009) defines vulnerability as the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. The following scheme is often used to illustrate the relations between the different aspects and components relating to vulnerability as defined by the IPCC.



The IPCC definition, thus, singles out exposure, sensitivity, and adaptive capacity (see below). This tripartite division provides a structure for analysing the influence of different types of stress. From the integrated perspective any analysis or assessment needs to encompass these three different dimensions. Otherwise vulnerability risks being over- or underestimated. Integrated vulnerability studies are rooted in a social vulnerability perspective asking *who*, *how*, and *why* somebody is vulnerable. They conceive vulnerability of systems as partly determined by exogenous change and physical risks, partly on the localization and quality of the socio–technical infrastructure (Leichenko and O’Brien 2002; Eakin 2005).

When following the IPCC definition of vulnerability, a vulnerability assessment should consider the character, magnitude and rate of climate change and variation to which a system is exposed, the system’s sensitivity, and its adaptive capacity. By analysing these three dimensions (exposure, sensitivity and adaptive capacity), a vulnerability assessment estimates not only the current and potential future impacts due to changes in climate variables and the existing sensitivity of the system but also its future vulnerability by considering the adaptive capacity of a system.

**Definition of keywords based on the IPCC (2007)**

<i>Vulnerability</i>	The extent to which a system or actor is susceptible to, or incapable of coping with the detrimental consequences of climate change, including climate variability and extremes. Vulnerability depends on the character, magnitude, pace and variability of the climatic change to which the system is exposed, as well as the sensitivity and adaptive capacity of the system or actor.
<i>Exposure</i>	The degree of climate stress upon a particular unit or system; it may be represented as either long-term changes in climate conditions, or by changes in climate variability, including the magnitude and frequency of extreme events.
<i>Sensitivity</i>	The degree to which a system or actor is either adversely or positively influenced by climate variability or climate changes.
<i>Adaptive capacity</i>	The capabilities, resources or institutional capacities of systems, organisations or (individual) actors that enable them to adapt to climatic conditions that have altered or will alter in future and their possible impacts. Adaptive capacity includes to take effective adaptation measures and, by these means, to reduce potential damages, to take advantage of opportunities or to cope with the consequences, mainly by reducing its sensitivity by adaptation measures. To estimate the adaptive capacity, socioeconomic conditions and future developments need to be investigated, which is often done by scenarios and expert judgment.

### **3.1 Vulnerability assessments**

A vulnerability assessment addresses the observed and potential environmental exposures and the socio-economic context to analyse who or what is vulnerable and to what, when and where. In general, a vulnerability assessment aims at enabling a comparison of sources of vulnerabilities and identifying spatial and thematic hotspots in order to support or facilitate prioritization of adaptation responses. Vulnerability assessments are used in many different applications and, thus, use different methodologies. Accordingly, there is no common framework for a vulnerability assessment; rather several guidelines and frameworks co-exist. These existing methodological approaches range from purely qualitative-descriptive to mainly quantitative ones. All of them have advantages and limitations; and they have to meet the challenges to deal with uncertainty and to support political decision-making. Any summary of existing vulnerability assessments must therefore recognise the different methodologies used and carefully assess to what extent the findings are comparable; in practice they often are hardly comparable at all.

In comparison to the outcome of an impact assessment, conducting a vulnerability assessment adds the value of detecting specific adaptation capacities and needs and also adaptation potentials. A vulnerability assessment can be constructed to consider not only sectoral impacts but also cross-sectoral interactions, thus enabling an integrated assessment. Depending on the spatial and temporal scope of a vulnerability assessment, it can facilitate the determination of specific regional or sectoral vulnerability hotspots as well as to design suitable adaptation measures. A vulnerability assessment therefore enables a better prioritization of adaptation needs and potentials than solely an impact assessment. However, conducting a vulnerability assessment is time and resource consuming. Thus, a less comprehensive impact analysis could be done as a first step to create awareness of climate change vulnerability and adaptation.

A macro-regional vulnerability assessment of the Baltic Sea Region in support of a trans-regional adaptation strategy and adaptation action plan shall enable the identification of transnational adaptation needs due to climate-driven changes in the Baltic Sea Region. The focus of the Baltadapt adaptation strategy is hereby on the ecosystem of the Baltic Sea, the fishery as well as infrastructure and tourism in the coast area.

## 4 Five Challenges for Assessing System Vulnerability

Based on a review of recent scientific literatures in the regional vulnerability to climate variability and change and local responses to climate change, five challenges for achieving integrated vulnerability have been identified. These five challenges are: 1. adequate scope and goals; 2. ability to reflect the context; 3. inclusion of socio-economic stress and change; 4. clear connection between vulnerability assessments and decision-making on responses (and integrate knowledges and policies across sectors and administrative levels); and 5. ability to merge top-down and bottom-up approaches.

More than a decade ago, Adger (1996) characterized approaches to vulnerability to climate variability and change. Some of his observations are still valid. For instance, Adger argues that social vulnerability is the key dimension of vulnerability because it puts the emphasis on *who*, *how* and *why* somebody is vulnerable. By doing so, it shifts the attention

### 4.1 Challenge 1: Adequate scope and goals

Firstly, researchers and policy-makers agree that when preparing an adaptation strategy, it is pertinent to assess what factors shape current and future vulnerability to climate change. In practise vulnerability assessments, however, have often been carried out through a so-called risk-hazard approach; as for instance was concluded in the Baltadapt review of vulnerability assessments (Alberth et al 2012). This approach highlights exposure and sensitivity of the current natural and social systems, while downplaying their adaptive capacity, that is “the ability or potential of a system to respond successfully to climate variability and change” (Adger et al 2007, p 727).

Adaptive capacity had been proven crucial for enabling climate adaptation in a large variety of applications. While communities and sectors differ in their adaptive capacities, adaptation scholars have, among other things, suggested lists of generic factors that determine ability or capacity to adapt or respond to climate change (e.g. Smit and Philiposova 2001). Smit and Philiposova (2001) suggest that, broadly speaking, economic resources, technology, information and skills, infrastructure, institutions, and equity largely determines a community’s ability to adapt. These broad determinants have since been applied to different contexts. Keskitalo et al. (2011) conclude that in a developed country context, despite being well-endowed with economic and material resources, overall vulnerability may still be high due to a significant lock-in of these resources in technologies and infrastructure. Accordingly, the resources are not necessarily transformed into adaptation. This supports other claims that a high capacity to adapt at the national level is not necessarily reflected as high capacity at the lower levels of governance (e.g. O'Brien et al. 2006). In a study of vulnerability to climate change in Sweden, Jonsson et al. (2012) found that the ability to adapt at the community level was mainly determined by internal factors such as unclear distribution of responsibility across actors and significant different rules and available funds for investment in various municipal departments in the same city. This finding supports the so called “weakest link” hypothesis (Tol and Yohe, 2007), holding that overall ability to adapt is controlled by the weakest determinant.



To conclude, if adaptive capacity is excluded, the system vulnerability then risks being under- or over-estimated. In contrast, the integrated vulnerability concept departs from a tripartite definition spanning all these three elements of vulnerability: exposure, sensitivity, and adaptive capacity.

Furthermore, goals of vulnerability assessments must be clearly stated. There are growing demands for assessments of vulnerability to climate change from policy-makers at virtually all levels and in all segments of society. The recent emergence of vulnerability assessments therefore comes as no surprise. In view of this trend, it is essential to scrutinize these applications with reference to, for instance, what goals they aspire, what they considers to be vulnerable and to what stresses it is vulnerable as well as the specific methodology underlying the vulnerability assessment.

In a recent review of forty-five vulnerability assessments using geographic visualization to represent vulnerability, Preston *et al.* (2011) distinguished between the following goals of the vulnerability assessment for: identifying determinants of vulnerability; method development; risk identification; and decision-making. In Baltadapt, we see decision-making as the primary goal of the vulnerability assessment but with significant influences of the ability to identify underlying causes of vulnerability as well as the risks following from climate variability and change. Preston *et al.* (2011) rearticulate the criticism for using vulnerability mappings to support decision-making rooted in an insignificant capacity of extant vulnerability indices to serve as robust indicators of underlying socio-ecological vulnerability, even those that include aggregate socio-economic indicators (Barnett *et al.* 2008, Kienberger *et al.* 2009). This criticism is important for the Baltadapt context. We should view the application of the integrated vulnerability concept as not only about reaching an outcome, but as an iterative process through which Baltic societies deliberately engage in which to induce transformation into more climate compatible futures.

## **4.2 Challenge 2: Ability to reflect the context**

Secondly, as more knowledge of regional climate changes in the Baltic Sea Region becomes available, evidence grows that climate change will not manifest itself uniformly across the region. Such regional studies and assessments generally suggest an uneven distribution of the impacts of climate change (e.g. Metzger *et al.* 2008, Reidsma *et al.* 2009) as well as the capacities to adapt to these changes across and within the Baltic Sea Region (O'Brien *et al.* 2004; Folke *et al.* 2005; EEA 2012). Moreover, Adger (1996) recognized the need to distinguish between vulnerability at a collective—or community level—and at the individual level. Since exposures, sensitivities and adaptive capacities differ, resulting vulnerability can also differ significantly between individuals residing in the same local area. There is, hence, growing recognition and examples that vulnerability to climate change needs to be contextualised, and that the factors shaping local exposure, infrastructure sensitivity, ability to address the changing climate, experience and political support for climate adaptation differ significantly from locale to locale (cf Engle 2011; Eriksen *et al.* 2011; Malone and Engle 2011). Evidently, a regional strategy for climate adaptation needs to be able to reflect this.

### ***4.3 Challenge 3: Inclusion of socio-economic stress and change***

Thirdly, the evidence is amassing that vulnerability to climate change is intimately connected to other social change. Indeed, economic globalisation is likely to also shape vulnerability to climate change by not only influencing sensitivity and adaptive capacity but also through “adaptation” to the changed socio-economic and climate policy contexts (Langlais 2009). For instance, the influence of economic globalisation has been demonstrated to affect decisions to create a more metropolitan-like city core in spite of high current and future exposure to flooding (e.g. Hjerpe and Glaas 2012). This suggests that a vulnerability assessment and, consequently, a strategic response to climate change, should also be able to incorporate influence of socio-economic stress, which is often captured by seeing vulnerability in the context of multiple stressors.

### ***4.4 Challenge 4: Clear connection between vulnerability assessments and decision-making on responses***

Fourthly, recent research indicates that vulnerability assessments are rarely linked to adaptation planning and the actual process of implementing policies and measures to reduce vulnerability to climate change (e.g. Preston et al 2011) or to mitigate climate change. Adaptation is therefore treated as external to vulnerability, both in science, policy and practice (Hjerpe and Glaas 2012). Interestingly, only half of the vulnerability assessments reviewed by Preston et al. (2011) explicitly aiming to support decision-making also addressed adaptation measures. We align with Preston et al. (2011) and Kellstedt et al. (2008) in viewing this as a reflection of a “knowledge-deficit” bias that exists among the scientific, government and other institutions. To be relevant and useful, vulnerability assessments need to meet the dual challenges of integrating, aggregating, and combining knowledge produced at different spatial and administrative (vertical) levels as well as from different sectoral (horizontal) or epistemic communities perspectives. In practice, means to bridge cross-sectoral and multi-level gaps has been viewed as critical but difficult to encounter and assess. In case of the Baltadapt work with developing a draft Baltic Sea Region Climate Change Adaptation Strategy, horizontal and vertical interplay is essential to ensure that the actors at local and regional level are not exhausted by institutional complexity, but facilitated through mutually reinforcing institutions. Accordingly, this challenge needs to be turned into an opportunity for the Baltadapt integrated vulnerability concept and the Baltic Sea Region Climate Change Adaptation Strategy. Supporting the need for continuous development and work with adaptation, to be successful an adaptation strategy needs to clearly develop how the vulnerability assessments relate to the political and administrative decisions and acknowledge and create forms that enable integration of policies and knowledges across sectors and administrative levels.

#### ***4.5 Challenge 5: Ability to merge top-down and bottom-up approaches***

Fifthly, available evidence suggests that the knowledge or data for making comprehensive vulnerability assessments is largely lacking (e.g. Malone and Engle 2011), although it recently has been rapidly amassing. The Baltadapt review of vulnerability assessments similarly concluded the same (Alberth et al. 2012). Studies also suggest that two general approaches to assessing local vulnerability are emerging. The first approach is referred to as top-down. It commonly draws on calculating a comprehensive vulnerability index for all local areas in a region (see for instance Röd et al 2012; Grieving et al. 2011). Recent reports present detailed scenarios on impacts, sensitivity and adaptive and mitigative capacities (Grieving et al. 2011) and factors affecting urban adaptation to climate change (EEA 2012). Other Europe-wide studies have expanded our knowledge on the sensitivities of regional economies (Aversano-Dearborn *et al.* 2011). Accordingly, findings from regional assessments of various elements of vulnerability to climate change are becoming increasingly available. These results should, however, be interpreted with caution. For instance, Preston and colleagues (2011) argued that the vulnerability indices currently in use are insufficient as robust indicators of the underlying socio-ecological vulnerability, thus questioning their validity (Malone and Engle 2011).

The second approach departs from the fact that climate adaptation is also taking place from the bottom and up. There is a large body of literature pointing to municipalities and local administrators as key actors for making local climate adaptation and mitigation happen (e.g. Bulkeley and Betsill 2003, Betsill and Bulkeley 2007). A significant number of studies have elaborated on drivers and barriers to local climate action, identifying barriers such as recognition of non-climate benefits of responses, linking climate to other political concerns, strong political and technical support, and collaboration to raise funds (Allman *et al.* 2004; Robinson and Gore 2005; Urwin and Jordan 2008). These studies have improved our understanding of the factors shaping adaptive capacity and the roles of local government in responding to climate change. It has also been established that high national adaptive capacity based on general statistics does not necessarily transfer into response action (O'Brien *et al.* 2006). Bottom up studies commonly use cases or analogue methods addressing one or a few municipalities in a country (Posey 2009; Ford *et al.* 2010; Malone and Engle 2011); those of relevance for the Baltic Sea Region tend to make no exception (e.g. Keskitalo 2008; Storbjörk 2010; Glaas *et al.* 2010) although recently a few cross-country local scale comparisons have emerged (Keskitalo *et al.* 2011, Reidsma *et al.* 2009). Currently, however, it still is hard to abstract the generic from the case-specific, even though we are now in a position that allows us to relatively quickly characterize a local case using the sets of drivers and barriers. Accordingly, the knowledge of factors shaping vulnerability and adaptation from below is also accumulating.

To conclude, a regional adaptation strategy needs to connect and balance knowledge generated from applying vulnerability indices from the bottom and down to the local communities with the one

stemming from the locally grounded vulnerability assessments and adaptation studies. We see an integrated strategy as a framework that fruitfully connects these two fields of knowledge into robust assessments.

Moreover, the bottom-up studies often incorporate the views of local stakeholders, either implicitly as primary data collected through appraisals and interviews or explicitly as participants in the actual assessment process. This has proven to be beneficial, especially for assessing sensitivity of the current system. The ability to assess vulnerability to climate change in local governments and by local actors is also pertinent for Baltadapt. A transnational strategy should nurture local capacity and ability to assess climate vulnerability in order to facilitate adaptation decisions and responses to climate change. In this respect, it is essential that the transnational strategy helps clarify distribution of responsibility across administrative levels and that it ensures the establishment of a macro-regional knowledge base. Evidently, the research agrees in pointing to political support as a key factor for local engagement in climate adaptation. However how political support is created is less well understood. The Baltadapt strategy could here serve as a catalyst for (local) political engagement clearly assigning responsibility, suggesting institutional set-ups, and by creating positive incentives to engage in climate adaptation such as macro-regional funds for climate adaptation, contests to reward the best local adapters, etc. Hence, in Baltadapt we see an institutional setup that nurtures local action, straightens out unclear distribution of responsibilities, and creates positive incentives as key.

## 5 Conclusion and recommendations

The most central conclusion to draw from the integrated vulnerability concept is to agree on the challenges: adequate scope and goals; ability to reflect the context; inclusion of socio-economic stress and change; clear connection between vulnerability assessments and decision-making on responses (and integrate knowledge and policies across sectors and administrative levels); and ability to merge top-down and bottom-up approaches. At this early stage, these should be seen as strongly proposed suggestions. Hopefully, after having discussed and scrutinized them, a revised set of challenges can be developed.

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