Co-designing climate services to support adaptation to natural hazards: two case studies from Sweden

SEI discussion brief
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This SEI discussion brief shows how co-designed climate services can better support adaptation processes by focussing on users' needs, and gaining greater understanding of the challenges they face in making real-world policy decisions.

IMAGE (ABOVE): Stockholm: St.Jacob's church. The Stockholm case study involved examining whether a "greener" city would be more resilient to heat waves. © ROSMARIE WIRZ /GETTY IMAGES

Key messages

- **The types of climate services needed depend on context, including users' prior experience, and the stage of the adaptation learning cycle.**
- **To deliver climate services that address stakeholder-specific needs and intended uses, providers and intermediaries must understand institutional and decision contexts.**
- **The co-design of climate services should better address the tendency for stakeholders to select and assess adaptation options one at a time, rather than considering multiple options.**
- **Co-design approaches should better reflect the need for decision-makers to address both climate- and non-climate-related concerns and priorities.**
- **Co-design processes may overcome common barriers (such as uncertainty in climate projections, and policy priorities that compete with climate adaptation) to the use of climate research in practice.**

Introduction

Despite a strong increase in climate change adaptation research over more than a decade, climate information is seldom used to its full potential in adaptation planning and decision-making. This gap between research and action (Klein and Juhola 2014; Palutikof et al. 2019) signals that there is a lack of actionable knowledge to support adaptation decision-making (Ernst et al. 2019). One of the ways forward is the use of more bottom-up and inclusive approaches that challenge providers to tailor information to users' specific institutional and decision contexts (Hewitt et al. 2017; Palutikof et al. 2019).

Tailored information meets the ambition to bridge the gap between providers and users of climate information. It has been shown to assist and improve climate change adaptation (hereafter adaptation) decision-making, and such climate information outputs have come to be widely known as climate services (Vaughan and Dessai 2014). Climate services may be in different formats such as models, assessments or participatory processes (Daniels et al. 2019) or "tools, products, websites" (Vaughan and Dessai 2014, p.588).

The Tandem framework has been developed in the SEI Climate Services Initiative (further described in Daniels et al. 2019; Daniels et al. n.d.) to inform processes for co-designing climate services. This brief is part of a series designed to test and refine the Tandem framework using completed and ongoing projects related to climate services and adaptation decision making.

Drawing on two Swedish case studies of Karlstad municipality and City of Stockholm where the Tandem framework has been applied, the overall aim of this brief is to understand how the co-design of climate services can support adaptation planning and decision-making. From the perspective of climate service users, we focus specifically on the following:

- What are the adaptation challenges, institutional contexts, information needs and possible adaptation measures decision makers face?
- How can a co-designed climate service help support adaptation processes?
- What lessons can be learned to improve adaptation processes and the co-design of climate services in general, and, specifically, the Tandem framework?

BOX 1. KEY CONCEPTS

Climate service users (e.g. local planners and decision makers) employ climate information and knowledge for decision- making; they may or may not participate in developing the service itself.

Climate service providers are actors (e.g. climatologists, meteorologists, consultants) who supply climate information and knowledge.

Climate service intermediaries are actors (e.g. adaptation and learning specialists, project managers, consultants and researchers) who "translate" between providers and users.

Co-design processes involve end-users throughout the process of designing a climate service.

(Daniels et al. 2019; Steen et al. 2011; Vaughan and Dessai 2014)

The Tandem framework

The Tandem framework has been developed to guide providers and intermediaries (see Box 1) of climate information through seven iterative steps that are intended to produce relevant, actionable and sustainable climate services that meet the needs of the users of the climate information:

- **Step 1** consists of identifying and defining an adaptation challenge that would benefit from the use of a climate service.
- **Step 2** focuses on identifying and engaging with potential users of a climate service.
- **Step 3** involves co-defining the desired objectives of a climate service, and reviewing advantages and shortcomings of existing services.
- **Step 4** entails gaining an understanding of the institutional and decision contexts in which the climate service will be embedded.
- **Step 5** guides providers and users of the climate service in co-exploring data and information needs, including their sources, formats and modes of dissemination.
- **Step 6** consists of appraising adaptation measures, in which decision-support methods may be used to identify, evaluate, prioritize and sequence interventions.
- **Step 7** ensures that the climate service is used in practice by embedding it in existing institutions, and ensuring that mechanisms are in place for maintaining, evaluating and upgrading the service as appropriate.

Improving adaptation planning in Swedish municipalities

In Sweden, municipalities play an important role in planning and implementing adaptation measures at local level. Sweden's National Strategy for Climate Adaptation (Government bill 2017/18:163) and the resulting changes to the Swedish Plan and Building Act further strengthened this role. Municipalities must now consider climate risks, and how to minimize or eliminate these risks in the built environment. Swedish municipalities have advanced their adaptation work in recent years, in the sense that an increasing number of municipalities state that they work with adaptation, according to a recent study (Matschke Ekholm and Nilsson 2019). Yet, at the same time, the study shows that more knowledge and guidance is needed to continue to systematically analyze risks, and to develop adaptation measures.

This brief builds upon work carried out within the project HazardSupport,[1] which runs from 2015 to 2020. The project aims to develop a new, collaborative method for tailoring information about the impacts of climate change on natural hazards to inform adaptation decisions. It involves providers, intermediaries and users of climate services from the

1 https://www.smhi.se/en/research/research-departments/hydrology/hazardsupport-1.96217

Swedish Meteorological and Hydrological Institute (SMHI), Stockholm Environment Institute (SEI), and municipal officers from Karlstad Municipality and the City of Stockholm.[2]

HazardSupport has employed a co-design process that has to date included a series of focus group meetings, workshops and interviews carried out and documented during 2015–2019. The various participatory forums have aimed at scoping the adaptation challenge (Step 1) and the decision-making and institutional context (steps 3-4), and assessing the stakeholders' current use of and needs for climate information (Step 5) to tailor-make climate services that can be used to appraise adaptation measures (Step 6). In the coming phase of the project, climate services will be embedded in the institutional context (Step 7). All notes and transcripts from the participatory forums have been reviewed and analyzed in line with the Tandem framework.

Results

For the two Swedish municipalities, the process of defining an adaptation challenge and identifying adaptation measures extends well beyond that of a climate service project such as HazardSupport, and was hence underway prior to the project. Consequently, in the following sections, we take our starting point in the municipalities' internal planning processes related to adaptation, and outline how they arrived at defining the adaptation challenge, and identified adaptation measures for which there is a need for a climate service.

As climate service providers and intermediaries, scoping these processes has been part of the climate service development, corresponding to steps 1-4 of the Tandem framework. After describing these processes, we present the development of the climate service (Step 5), how it is used to appraise adaptation measures (Step 6), and its further use in planning and implementation (Step 7).

Case study 1 – Developing a climate service to support adaptation to multiple water hazards in the municipality of Karlstad

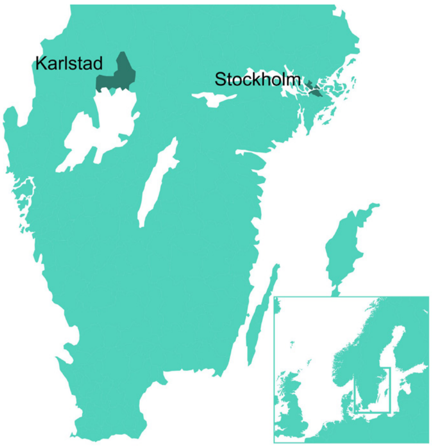
Growing awareness of flood risk and identification of adaptation measure

In the Karlstad case study, the adaptation challenge in focus is flood protection of the Skåre area, located in northern Karlstad. Skåre is an attractive residential area with plans for densification, but is at risk of flooding from multiple water hazards including river floods and cloudbursts. Defining the adaptation challenge and identifying the adaptation measure have been gradual processes, in which awareness and momentum for addressing it have been growing over years.

With its location in the river delta of Klarälven that discharges into Vänern, Sweden's largest lake, the municipality of Karlstad is no stranger to flooding. The adaptation challenge of "flooding has [long] been on the agenda" (municipal officer, Karlstad). The municipality initiated a flood protection programme (Karlstad municipality 2010) in 2010 to guide planning in managing current and future flooding risks, including those related to climate change. The programme's flood map showed that the Skåre residential area is particularly vulnerable. The programme identified, for the first time, the prospect of building a flood defence wall to protect the area as an adaptation measure.

Gradually, awareness increased that the adaptation challenge was not limited to addressing river floods, but also cloudbursts. The severe cloudbursts that had caused the closing of major roads and the disruption of rail services in 2014 triggered a

2 HazardSupport also includes a third case involving the Swedish insurance company Länsförsäkringar. Due to the different nature of that case, it is not included in this brief.



realization that "there are multiple hazards that may happen simultaneously" (municipal officer, Karlstad).

The adaptation challenge for Skåre reached a critical point in 2016, when flooding risks led the County Administrative Board to reject a municipality-proposed densification plan for Skåre. The municipality then realized that it "had to give the flood defence wall higher priority" (municipal officer, Karlstad) so that the lack of flood defence in the area would not hinder development. Consequently, the municipality initiated a flood defence programme for Skåre to investigate and implement a comprehensive solution. Officials at this point understood the adaptation challenge to involve the questions of how to adequately provide flood protection and whether to prioritize river- or cloudburst-linked flooding. Further, they also needed to assess whether a flood defence wall would be an effective adaptation measure, and, if so, where it would best be placed.

Co-exploration of climate data and information needs

As part of the HazardSupport project, SEI and SMHI engaged in discussions with representatives from the Karlstad municipality in conjunction with the increased priority given to addressing Skåre's flood protection. The municipality identified a need for tailored information to assess whether the proposed flood defence wall would indeed be effective in a future climate, including under scenarios with multiple extreme events of simultaneous river flooding and cloudbursts.

Initial discussions focused on articulating the adaptation challenge and exploring the institutional context (corresponding to steps 1-4 in Tandem). Subsequently, SMHI presented a set of proposed alternative climate services. Based on these alternatives, the municipality sought estimates of water amounts and flows for defined scenarios (incorporating possible extreme events) to meet legal requirements. (This iterative dialogue to define data needs corresponds to Tandem Step 5.)

To meet this need, SMHI assessed current and future conditions using a hydraulic model that included the proposed flood defence wall. The model drew on data on expected future waterflows in the rivers, as well as data on cloudbursts.[3] Maps showed the flooded areas of Skåre under different scenarios of the model.

Using climate information to appraise and plan adaptation measure

The modelling results from the climate service showed that the flood defence wall would indeed be effective to prevent river flooding, and would not cause unmanageable flows in the event of cloudbursts. SMHI is also generating information on the combined effects of multiple water hazards happening simultaneously. The results will support the municipality in its appraisal of the adaptation measure (corresponding to Step 6 in Tandem). The information will feed into the municipality's appraisal process in advance of budget and implementation decisions.

Case study 2 – Developing a climate service to support adaptation to heat waves in the City of Stockholm

Growing awareness of heat waves and identification of adaptation measure

The adaptation challenge in the case study of Stockholm relates to the city's rapid growth and urgent development needs. The official target of building 140,000 homes by 2030 (City of Stockholm 2018) will mean making the city denser, and developing new residential areas. As identified by municipal officers during the initial phase of HazardSupport, this development goal might have implications for the vulnerability of

3 For more information about the method used by SMHI, see (Olsson et al. 2017).

the city to climate change and heat stress. Hence, a key question for Stockholm has been to further understand how the city can develop while ensuring that it adapts to current and future climate risks.

Defining the adaptation challenge in Stockholm – as in Karlstad – has been a gradual process, in which awareness and momentum for addressing it have grown over the years. The 2007 launch of the Governmental Commission on Climate and Vulnerability (Swedish Government Official Reports 2007:60), which analysed the consequences of climate change for different sectors and geographical locations in Sweden, served as a milestone to raise awareness on the vulnerability of Stockholm to climate-related heat waves.

At that time, the issue of adaptation was relatively new in Sweden, and information on risks related to heat waves was limited. Since then the knowledge base has steadily grown, and municipal officers in Stockholm have actively initiated studies and research collaborations to get a better understanding of heat-related risks in relation to urban planning. A key related issue is the role of ecosystem services and green infrastructure (GI) as an adaptation measure to mitigate heat stress. To address this issue, the City developed a planning tool, the Green Space Index,[4] which focuses on GI as a means to manage surface water and biodiversity, and aims to better capture adaptation considerations alongside social and biodiversity values.

Moreover, as described by municipal officers in Stockholm, internal adaptation work has developed over the years. The City Plan, adopted in 2018 (City of Stockholm 2018), includes aspects of adaptation, such as cloudbursts, sea-level rise and heat waves. Another event of 2018 – the severe heat wave that hit Sweden in the summer – helped create an environment conducive to working systematically to obtain more information about heat waves and to evaluate related adaptation measures.

Co-exploration of data and information needs

To meet the municipality's need for a better understanding of what densification means for heat stress risks (corresponding to Tandem steps 1-4), SMHI and municipal officers identified two overarching questions:

1. What impact will the planned expansion and densification have on urban air temperatures?
2. How sensitive are urban air temperatures to "greening", or measures that include GI?

To address the first question, SMHI analyzed the effects on air temperature of four different municipal and regional planning scenarios with different ratios of green spaces: Scenario 1 is based on the current City Plan (including plans for 140,000 additional homes) and represents the city in 2030. Scenario 2 is based on a regional planning scenario; it represents the Stockholm region in 2050. Scenario 3 represents a "black city" scenario in which development plans incorporate very little green space. Scenario 4 represents a "green city" scenario with more green spaces. In the development of these scenarios, the iterative exchange of information and data between SMHI and local stakeholders appears to have been critical to ensure their relevance to ongoing planning processes in Stockholm (corresponding to Tandem Step 5). So far, results confirm that green spaces reduce air temperatures locally, though the "green city scenario" analysis, which has yet to be finalized, is expected to provide more detail.[5] Once the general effect of green spaces on air temperatures is better understood, planners will need more information on the effect of specific types of GI, and how these can be combined to effectively address heat stress at the urban district level.

4 Originally developed by City of Malmö.
5 For more information about the analysis by SMHI see Amorim et al. (Forthcoming).

Using climate information in future city planning

The information is expected to feed into municipal planning processes in two ways. First, it will provide the municipal officers with general information about the role of GI for heat stress mitigation. The scenario results can be used in communication to enhance awareness and create discussions about the future development of the city. The green city scenario will be particularly important to further motivate the role of GI in the continued planning of the city. For example, the results may inform the coming phase of developing a new environmental programme for the city in 2020. Second, the information may inform further development of the Green Space Index tool, for instance by integrating air temperature benefits into the tool.

Discussion

These two cases offer lessons both for adaptation processes and the Tandem framework.

Different types of climate services for different needs

The two case studies differ in terms of previous experience and existing institutional contexts, both of which steer their specific climate information needs. Karlstad has prior experience of the issue, including experience of building flood defence walls, and thus needed granular, place-specific climate information. Stockholm, by contrast, has limited prior experience of considering heat stress in municipal planning. Officials there still need more generic climate information to assess and create awareness of the role of city planning in general, and green infrastructure in particular, in managing heat waves. The situation also reflects the fact that heat waves generally have not received as much attention as flood risks.

The two municipalities studied here are in different points of the adaptation learning cycle (PROVIA 2013). Karlstad is moving into implementation of a specific adaptation measure against flooding, whereas Stockholm is in an earlier phase of coming to grips with the magnitude of the problem of heat waves, and the role of green spaces. These differing needs require different types of climate services at different scales and different levels of detail. These differences underscore the importance of having a decision-focus throughout the co-design process (see e.g. Vincent et al. 2018), and of clearly understanding the institutional and decision contexts of the climate service as put forward by the Tandem framework (Daniels et al. 2019).

Assessment of one adaptation measure at a time or many alternatives

In both case studies, the adaptation challenge and adaptation measure were pre-defined at the outset of the climate service co-design process. Thus, the emphasis during the initial phase of HazardSupport was to ensure that users and providers shared a similar understanding of the adaptation challenge, and to subsequently agree on the specific needs for tailored climate information.

The pattern of evaluating one adaptation measure at a time rather that comparing a menu of options is also highlighted in a recent report by Matschke Ekholm and Nilsson (2019), which shows that only 13 percent of the responding Swedish municipalities have evaluated several different adaptation measures as part of their adaptation work. This singular focus is potentially problematic in the sense that municipalities may miss out on innovative solutions, leading to sub-optimal investments and less effective adaptation work.

Our results give a few indications as to why we see the pattern of using climate services to evaluate a specific adaptation measure rather than appraising several alternatives. A first reason may be that civil servants drive a lot of the adaptation work forward, and they work with the solutions available given their institutional mandate. For a city planner, GI is one of the few institutionally acceptable options for dealing with heat waves. Other possible measures (updating elderly care routines, for example) may fall under different department mandates. Another reason may be that adaptation measures often must address concerns other than adaptation. In the Stockholm case, for example, heat stress mitigation is only one among many arguments for GI and until recently the two agendas of heat waves and GI largely developed independently. An element of politics may arise, with users of climate information seeking support for their preferred solution. This resonates with the ideas put forward by Kingdon (1984) regarding the need to find "streams" of problem definitions, available solutions, and politics that converge to open a window of opportunity for shifting policies and priorities. In reality, the starting point for a climate researcher who wants to support adaptation work may thus be to find "champions" who want to push adaptation forward (often through the promotion of a specific solution), and who need evidence to do that. Identifying potential windows of opportunity and considering the timing of the climate service may also be important factors to potentially increase impact.

Climate service frameworks such as Tandem could broaden their scope to better reflect a reality in which adaptation measures are not necessarily appraised and compared, but are often pre-defined, with climate services used to evaluate and help design specific adaptation measures.

Using climate services in adaptation planning

Throughout the project, the SMHI and stakeholders engaged in an iterative dialogue to further define and specify needs. The presentation of emerging results (corresponding to Tandem Step 5) clearly facilitated the continued dialogue and exchange of data. This step was important to further define and specify their needs in more detail, and it provided support for continued work. For example, the emerging results in Karlstad showed that some of the flooding risks associated with building the wall were not as significant as municipal officers had feared. These insights then helped prioritize the next steps of developing tailored information.

Once the climate service enters the planning process, however, the service itself become only one component amid an array of information needed by municipal officers. In both case studies, any climate-related benefits of the adaptation measures are weighed against other concerns. These included other feasibility and budgetary concerns in Karlstad, and other planning considerations such as the demand for more housing in Stockholm. Our case studies confirm findings from Klein and Juhola (2014) who state that a main barrier to increased use of climate information in practice is the fact that climate information itself is only one among many considerations for practitioners. As illustrated by our study, however, co-designed climate services may help overcome this barrier by providing actionable information that is tailored to the user's decision context.

Further, and contrary to what is often the case (Klein and Juhola 2014), uncertainty in the climate information was not a barrier for its use in practice in the two cases studied here. In Karlstad, uncertainty in projections of a future climate was addressed by adding a standardized "climate factor" to the water levels, as recommended by the Swedish Water & Wastewater Association, and by illustrating the results in map formats that were easy for municipal officers to interpret. In Stockholm, climate information described the role of green spaces for air temperature in the city in general, irrespective of the degree of future climate change. Thus, uncertainty does not appear to be an insurmountable challenge. Nevertheless, strategies to overcome or navigate uncertainty may be needed, and co-design processes may help identify the issue, and the possible ways to address it.

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References

Amorim, J., Segersson, D., Körnich, H., Asker, C., Olsson, E. and Gidhagen, L. (Forthcoming). High resolution simulation of Stockholm's air temperature and its interactions with urban development. Urban Climate, Under review.

City of Stockholm (2018). Översiktsplan för Stockholm [Stockholm City Plan]. City Planning Administration, Stockholm

Daniels, E., Bharwani, S. and Butterfield, R. (2019). The Tandem Framework: A Holistic Approach to Co-Designing Climate Services. SEI Discussion Brief. Stockholm Environment Institute

Daniels, E., Bharwani, S., Gerger Swartling, Å. and Vulturius, G. (n.d.). Broadening the climate services lens: introducing a framework for co-designing "transdisciplinary knowledge integration processes" to build climate resilience.

Ernst, K. M., Swartling, Å. G., André, K., Preston, B. L. and Klein, R. J. T. (2019). Identifying climate service production constraints to adaptation decision-making in Sweden. Environmental Science & Policy, 93. 83–91. DOI: 10.1016/j.envsci.2018.11.023

Government bill (2017). Nationell strategi för klimatanpassning [National Strategy for Climate Adaptation]. Proposition 2007/18:163. Ministry for the Environment and Energy, Stockholm

Hewitt, C. D., Stone, R. C. and Tait, A. B. (2017). Improving the use of climate information in decision-making. Nature Climate Change, 7. 614–16. DOI: 10.1038/nclimate3378

Karlstad municipality (2010). Översvämningsprogram Karlstad kommun [Flood Defense Program Karlstad Municipality]. Karlstad municipality, Karlstad. https://karlstad.se/globalassets/filer/miljo/sjoar_och_vattendrag/oversvamningsprogram.pdf

Kingdon, J. W. (1984). Agendas, Alternatives and Public Policies. Little, Brown and Company, Boston

Klein, R. J. T. and Juhola, S. (2014). A framework for Nordic actor-oriented climate adaptation research. Environmental Science & Policy, 40. 101–15. DOI: 10.1016/j.envsci.2014.01.011

Matschke Ekholm, H. and Nilsson, Å. (2019). Klimatanpassning 2019 - Så långt har Sveriges kommuner kommit [Climate adaptation 2019 - so far has Swedish municipalities come]. IVL, Swedish Environmental Research Institute, Stockholm

Olsson, J., Berg, P., Eronn, A., Simonsson, L., Södling, J., Wern, L. and Yang, W. (2017). Extremregn i nuvarande och framtida klimat: analyser av observationer och framtidsscenarier. Klimatologi nr 47. Swedish Meteorological and Hydrological Institute, SMHI, Norrköping, Sweden. https://www.smhi.se/publikationer/publikationer/extremregn-i-nuvarande-och-framtida-klimat-analyser-av-observationer-och-framtidsscenarier-1.129407

Palutikof, J. P., Street, R. B. and Gardiner, E. P. (2019). Decision support platforms for climate change adaptation: an overview and introduction. Climatic Change, 153(4). 459–76. DOI: 10.1007/s10584-019-02445-2

PROVIA (2013). PROVIA Guidance on Assessing Vulnerability, Impacts and Adaptation to Climate Change. Consultation document. United Nations Environment Programme, Nairobi, Kenya

Steen, M., Manschot, M. and Koning, N. D. (2011). Benefits of Co-design in Service Design Projects. International Journal of Design, 5(2). 53–60.

Swedish Government Official Reports (2007:60). Sverige inför klimatförändringarna: hot och möjligheter [Sweden Facing Climate Change: Threats and Opportunities]. SOU 2007:60. Ministry of the Environment, Stockholm

Vaughan, C. and Dessai, S. (2014). Climate services for society: origins, institutional arrangements, and design elements for an evaluation framework. Wiley Interdisciplinary Reviews: Climate Change, 5(5). 587–603. DOI: 10.1002/wcc.290

Vincent, K., Daly, M., Scannell, C. and Leathes, B. (2018). What can climate services learn from theory and practice of co-production? Climate Services. DOI: 10.1016/j.cliser.2018.11.001

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