EVOKED

Enhancing the value of climate data

Deliverable 2.1

Local set of scenarios (narratives and population projections)

Work Package 2: Co-develop

Deliverable Work Package Leader:
Kiel University (CAU)

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Summary

A multi-scale co-development approach has been used for the development of a series of local scenarios in the context of the EVOKED project. These scenarios were developed for the four case studies of the project, namely the City of Flensburg (Germany), Larvik (Norway), Värmland and Arvika (Sweden) and the regions of Fluvius and North Brabant (Netherlands). For this purpose we have employed the new scenario framework used in climate impact research, namely the Shared Socioeconomic Pathways (SSPs). We used the SSPs as boundary conditions for the local extensions in order to embed the local scenarios in a global context. Using the global SSP elements we developed sets of local elements; determined plausible future developments of these elements; and constructed local narratives. During this process we incorporated feedback from the stakeholders of every case study.

The results of this activity include scenario narratives and quantitative population projections for each of the case studies of EVOKED. Owing to the co-development approach used, the produced scenarios are locally relevant and accepted by the case-study stakeholders, while at the same time they are also consistent with the global SSPs. Therefore the local scenarios can be compared to other regional downscaled scenarios that use the SSPs as boundary conditions. As the co-development process relies on the feedback of stakeholders, we must emphasise the importance of thorough preparation of the activities related to obtaining feedback from stakeholders and the benefits of utilizing a range of visualization techniques, such as figures, graphs, animations and posters, in order to facilitate comprehension.

Contents

1 Introduction

This document describes the process of development of local scenarios for the different case studies of EVOKED. First, we discuss the current state-of-the-art scenario framework in climate impact research, which constitutes the boundary conditions for the development of the local scenarios in EVOKED. Then, we present the multi-scale co-development approach that has been used for the development of the local scenarios; the process that was followed for incorporating feedback from the stakeholders for every case study; and the results of this activity in the form of scenario narratives and population projections for each case study. Finally we critically discuss the advantages and limitations of the developed approach and present possible ideas for further work.

1.1 History of scenarios in climate research

Scenarios are used in climate research to account for uncertainty in future socioeconomic development. This development defines emissions and thus climate change and associated potential impacts. Scenarios provide plausible descriptions of how the future may evolve with respect to demographic change, social and economic development and the rate and direction of technological change. However, they are not forecasts or predictions but rather represent a range of possible future outcomes (Ebi et al. 2014; Nicholls et al. 2008; Moss et al. 2010). An overview of the most prominent scenario frameworks that have been used in climate research is provided in Figure 1, along with the IPCC Assessment Report in which they were used and a brief description.

YEAR	NAME	USED IN	BRIEF DESCRIPTION
1990	**SA90** 1990 IPCC Scenario A	First Assessment Report	Four emissions pathways: one business as usual and three policy scenarios (IPCC 1990)
1992	**IS92** 1992 IPCC Scenarios	Second Assessment Report	Six emissions scenarios including economic growth, population and technology; no policies included (Leggett et al. 1992)
2000	**SRES** Special Report on Emissions Scenarios	Third and Fourth Assessment Report	Four emissions scenario families including population, economy, technology, energy, agriculture and land-use as driving forces; first time use of qualitative narratives (Nakićenović 2000)
2009	**RCPs** Representative Concentration Pathways	Fifth Assessment Report	Four pathways of radiative forcing due to the emission of greenhouse gases (van Vuuren et al. 2011); to be combined with Shared Socioeconomic Pathways that describe the underlying driving forces (van Vuuren et al. 2014)

Figure 1 History of scenario families (based on Moss et al. 2010

In the past, scenarios have been defined in a sequential approach (Figure 2), starting with alternative illustrative storylines on socioeconomic development, from which emission scenarios, the resulting radiative forcing and ultimately the climate scenarios were derived (Moss et al. 2010). This approach for developing scenarios, however, is very time-consuming and does not take into account that two socioeconomic storylines may lead to a similar emission scenario but can pose very different challenges for adaptation and mitigation. A more flexible scenario framework, the Representative Concentration Pathways (RCPs) and the Shared Socioeconomic Pathways (SSPs) was developed to explore

various permutations of climate policies and social, technological, and economic circumstances (Moss et al. 2010; Hallegatte et al. 2011; Kriegler et al. 2012; Ebi et al. 2014; van Vuuren et al. 2014).

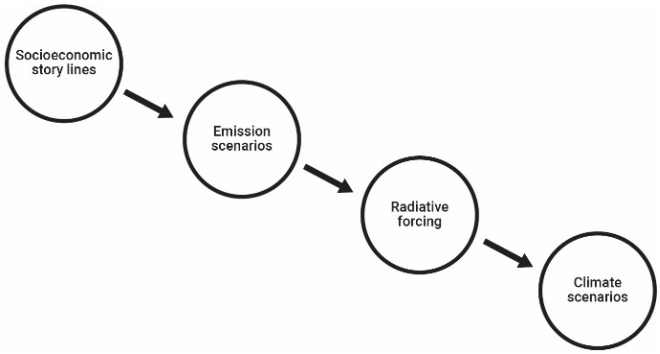

Figure 2 Sequential approach to define scenario families

1.2 The new scenario framework in climate impact research

1.2.1 The SSP-RCP framework

The RCPs are a set of four pathways that lead to different levels of radiative forcing caused by humans due to the emission of greenhouse gases. The RCPs cover radiative forcing levels of 2.6, 4.5, 6 and 8.5 W/m^2, compared to the pre-industrial period, at the end of the century (Figure 3). These values represent the range of forcing levels covered in the literature and contain relevant information for climate model runs, such as emission, concentration and land-use trajectories. The RCPs have been specifically designed as input to climate models and become fully integrated scenarios, once they are combined with different SSPs (van Vuuren et al. 2011; van Vuuren et al. 2014).

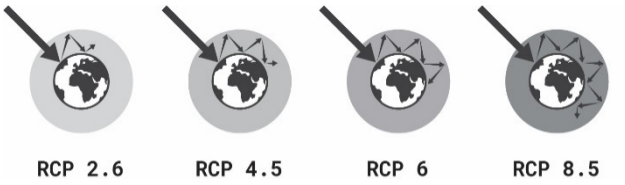

Figure 3 Radiative forcing under the four RCPs (own figure)

The SSPs describe possible pathways for society and society-influenced systems to develop in the course of the 21st century. They have been developed on global to regional scales based on socio-economic challenges for mitigation and adaptation (Figure 4). The highest Gross Domestic Product (GDP) and the lowest population are attained under SSP1 and SSP5. GDP is lowest and population highest under SSP3 and a similar but less extreme trend is followed under SSP4. SSP2 reflects a world with medium assumptions between the other four SSPs.

A key difference between the new RCP (Representative Concentration Pathway) and SSP (Shared Socioeconomic Pathway) framework and previous scenario families is that the linear approach was replaced by a parallel development process (Figure 5) in which plausible climate outcomes are separated from socioeconomic storylines. The aim of this process is to allow for a more flexible assessment of impacts and vulnerability, under different mitigation and adaptation challenges. So rather than prescribing the socioeconomic development and evaluating its effects on the climate, researchers can now select a climate scenario (RCP) that is compatible with, for example the 2°C target of the Paris Agreement, and then assess various technology and policy options to achieve the emissions consistent with that pathway and target. Within the new scenario framework, individual SSPs can be combined with different RCPs in order to construct climate change scenarios for the 21st century.

Figure 4 The five SSPs with their challenges for mitigation and adaptation (adapted from O'Neill et al. 2017)

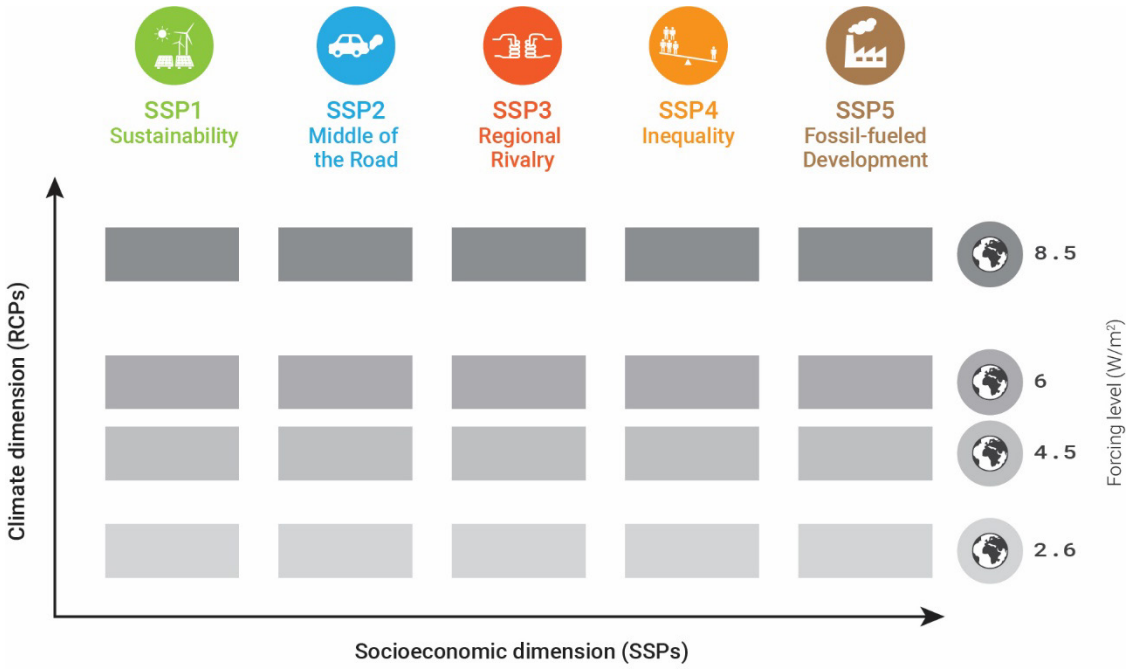

Figure 5 RCP-SSP framework (adapted from van Vuuren et al. 2014)

2 Developing local socioeconomic scenarios using a multi-scale co-creation approach

Socioeconomic scenarios that reflect the local context of a study site can play an important role in devising robust adaptation strategies, as climate change impacts do not only depend on changes in the climate system but also on prevailing socioeconomic conditions (Nicholls et al. 2008). A range of locally relevant scenarios are therefore essential for exploring the range of uncertainty regarding plausible future social and economic development. For the development of such scenarios, we propose a step-by-step process for drafting scenario narratives, based on expert knowledge, that can be communicated and refined with the help of stakeholders, both during and at the end of the drafting phase:

Step 1 Determine global scenarios as boundary conditions
Step 2 Establish local scenario element
Step 3 Determine plausible future developments of each scenario element
Step 4 Draft scenario narratives
Step 5 Facilitate feedback and discussion with local stakeholders
Step 6 Refine scenario narratives based on stakeholder feedback

Subsequently, the developed narratives can be quantified to form the basis for vulnerability and impact assessments. The six steps for developing the local scenarios as implemented in EVOKED are described below.

Step 1 Determine global scenarios as boundary conditions

When drafting local-scale socioeconomic scenarios, it is important to not only account for local developments, but also to consider that each case study is embedded in developments at different spatial scales, ranging from global to European, national and regional levels (van Vuuren et al. 2010; van Ruijven et al. 2014). Therefore, we need to select global-scale scenarios as boundary conditions for the local scenarios in a first step.

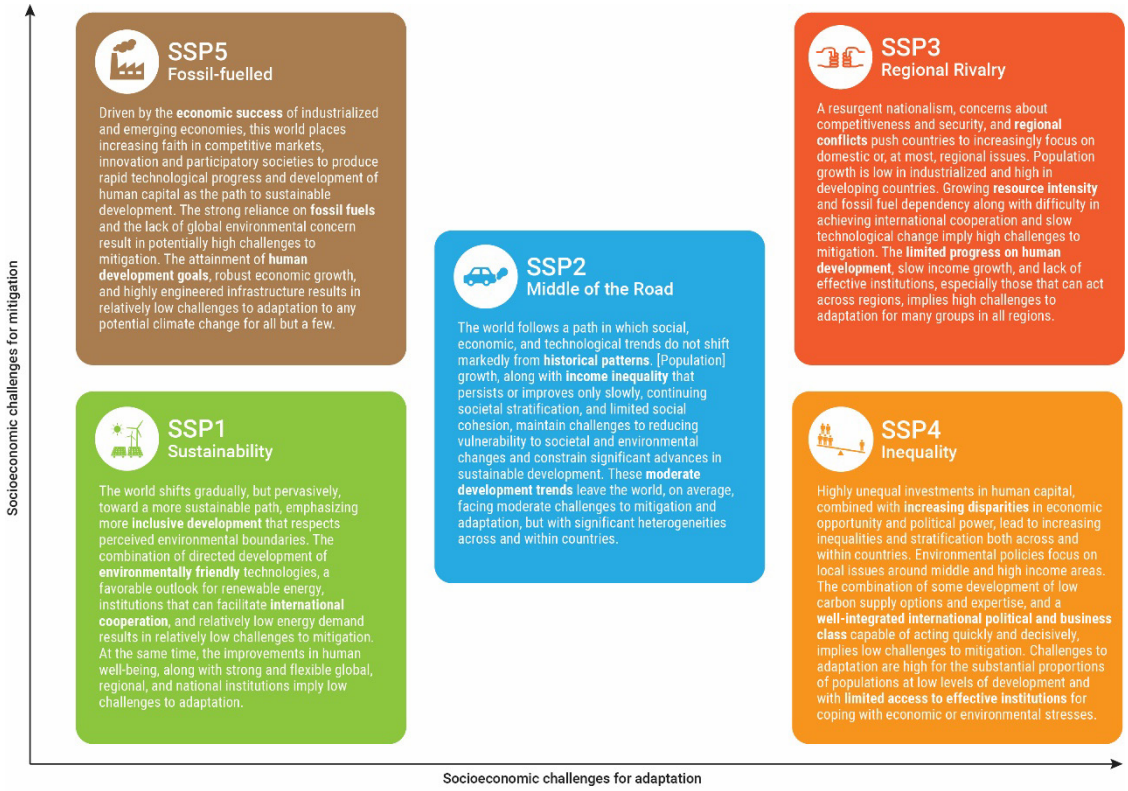

Figure 6 The five SSPs with excerpts of the global SSP narratives and their challenges for mitigation and adaptation (O'Neill et al. 2017, own emphasis added)

In EVOKED, we use the global SSPs as boundary conditions. Figure 6 provides an excerpt of each global SSP narrative that presents the general idea of the global-scale developments described in each scenario; the complete set of narratives can be found in O'Neill et al. (2017). Each narrative describes broad-scale societal developments of the respective SSP based on a set of more than 30 key elements that have been identified as important factors of socioeconomic development (Table 1; O'Neill et al. 2017). We adopt the global-scale SSP narrative elements and use them as a starting point for the local scenarios.

Table 1 Key elements of the global SSPs as identified by O'Neill et al. 2017

Category	**Element**	**Category**	**Element**
Demographics	Population growth Fertility Mortality Migration (international) Urbanization (level, type)	*Human development*	Education Health investments Access to health facilities, water, sanitation Gender equality Equity Social cohesion Societal participation

Economy & lifestyle	Growth (per capita) Inequality International trade Globalization Consumption and diet	*Policies & institutions*	International cooperation Environmental policy Policy orientation Institutions
Technology	Development Transfer Energy tech change Carbon intensity Energy intensity	*Environment & natural resources*	Fossil constraints Environment Land use Agriculture

Step 2 Establish local scenario elements

To establish local scenario elements that are important drivers of societal development in each case study region, project partners reviewed the locally relevant literature and analyzed data of the local and regional administrations and statistics offices. A number of guiding questions for each case study region have additionally driven the process, for example:

- What is the demographic structure of the population?
- What are recent population trends?
- What are the major issues of political and socioeconomic importance and/or concern in the case study region (e.g. development of eastern part of harbor, climate mitigation, touristic development)?
- How are local politics embedded in regional, national and global politics? What are the biggest companies in the city? Are they national, regional or global players?

Subsequently, each project partner selects the global SSP elements (Table 1) that are most relevant to the case study and extends them with the local SSP elements. By selecting only central global elements, we reduce the total number of scenario elements, ensuring that the narrative is as short as possible to facilitate the communication with stakeholders.

Step 3 Determine plausible future developments of each scenario element

In a next step, the characteristics of the narrative elements established are determined for each scenario. As it is important to concentrate on a manageable number of scenarios to enhance communication and to facilitate productive discussion with local stakeholders, we propose using a set of three to four scenarios (Kok et al. 2006b; Nicholls et al. 2018). This number is sufficient to guarantee that the range of uncertainty regarding the challenges for mitigation and adaptation as defined in the global SSPs is covered.

To maintain consistency with the global SSPs, we use the developments of the global SSPs as a basis for each scenario; adapt them partly to reflect the developments at local scale; and enhance them with further socioeconomic context based on the local elements. Here, it is important to develop plausible assumptions of the future developments in each

scenario, which importantly aim at spanning the full range of plausible future developments (Nicholls et al. 2008; Kok et al. 2006a; Kebede et al. 2018).

Step 4 Draft scenario narratives

With the help of the local elements established in Step 3, a full-text narrative has been drafted for each scenario. The narratives ('storylines') add further context to the scenario elements, with the aim to facilitate stakeholders' understanding of each scenario.

Step 5 Facilitate feedback and discussion with local stakeholders

The first draft of the narratives along with the scenario names has been discussed with the stakeholders of each case-study to ensure plausibility and acceptance of the local scenarios. In this context, we found that it is important to communicate to the stakeholders that the scenarios should be plausible, not necessarily what they consider as most realistic. These discussions can take place in different communication formats, such as focus groups, interviews, or workshops. In addition to the narrative text, other visualization tools can be used in order to ease understanding of each scenario, for instance pictures, graphs, a comic, or an explanatory video.

Step 6 Refine scenario narratives based on stakeholder feedback

Feedback from the stakeholders has been integrated into the narratives, which should be adjusted to also include the ideas of the stakeholders. Subsequently, the reviewed narratives have been discussed with the local stakeholders in several iterations, if and where possible (Kok et al. 2015; Nicholls et al. 2018; Pedde et al. 2018). This iterative process further increases acceptance of the local scenarios, which is important for developing scenario-relevant adaptation strategies.

3 Local scenarios

3.1 City of Flensburg (CAU)

3.1.1 Process summary

The local scenario development for the city of Flensburg closely followed the steps described in section 2. The selection of global scenarios as boundary conditions and the establishment of local scenarios (steps 1 & 2) were based on literature specific to the case study and on the analysis of data of the local and regional administrations and statistics offices. Preliminary results of Step 3 'Determine plausible future developments of each scenario element' were discussed with representatives of the city of Flensburg in a focus group of four participants. The scenario elements along with their characteristics in each scenario were presented in tables (similar to Table 2) and the end-users

identified missing elements as well as items that were not relevant for the city of Flensburg. Based on the stakeholder feedback, we revised the scenario elements and subsequently drafted the scenario narratives (Step 4).

As part of Step 5, three narratives (SSP1, SSP3 and SSP5) were discussed with local stakeholders in a workshop with 13 participants in November 2018. We decided to use only three scenarios due to time constraints and the number of workshop participants. As our aim was to initiate a lively discussion of the scenarios developed, we decided upon a group size of 4-5 participants for each scenario.

Figure 7 Group exercise 1, pieces of the graphical elements

Figure 8 Group exercise 1, completed jigsaw puzzle

In the beginning of the workshop, general information of the SSP framework were provided via a flip chart presentation to the stakeholders. In order to obtain a better understanding for each scenario, the participants assigned the different scenario elements and their characteristics to the respective SSP. Similar to a jigsaw puzzle, the task was to use graphical elements of the SSPs cut into several pieces and organize them on a poster (see Figure 7, Figure 8).

In a next step, the narratives were discussed in smaller groups, with each group discussing one SSP (Figure 9). Stakeholders were asked to give feedback on the identified elements; report on missing ones; and to provide feedback on the narratives as a whole (Figure 10). The aim of this step was to determine the plausibility of the narratives. After the discussion in smaller groups the comments were discussed in the plenary. During these discussions, the stakeholders also identified the need for an SSP2-based (considered 'business as usual') scenario.

Figure 10 Group exercise 2, feedback on elements and narratives

Figure 9 Group exercise 2, discussion of the narratives

We refined the narratives by integrating the workshop participants' comments into each narrative as part of Step 6. It was not possible to integrate all comments into the local scenarios as some contradicted with the general narrative of the SSP used as a boundary condition. Next the narratives were revised and sent to the stakeholders via email for a second round of comments. We also attached a justification and explanation document in those cases where we could not include specific comments. As we received further minor comments on SSP5 'Fossil-fueled Flensburg', we changed the narrative accordingly. We additionally developed the SSP2-based narrative 'The old Flensburg', following Steps 1 to 4 and presented this narrative to our end-users for their feedback (Step 5) before finalizing it.

3.1.2 Local narratives

Table 2 Scenario narrative elements of Flensburg

Elements	**Sustainable Flensburg (SSP1)**	**The old Flensburg (SSP2)**	**Aging and shrinking Flensburg (SSP3)**	**Fossil-fueled Flensburg (SSP5)**
Demographics				
Population growth	Relatively high	High, decreasing after a few decades	Low/declining	High
Migration	Medium, high for young people	Medium, gradually increasing	Low, strongly constrained	High
Urbanization (level; type)	High, trend 'back to the city'; Well-managed, compact, sustainable, relatively low space needs	Medium, trend 'back to the city'; Moderate to high space needs	Low; Poorly managed, unattractive, moderate space needs, abandoned properties	High, trend 'back to the city'; Attractive, desirable housing, high urban sprawl, very high space needs, spatial conflicts between housing, gastronomy, culture and economy
Human development				
Education; Institutions of higher education	High; Constant renewal, international programs	Medium; Gradual growth, infrastructure and study programs struggle to meet demand	Low; Decrease in student numbers, finally close down	High; High growth, universal access
Health investments; Care for the elderly and childcare	High, high-quality health care in all hospitals, sports programmes ('Sportentwicklungsplanung'); Well-organized, large investments, high demand for flexible childcare	Medium, focus on hospital "Peelwatt": provision of high-quality health care after extensive renovation; Increased focus on care for the elderly, maintained standard of childcare	Low, focus on hospital 'Peelwatt'; Left to themselves, hardly any childcare facilities (low demand)	High, high-quality health care in all hospitals, sports programmes; Well-organized, large investments, high demand for flexible childcare
Social cohesion	High, emphasis on programme 'social city'	Medium, some improvement due to programme 'social city'	Low and stratified between neighbourhoods	High, emphasis on programme 'social city'

Societal participation	High, central and decentral structures of participation e.g. by project 'dedicated city' and neighbourhood initiatives ('Stadtteilforen', 'Nachbarschaftstreffpunkte')	Medium, some new central and decentral structures like neighborhood initiatives	Low, some neighbourhood initiatives	High, central and decentral structures of participation e.g. by project 'dedicated city' and neighbourhood initiatives
Household-level adaptation[1]	Sustainable solutions, combining knowledge, communal cooperation, preparation, and structural measures	Medium-investment solutions: people are interested and want to be informed, but they don't see the evidence for structural investments and prefer low-effort measures	Low-investment solutions, focus on preparation measures	High-investment solutions, focus on structural measures
Economy & lifestyle				
Growth (per capita)	Medium	Medium	Slow	High
Inequality (between neighbourhoods)	Low	Medium, slightly increasing	High, increasing	Strongly reduced, some inequalities persist
International trade; Maritime and arm industry	Moderate; Maritime industry develops sustainably, abandonment of arm industry	Moderate, but international companies might leave; Low maritime industry and moderate arm industry	Strongly constrained; Deterioration of the maritime industry, growth of arm industry	High, with regional specialization in production; Revival and high growth of the maritime industry, decline of arm industry
Globalization; Local economy	Connected markets, regional production; Revitalization of local companies, robust local job market,	Mix of connected markets and regional production, global connection functions imperfectly;	De-globalizing, regional security; Reliance on regional/local products, weak local job market, no start-up scene	Strongly globalized, increasingly connected;

[1] based on Koerth et al. 2013

	esp. in services and trade, development and modernization of commercially used areas, local start-up-scene (sustainability-oriented), offers for innovation (co-working spaces, space for events)	Stable local economy, growing start-up scene, decrease in the number of manufacturing companies		Export-oriented, production within city boundaries, robust local job market, local start-up-scene (economy-oriented), offers for innovation (co-working spaces, space for events)
Consumption and diet; Tourism	Low material consumption, regional products, urban gardening for self-supply; Sustainable regional tourism, also cross-border via public transportation (esp. of the region Sønderjylland-Schleswig)	High consumption, some local products that struggle to be competitive, three main shopping centers (city center, Förde Park, City Park); Gradual increase in regional, international, and cross-border tourism (region Sønderjylland-Schleswig)	Material-intensive; No (cross-border) tourism	Materialism, status consumption, high mobility, three main shopping areas: city center, Förde Park, City Park; International tourism, also cross-border (region Sønderjylland-Schleswig)
German-Danish culture tradition	Intensive, preservation (e.g. Danish newspaper, library, cross-border cultural programs)	Intensive, preservation (e.g. Danish newspaper, library, cross-border cultural programs)	Gradual deterioration	Intensive, preservation (e.g. Danish newspaper, library, cross-border cultural programs)
Development of the eastern harbour	New green space and retention area, including 'Hafenspitze' and 'Harniskaispitze', direct connection to 'Volkspark' and 'Gängeviertel'	Mixed usage: economic use, 'Hafenspitze' transformed into retention area, 'Hafenspeicher' used for housing and gastronomy	Use for local industrial purposes	Use for global-oriented industrial purposes, use of 'Hafenspeicher' for economic purposes
Local infrastructure	Car-free city, esp. along the coast/harbour ('Flensburger Y'), expansion of public transport and bike network ('Velorouten-	Maintenance of existing infrastructure, new projects only realized due to urgent needs (e.g. new ring roads due to increasing	Deterioration of local infrastructure, limited accessibility, no emphasis on the development of public transport	Expansion of roads ('autogerechte Stadt') with the aim to decrease travel time, daily needs well covered

	netz'), e.g. on old train rails, sustainable mobility according to Flensburg's 'Masterplan Mobilität', focus on historical city centre, e-mobility and autonomous driving, short distances for daily needs	traffic in the center), few innovative ideas		
Housing	High-quality and affordable, investment in social housing, retrofitted low-energy houses, new construction concentrated in current city boundaries ('Leerstandsaktivierung'), renovation of historical buildings (e.g. Eckener Haus, Deutsches Haus)	Mixed, investments to respond to increasing demand due to population growth and increase in single-person households, investments in new housing (e.g. Wohnquartier, Schwarzenbachtal, Bahnhofstal), some retrofitted low-energy houses, but many old, energetically unfitted buildings remain	Low-quality, deterioration of existing housing, hardly any investments ('Sanierungsstau'), many vacancies in unattractive sites in buildings and gardens ('Kleingärten'), high demand of accessible housing	High-quality and affordable for majority of the population, large investments in new housing (e.g. 'Wohnquartier Schwarzenbachtal','Bahnhofstal'), usage of old hospitals of 'Diakonissenkrankenhaus','St. Franziskus Hospital') for housing, no interest in energy retrofitting, mostly single-family homes
Policies & institutions				
International cooperation; Embeddedness in global politics; Cross-border relations	Effective; Embedded in global politics; Well-maintained cross-border relations	Mixed, functions imperfectly; Moderately embedded in global politics; Maintenance and improvement of cross-border-relations	Weak, uneven; Focus on local/regional politics; Halt of cross-border relations	Effective; Highly embedded in global politics; Increase in cross-border relations
Environmental policy	Improved management of local issues, strict regulation regarding emissions and pollutants, successful implementation of 'Masterplan 100% Klimaschutz'	Focus on local and regional environment, slow implementation of 'Masterplan 100% Klimaschutz'	Low priority for environmental issues, no regulatory policies	Focus on local environment with obvious benefits to well-being, highly engineered solutions (e.g. sequestration of emissions and pollutants)

Institutions; Implementation of adaptation measures	Effective at national and international scales; Effective, proactive, focus on nature-based solutions, setback zones in areas at risk from flooding, flood protection publicly subsidised, protection of historic city	Lack of cooperation on local, regional and national scales; Attempts to implement adaptation measures, but no financial capacity for highly engineered solutions	Weak global institutions, national/local governments dominate societal decision-making; Ineffective	Increasingly effective, oriented toward fostering competitive markets; Effective, highly engineered solutions
Technology				
Development & transfer	Rapid, digitization (e.g. high-speed internet ('Flensburger Breitbandausbau'), strong impulses of technology center (Technologiezentrum) and Chamber of Industry and Commerce (Industrie- und Handelskammer, IHK)	Moderate, digitization (e.g. high-speed internet ('Flensburger Breitbandausbau') with some delay, impulses of technology center often not adequately implemented by local politics	Slow, outdated technologies	Rapid, digitization (e.g. high-speed internet ('Flensburger Breitbandausbau'), strong impulses of technology center (Technologiezentrum) and Chamber of Industry and Commerce (Industrie- und Handelskammer, IHK)
Energy tech change; CO_2 neutrality	Directed away from fossil fuels, toward efficiency and renewables, decentralization of energy suppliers and usage of a variety of energy sources; Rapid energy transition toward CO_2 neutrality	Continuing progress, but no fundamental breakthroughs; Dependence on fossil fuels decreases slowly, but not consequently enough to reach CO2 neutrality until 2050	Slow tech change, directed toward domestic/local energy sources (coal, nuclear, some renewables); decreasing energy demand; CO_2 neutrality impossible	Directed toward fossil fuels, central energy supplier, alternative sources not actively pursued; CO_2 neutrality is given up due to lack of interest
Environment	Improving conditions over time, increase in green spaces: green belt through city (former train rails), recreation areas (e.g.	Some local improvements, e.g. new recreation areas ('Hafenspitze'), but overall the environment experiences degradation	Serious degradation, no interest in environment and green spaces, deterioration of recreation areas	Highly engineered approaches, successful management of local issues, conflicts between housing and landscape conservation,

	'Volkspark'/'Stadion', 'Museumsberg', 'Alter Friedhof', 'Christiansenpark')			restructuring of land-use plan ('Flächennutzungsplan')

Sustainable Flensburg (SSP1)

In Sustainable Flensburg, the city rapidly shifts toward a sustainable path in which inequalities between neighborhoods are low due to effectively functioning local and regional institutions and high investments in health care and education. Through globally effective international cooperation, the global wealth gap is strongly reduced, which leads to medium international migration and generally low population growth. Due to a high urbanization rate, the population in Flensburg grows steadily.

Most people live in high-quality, affordable housing owing to investments in social housing. Historical public buildings, such as the 'German House' and the 'Eckener House', are renovated. High social cohesion and opportunities for participation in district forums and neighborhood initiatives ensure that all citizens of Flensburg can participate in local decision-making processes. The programs 'committed city' and 'social city' are implemented. Also, care for the elderly and childcare are well-organized and high-quality health care is provided by local hospitals as well as sports programs. Flensburg's institutions of higher education are characterized by transdisciplinary research, constant innovation and international study programs.

High environmental awareness, low material consumption and a preference for local products require moderate international trade. Even though markets are working globally, Flensburg concentrates on local production, which leads to the revitalization of local companies and moderate growth of the local economy. Local jobs are therefore maintained or created, especially in the trade and service sectors. Commercial areas are being modernized and there is a large number of start-ups, especially in the sustainability sector. This boom is driven by the public provision of co-working spaces and premises for events. Further, community gardens for self-supply are established throughout the city. Flensburg's maritime industry develops sustainably and the arm industry declines rapidly. Bilateral relations with Denmark are well maintained, including intensive, sustainable tourism (e.g. by public transport), especially in the Sønderjylland-Schleswig region. The German-Danish culture is sustained, for example by preserving and expanding the Danish newspaper, library and cross-border cultural cooperation.

With strong environmental policy, effective embeddedness in global politics, and rapid technology development and transfer, the energy transition toward energy efficiency and renewable energy sources progresses rapidly. Digitization and broadband internet expansion commence rapidly. Important impulses from the technology center and the Chamber of Industry and Commerce foster technological development and transfer. In order to achieve the goal of CO_2 neutrality and the '100% climate mitigation master plan', existing buildings are retrofitted into low-energy houses, the bike and public transportation networks are expanded. . The city center, especially along the Flensburg Y, is converted into a car-free zone. Due to an additional focus on autonomous transport and e-mobility, the 'Masterplan Mobility' can be reached. Construction of new buildings is favored within the current city boundaries with the aim to guarantee compact city development with short distances for daily needs. Environmental conditions improve over time due to strict regulation regarding emissions and pollutants as well as creation of

new green spaces across the city. One of these green spaces is created in the area of the eastern harbor, which can additionally serve as a retention area during storm flood events.

In Sustainable Flensburg, the society is characterized by a high adaptive capacity. Individuals choose sustainable adaptation strategies by combining knowledge, communal cooperation, preparatory and structural measures, which are supported by public funds. On an institutional level, adaptation is implemented proactively by focusing on nature-based solutions such as the conservation of green spaces and coastal ecosystems and avoiding additional soil sealing. Preservation of the historic center of Flensburg plays a central role in adaptation planning and development in locations potentially at risk from coastal flooding is regulated in stringent land-use plans. Also, mitigation is actively pursued and the goal of CO_2 neutrality is reached by 2050.

The old Flensburg (SSP2)

In the old Flensburg, socioeconomic development in the city follows historical patterns. The government maintains economic success and, at the same time, pursues sustainable adaptation strategies. Investments in education, health care and the housing sector reduce growing inequalities. Flensburg's population grows steadily the urbanization rate stabilizes at a moderate level with an increasing number of migrants moving into the city.

Due to these conditions and an increasing proportion of single households, demand for housing is high. Consequently, investments in the housing sector increase (e.g. district 'Schwarzenbachtal'). However, due to the constant need for more housing, energetic retrofitting of existing buildings progresses slowly. The program 'social city' and neighborhood initiatives strengthen social cohesion and participation opportunities. Investments in the health sector are moderate and concentrate mainly on the hospital 'Peelwatt', which provides high-quality health care. Also, care for the elderly and childcare are well-organized. Demand for educational institutions and universities increases, and the city of Flensburg faces the challenge of adapting to the growing number of students.

Trade continues to focus on a mix of international markets and regional production. However, local products cannot meet the high demand due to continuing high consumption. While the start-up scene grows, the manufacturing industry declines. Thus Flensburg loses attractiveness as a location for international companies. The maritime industry develops on a moderate level and the arm industry declines. The eastern harbor is used for a diverse range of usages: the 'Hafenspitze' is transformed into a recreational area and the 'Hafenspeicher' is used for housing and gastronomy. Cross-border relations with Denmark are maintained and constantly expanded. In addition to stable bilateral relations, German-Danish cultural traditions (e.g. Danish newspaper, library) are preserved. Also, cross-border tourism increases further.

Digitization develops moderately, the expansion of broadband internet takes longer than expected and impulses from the technology center and Chamber of Industry and Commerce (IHK) are often not implemented adequately. Despite continuing technological development, technological breakthroughs do not take place. There is a growing effort to expand green spaces and recreational areas across the city, similar to those at the 'Hafenspitze'. However, the local infrastructure remains largely the same and environmental degradation continues due to a high use of individual modes of transport, primarily using cars with conventional combustion engines. Consequently, the '100% climate mitigation master plan' is implemented more slowly than originally planned.

In 'The old Flensburg', society is characterized by a moderate adaptive capacity. Awareness is moderate to high and the population is interested in implementing adaptation strategies. As financial capacities for engineered solutions are limited, low-effort adaptation measures are preferred to structural measures. The target of CO_2 neutrality by 2050 is not achieved as dependence on fossil fuels decreases only slowly.

Ageing and shrinking Flensburg (SSP3)

In 'Aging and shrinking Flensburg', nationalist tendencies emerge and people are concerned about competitiveness and security, at regional and national level. Global institutions function imperfectly, and most decisions are made on local and national level, mainly focusing on security issues. Rapid decrease in international cooperation combined with limited mobility lead to low migration, both within Germany and on a global scale, leading to a declining. Due to a low urbanization rate, the population of Flensburg declines as well.

Although the demand for accessible housing for the rapidly aging population is high, investments in housing are low. This causes an urgent need for renovation and renewal of the urban infrastructure in some locations, which leads to a high rate of abandoned properties. Social cohesion and participation opportunities for citizens are low and stratified across different neighborhoods. Due to limited investments in education and health care, inequalities are exacerbated. Investments in health care mainly focus on the 'Peelwatt' hospital and care for the elderly as well as childcare are neglected. The quality of education declines, so does the number of students, which forces institutions of higher education to eventually close down.

A global shift toward de-globalization leads to a rapid decrease in international trade. Flensburg concentrates on regional and national products. Due to slow economic growth, the local job market is weakened and the number of start-ups decreases. As international trade is limited, the maritime industry declines, however, the arm industry experiences growth owing to the focus on security issues. In order to meet the high local demand due to high material consumption, the eastern harbor is used for industrial purposes. A lack of bilateral relations between Denmark and Germany result in a decline in the German-Danish culture tradition. International tourism is extremely limited due to limited mobility and border patrols.

Due to low environmental awareness, weak global institutions, slow technological development and a focus on national security, a transition toward renewable energies does not take place. Regional and national energy sources are used, with coal and nuclear power being the dominant sources of energy. Generally, technologies are outdated and the local infrastructure deteriorates. Little effort is put into improving accessibility of different neighborhoods or expanding the public transportation system. As a result, the city is highly segregated and environmental degradation is high. Due to limited interest in environmental conditions and green spaces, most community gardens and local recreation areas such as the 'Volkspark', 'Museumsberg' or 'Christiansenpark' are not maintained.

The scenario 'Aging and shrinking Flensburg' is characterized by a low adaptive capacity. As financial resources of the population are limited, individuals pursue low-cost adaptation measures and only few people are able to invest in structural measures. On institutional level, adaptation planning is hardly pursued and climate mitigation remains a challenge. Therefore, the goal of CO_2 neutrality by 2050 is not achieved.

Fossil-fueled Flensburg (SSP5)

In 'Fossil-fueled Flensburg', the city of Flensburg strives for economic success with globally connected markets and a high use of fossil fuels. Inequalities and the global wealth gap decrease due to effective cooperation of local and global institutions. As population growth is low, Germany depends on international migration of qualified personnel. Due to a high urbanization rate and the movement 'back to the city', Flensburg experiences high population growth.

High investments in the housing sector lead to a high quality of living. Instead of renovating and retrofitting existing houses, the focus lies on constructing new houses, especially single-family homes, in the districts 'Schwarzenbachtal' and 'Bahnhofstal'. Exceptions are the old hospitals 'Diako' and 'Franziskus', which are renovated for housing purposes. Flensburg experiences high urban sprawl as a result of the demand for high-quality and spacious housing. Social cohesion and participation opportunities in local decision-making processes are high and take place predominantly in district forums and neighborhood initiatives. These forms of participation are promoted through programs such as 'dedicated city' and 'social city'. High investments in the social sector lead to high-quality care for the elderly and flexible child care. Hospitals provide high-quality medical care and sports programs are promoted. Great importance is placed on the theme 'education for everyone' and institutions of higher education experience a large increase in student numbers.

Markets are globally connected and export-oriented international trade leads to high economic growth for all citizens of Flensburg. The local economy is characterized by regional specialization. The maritime industry experiences a high growth, resulting in the eastern harbor and the 'Hafenspeicher' being used for economic purposes as well. The arm industry declines as security issues are less important. In a robust local job market,

the start-up scene booms and public co-working spaces and event facilities are used frequently. High economic growth combined with low environmental awareness lead to high consumption and high material use. The three main shopping centers ('Innenstadt','Fördepark' and 'Citti-Park') benefit from these developments. Bilateral relations between Denmark and Germany are strong and focus mainly on economic cooperation. Cross-border cultural cooperation is preserved and expanded and traditions from both countries are maintained. International tourism is high, with the region Sønderjylland-Schleswig benefitting the most.

Effective global institutions concentrate on competitive markets. Flensburg is embedded in global politics, leading to rapid technological development and transfer. Strong impulses are given by the technology center and the Chamber of Industry and Commerce (IHK), resulting in rapid digitization and expansion of broadband internet. Environmental politics focus on the local environment with benefits to local well-being and highly engineered solutions. Flensburg concentrates on the use of non-renewable energies and on a central energy supplier; CO_2 emissions increase steadily. The use of renewable energy sources is not promoted, transition of the energy system and the '100% climate mitigation master plan' are not pursued and are abandoned eventually. In order to improve the accessibility within the city and to reduce travel times, the urban infrastructure is extended in accordance with the program 'car-friendly city'. Urban sprawl due to housing and economic development is increasingly regulated in the course of the century by more efficient land-use planning. Nevertheless, as technical and structural measures are a priority, many of Flensburg's green spaces are lost due to soil sealing. The 'Christiansenpark' and the 'Volkspark' therefore decrease in size.

In ‚Fossil-fueled Flensburg, society is characterized by high adaptive capacity. Residents are able to invest in technical and structural household-level adaptation measures. On institutional level, highly engineered adaptation measures are implemented. Due to a lack of interest, climate mitigation is not actively pursued; therefore, CO_2 neutrality by 2050 is not achieved.

3.2 Larvik (NGI)

3.2.1 Process summary

The local scenarios for Larvik were developed based on the five global-scale Shared Socioeconomic Pathways (SSPs). For step 1 and 2 relevant literature and data specific to Larvik were reviewed and analysed to investigate challenges and potential trends visible in Larvik today. Three of the global SSP's were chosen, based on discussions with the municipality to select those SSPs having most relevance for Larvik. The SSP's selected included SSP1, SSP2 and SSP3, and plausible future developments were determined within each scenario element in step 3.

SSP1, "Sustainable Larvik", is mainly based on the municipal plans, as land-use plan and energy- and climate plan, as well as relevant strategies and action plans. This scenario reflects the Larvik that is currently planned for the future. SSP2, "Business as

usual", is mainly based on relevant strategy documents and knowledge bases, discussing the situation in Larvik today. SSP3, "Regional rivalry", is also based on municipal strategies, but considered more as the scenario that could take place if the strategy "fails". Larvik and its neighbouring municipalities are already preparing for an anticipated centralization process towards the larger cities, especially in the Oslo region. Regional cooperation is therefore an important factor for the future of Larvik. However, if the regional municipalities are not able to compete at the same level as the neighbouring urban metropolitan areas, regional rivalry could result with these municipalities competing amongst one another.

In dialogue with the municipality it was considered important not to develop "doomsday" scenarios, since Norway is a welfare state with quite robust safety net system for its citizens. The municipality did not believe such scenarios would be taken seriously by the stakeholders involved in their ongoing urban development plans (that the EVOKED project is following). Here, legitimacy was an important concern for the municipality and a desire to develop scenarios that people could relate to was considered as a better approach, especially regarding interests.

For step 4 the scenario table was drafted with partners from the municipality of Larvik, who identified information missing or not relevant. After the scenario table was completed it was revised and rewritten into narratives. For step 5, the narratives were transformed into illustrations for children and youth (Figures 11-13). The illustrations were then used in a workshop at a primary school in Larvik. The children's feedback on these illustrations was then used for step 6, to further refine the narratives. It is expected that the illustrations will also be used in future Living Labs with other stakeholders in Larvik.

Figure 9 Vision of SSP1, a "Sustainable Larvik", based on strategic municipal plans (illustration by Bar Bakke).

Figure 10 Vision of SSP2, Larvik in a "Business as usual" scenario, based on current growth statistics and from discussing the situation in Larvik today (illustration by Bar Bakke).

Figure 11 Vision of SSP3, "Regional rivalry" for Larvik, a potential future if targets for growth and investments are not met (illustration by Bar Bakke).

3.2.2 Local narratives

Table 3 Scenario narrative elements of Larvik

Elements	*SSP1: Sustainable Larvik*	*SSP2: Middle of the road*	*SSP3: Regional Rivalry*
Demographics			
Population growth	Slightly rising (by approximately 1,5% every year) [2]	Stable	Low/declining
Migration (international)	Medium; Opportunity for increased diversity.	Medium; A reduced number of refugees are settling in Larvik. [3]	Low
Urbanization (urban/rural)	High; Development within prioritized development area ("Sommerfuglen"). Strengthen cities and villages, clear framework for growth in these areas. [4]	Medium	Low
Human Development			
Education	High; An increasing number of citizens complete secondary school and higher education. [5]	Stable; Share of the population that complete secondary school or have higher education is lower than the country level. [6]	Low; Decrease in student numbers
Health investments; Children, elderly, healthcare	High; Well organized, meet the needs of especially for children and the elderly. Increased	Stable;	Low:

[2] Kommuneplanens samfunnsdel 2012-2020
[3] Strategidokument 2019-2022 (Rådmannens forslag)
[4] Kommuneplanens samfunnsdel 2012-2020
[5] Kommuneplanens samfunnsdel 2012-2020
[6] Felles planstrategi for Larvik og Lardal kommuner samt nye Larvik kommune 2016-2020

	self-sufficiency increases health investments for others. [7]	A great amount of the total expenses is used on care-services. [8]	A great amount of the total expenses is used on care-services. [9]
Social cohesion	High; Larvik is a multicultural and including municipality.	Medium;	Low; The quality of the society detoriate significantly, and the number of people that feel left out increase. [10]
Social participation	High; Many of the inhabitants in Larvik are active participants in associations, and there are many partnerships and projects between private and public actors. Inhabitants are actively engaged in the society debate. [11]	Medium	Medium; In challenging times social participation could increase.
Safety (natural hazards)	High; Focus on natural hazards and more national funding available.	Medium; Focus on natural hazards, but limited funding available.	Low; Focus on natural hazards but losing in the competition for national funding.
Household-Level adaption	High; "Dugnadsånd" and households have information and knows what solutions they can contribute with. [12]	Medium; "Dugnadsånd" but households are unsure how they can contribute.	Medium; "Dugnadsånd" but households are unsure how they can contribute and awareness decreases.
Economy & Lifestyle			
Growth (per capita)	High; Well distributed	Medium; Well distributed	Low; Slow income growth, some inequalities.
Globalization	High;	Medium;	Low;

[7] Handlingsplan for framtidas helse- og omsorgstjenester 2017-2020
[8] Kunnskapsgrunnlaget "Mestring i alle livets faser" Handlingsplan for framtidas helse- og omsorgstjenester
[9] Kunnskapsgrunnlaget "Mestring i alle livets faser" Handlingsplan for framtidas helse- og omsorgstjenester
[10] Strategidokument 2019-2022 (Rådmannens forslag)
[11] Kommuneplanens samfunnsdel 2012-2020
[12] Klima- og energiplan Larvik kommune

	Regional cooperation. Lots of international oriented businesses, and Larvik is competitive internationally. [13]	Regional cooperation and some international cooperation.	Focus on local issues, little cooperation regionally.
Consumption and diet	Reduced consumption and waste, prioritize reuse. [14] Low-meat diet. Regional products.	Focus on reduction of consumption and waste, but still a materialistic lifestyle. Most people have a meat-based diet.	High material consumption and growing resource intensity.
Local infrastructure	High; Expansion of public transport and walk/cycle network, within Larvik kommune and to other cities. Infrastructure is adapted for zero-emission vehicles. [15] More than 1% of the pipeline network is renewed every year [16]. Leakage in the network are reduced.	Medium; Local transportation dominated by car, continued development of regional train connections. Parts of the pipeline network (both water and sewage) are old and poor. Improvements needed for the pipeline network, especially to reduce leak of water/sewage and the amount of extraneous water reaching the treatment plant. [17]	Low; Limited funds for maintenance of infrastructure.
Housing quality	High; High demand. Low-energy houses, concentrated in prioritized development areas with environmental efficient infrastructure. [18]	Medium	Low; Limited investment in existing housing.
Policies & Institutions			
International cooperation	High;	Medium;	Low;

[13] Kommuneplanens samfunnsdel 2012-2020
[14] Klima- og energiplan Larvik kommune
[15] Klima- og energiplan Larvik kommune
[16] Kommunalteknisk plan 2018-2021 Larvik kommune
[17] Kommunalteknisk plan 2018-2021 Larvik kommune
[18] Klima- og energiplan Larvik kommune

	More international cooperation. Additional EU financed research project.	Embedded in local politics, well maintained international relations (for example through sister cities). Partner in EU research projects (EVOKED, Urban Agenda for the EU – Partnership on Public Procurement).	Interested in cooperation but limited funds available.
Environmental policy and new regulations on climate adaption in comprehensive plans.	High; Easy to implement, there is political will and administrative competence in Larvik kommune.	Medium; Fairly easy to implement, there are administrative competence, but less political will.	Low; Difficult to implement climate and energy policy, little political will and resources.
Technology			
Development	High; Increasing digitalization. Use of new technology. [19]	High/Medium; Digitalization and use of new technology.	Medium; Moderate digitalization and use of new technology, due to limited resources.
Energy tech change	High; Fossil fuels are replaced by renewable energy. Rapid transition towards CO_2 neutrality. [20]	Medium; Moderate transition towards renewable energy.	Low; Larvik commune is still relatively dependent on fossil fuel.
Environment			

[19] Digitaliseringsstrategi 2018-2020
[20] Klima- og energiplan Larvik kommune

Nature and environment	High; Environments are free of pollutants and water quality is high. Green spaces and corridors increase biodiversity and ecosystem services.	Medium; Some pollution from use of fossil fuels. Improvement in water quality, but not has not yet reached good ecological status.	Low; Environments are polluted, and the water quality is not improving.
Land use	Land use is mainly concentrated to existing cities and villages. Green spaces and corridors are preserved, and new construction in valuable agricultural areas and nature/outdoor areas are prevented. [21]	Continues as current situation. Some development continues outside of cities and villages.	If private car usage increases this could lead to loss of green spaces.
Sustainable resource use	High; Overall a reduction of waste, waste is reused and recycled and partly used for energy. Use of local energy resources. [22]	High/medium; Waste is reused and recycled and partly used for energy. Use of local energy resources.	Medium; Waste is recycled, but limited funds for new technology.
Reduction of greenhouse gas emissions by 30% compared to 1990-level, and carbon neutrality. [23]	High; The goal of climate neutrality is achieved.	Medium; Close to neutrality, but still some fossil fuels.	Low; CO_2 neutrality not achievable.

[21] Planprogram Kommuneplanens arealdel 2014-2026
[22] Klima- og energiplan Larvik kommune
[23] Klima- og energiplan Larvik kommune

SSP1: A sustainable Larvik

Larvik is gradually shifting towards a more sustainable path, with growth and development taking place within natural limits. Increased knowledge and a better understanding of the social, cultural and economic costs of CO_2 emissions and environmental degradation are driving this shift. Management of the local community improves and is streamlined by increasing the efficiency and collaboration both within the municipality, nationally and internationally, as well as between institutions, organizations, the private sector and citizens. Educational and health investments make Larvik an attractive and inclusive place to live, leading to a continuous increase in population. There is a strong commitment to achieve determined climate targets, both locally and nationally. Investments in environmental technology lead to improved resource efficiency, reducing overall energy and resource use and improving environmental conditions over the long term. Development and population growth takes place in prioritized areas, which strengthen the city centres and towns in the municipality, while protecting the natural landscape. Investments, financial incentives and changing perspectives make renewable energy more attractive than fossil fuels. Consumption is oriented towards a low emission society with minimal material growth and lower resource and energy use. The combination of environmentally friendly technology, a favourable outlook for renewable energy, institutions that can facilitate regional and national cooperation, and a relatively low energy demand eases natural hazard mitigation effort. Furthermore, the active engagement of the local community, together with strong and flexible local, regional, and national institutions, facilitate climate adaption efforts.

SSP2: Business as usual

Larvik follows a path in which social, economic, and technological trends do not notably change from historical patterns. The population is stable with zero growth rate. Local and regional institutions work towards achieving set energy and climate targets, but the progress is slow and arduous due to limited national funding. Technological development continues at a fast pace, but without radical breakthroughs in environmentally friendly technology. Although there are reductions in the total use of resources and energy, nature and ecosystems continue to deteriorate. Furthermore, despite the reduction in fossil fuel dependency, there is no inclination to use unconventional fossil resources and car usage still dominates. Larvik continues to cooperate regionally and participate in international research projects with topics including climate measures and adaption; however, communicating this knowledge to citizens is challenging. The community spirit to work together is still present, but citizens are not certain of how they can contribute. These moderate development trends result in moderate challenges related to natural hazard mitigation and adaption.

SSP3: Regional competition

Concerns about regional competitiveness and conflict bring about an increased focus on strengthening local conditions. This trend is reinforced by poor coordination and cooperation between regional and national institutions. Cohesion within the community weakens and the number of people that disconnect from society increases, while at the

same time numerous citizens are actively engaged locally in an "us against them" mentality. Investments in education decline, and fewer people complete secondary school or complete higher education. To achieve determined climate and energy goals is a challenge due to little political will and strong regional competition for national funding. Investments in technological development decline and digitalization make slow progress due to limited resources. The focus on strengthening local conditions results in high material consumption and increased strain on resources. This, along with a lack of national priorities for climate and energy issues contribute to local pollution challenges and ecological degradation. Increased resource use, continued dependence on fossil fuel, slow technological change, as well as difficulties of achieving regional cooperation suggest extensive challenges to implement climate mitigation efforts. The lack of effective regional and national institutions, little national funding and weakened local cohesion, also indicate large challenges to climate adaption.

3.3 Värmland and Arvika (SGI)

3.3.1 Process summary

SGI made a first draft of the scenario elements in summer 2018. SSP2 was based on current statistics for 2017-2018 on the home pages of Arvika municipality and Värmland county. SSP1 was based on strategic documents for sustainable development: Sustainable Arvika, Värmlandsstrategin and Europe 2020. SSPs 3,4 and 5 were based on what would happen if the strategies for sustainable development were only partially realized (SSP3 and 4) or not at all realized. The scenario elements were presented in a skype meeting with representatives from VCAB and Arvika Teknik and Arvika municipality in September 2018 and discussed. Both VCAB and Arvika suggested changes which were instigated by SGI. After discussions with CAU the scenario elements were revised and rechecked by VCAB and Arvika.

Likewise the narratives were sketched by SGI and validated by both VCAB and Arvika who each suggested changes and additions to the narratives to make them more feasible and relevant.

3.3.2 Local narratives

Table 4 Scenario narrative elements of Värmland

Elements	SSP1: Värmlandsstrategin	SSP2: Middle of the Road; Business as usual	SPP3 Regional Challenges	SSP5: High economic fossil-fueled Development
Demographics				
Population trends	Slightly rising (by ca 700 persons per year)	Continued stability	Declining (losing population to other regions in Sweden)	Fast rising population
Migration (national and international)	High-Medium; balanced and easy to integrate. Flexible responses are facilitated	Medium	Low	High;
Urbanization (urban/rural)	Medium; balanced urbanization	Medium; still slightly losing to larger cities in region	Low; stabilized urbanization	High; Värmland becomes rapidly urbanized
Human development				
Education (basic and secondary supplied by municipality), percentage tertiary educated	High; several new secondary (gymnasium) schools, tertiary educated increases	Medium; continued good level, few school closings, tertiary education stable	Low; tertiary education level in region decreases	High, high rate of building new schools to keep up with population increase, tertiary education high
Welfare services (elderly, childcare, healthcare)	High: Welfare services meet the needs of the population. Municipal funding is allocated in a balanced way	Medium; Still some problems in meeting demand. Trade-offs needed in distribution	Low; declining public services due to declining population	High; increase in both private and public services,
Social Cohesion (Integration of asylum seekers and others)	High; integration funding allocated and community acceptance of newcomers	Medium	Low; society becomes more stratified and little acceptance for integration measures	Medium; some integration needed in order to fill many of the new jobs

Security, safeness (natural and other hazards)	High; flood protection and hazards against drought instigated, balanced and sustainable development of infrastructure. High level of protection in both city and hinterland. More national funding available	Medium-high; still risks of flooding etc, particularly in hinterlands	Low; private persons still mainly responsible for security against natural hazards. Large inequalities	Medium; the growth of many new buildings, housing and infrastructure makes the community more vulnerable (greater consequences) despite measures to reduce probability of hazards
Attractivity	High; Värmland is a very attractive place to live, work and invest in.	Medium; Värmland is a nice place to live, but less attraction for new residents	Low: social and inequality problems make Värmland county less attractive	Medium; County cannot keep up with very high population growth rate
Economy & Lifestyle				
Growth (per capita)	High; and well-distributed	Medium; and well distributed	Low;	High;
Employment	High, with support for competence development, and possibilities to make working lives longer	Medium	Low	High
Entrepreneurship and new businesses	High; it is easy to start and run new enterprises	Medium;	Low; it is difficult to start new businesses, especially for newcomers	High; many new enterprises started
New housing and infrastructure	Medium-high demand for housing and easy to new production in “safe” areas	Medium; good demand for housing, but need to develop supply more	Low; loss of population means that housing demand decreases	High, very high rate of new housing and infrastructure needed, but often being built in areas that are unsuitable
Accessibility	High; improved communication and infrastructure	Medium; Stable building of infrastructure, improvements to existing transport infrastructure	Low; rate of accessibility within region and nationally is lower	High; high growth demands better communication and infrastructure
Policies & Institutions				

International cooperation (INTERREG projects, etc)	Very high; More international cooperation; increase in municipal finances make it easier to co-finance EU projects	High; interest in international co-operation, but sometimes not enough time resources in municipality	Low; little interest or will to participate	High
Cross-border labour market (with Norway)	Dynamic; both in-commuting from Norway and out commuting to Norway	Slightly skewed; more workers commute to Norway, loss of tax income	Stalled; Cross-border commuting both ways decreases drastically	Dynamic; but more commuters from Norway to help fill jobs in the rapidly growing society
Flood protection, Flood directive, Sendai	High; flood protection is prioritized, including nature-based solutions	High, mixture of hard infrastructure and nature-passed and planning solutions	Medium; some flood protection but mainly based on hard infrastructure	Low; unchecked building and construction means development in too many flood-prone areas
New regulation on climate adaptation in Comprehensive plans	Easy to implement, there is political will and administrative competence	Fairly easy to implement; there is administrative competence, but less political will	Very difficult to implement; no political will and little administrative competence	Fairly easy to implement, but with reliance on technical solutions
Technology				
Digitalization	Increasing rate of digitalization, but not at the expense of personal interactions	Increasing	Decreasing	Increasing, but sometimes at the expense of personal interactions
New developments in renewable energy technology	Increasing, particularly renewable energy	Stable	Decreasing	Decreasing
Environment				
Sustainable resource use	High, waste is diminished and recycled (into partly energy) Household consumption is smart	High-medium	Low	Low, High growth-rate means much more unchecked consumption in society and little emphasis on long-term solutions.

A pollutant-free environment	High, all environments are free of pollutants, particularly schools and working places. Use of dangerous chemicals is reduced. Water quality is high	Medium; still too many fossil fuels being used, water quality improving, but still not optimal	Low	Low; transport and rapid development still reliant on fossil fuels. Chemical use in agriculture and other industries leads to very poor water quality
Climate neutrality	High; Värmland's vision that energy effectivity is part of all energy use and that all electricity used is renewable is achieved	Medium	Medium; lower rate of growth means as well that fewer fossil fuels and energy intensive methods are used in construction	Low

Table 5 Scenario narrative elements of Arvika

Elements	***SSP1: Sustainable Arvika***	***SSP2: Middle of the Road; Business as usual***	***SSP4: Inequality: A more insular Sweden (Arvika)***	***SSP5: High economic fossil-fueled Development***
Demographics				
Population trends	Slightly rising (by 25 persons per year)	Continued stability	High	Fast rising population
Migration (national and international)	High-Medium; balanced and easy to integrate. Flexible responses are facilitated	Medium	Medium	High;
Urbanization (urban/rural)	Medium; balanced urbanization	Medium; still slightly losing to larger cities in region	Medium, urban areas losing population/stagnating	High; Arvika becomes rapidly urbanized
Human development				
Education (basic and secondary supplied by municipality), percentage tertiary educated	High; several new secondary (gymnasium) schools, tertiary educated increases	Medium; continued good level, few school closings, tertiary education stable	Medium; more privately run schools and segregation, tertiary education stable	High, high rate of building new schools to keep up with population increase, tertiary education high

Welfare services (elderly, child-care, healthcare)	High: Welfare services meet the needs of the population. Municipal funding is allocated in a balanced way	Medium; Still some problems in meeting demand. Trade-offs needed in distribution	Medium; rise in private facilities	High; increase in both private and public services,
Social Cohesion (Integration of asylum seekers and others)	High; integration funding allocated and community acceptance of newcomers	Medium	Low; society becomes more stratified and little acceptance for integration measures	Medium; some integration needed in order to fill many of the new jobs
Security, safeness (natural and other hazards)	High; flood protection and hazards against drought instigated, balanced and sustainable development of infrastructure. High level of protection in both city and hinterland. More national funding available	Medium-high; still risks of flooding etc, particularly in hinterlands	Low; private persons still mainly responsible for security against natural hazards. Large inequalities	Medium; the growth of many new buildings, housing and infrastructure makes the community more vulnerable (greater consequences) despite measures to reduce probability of hazards
Attractivity ("En attraktivare kommun")	High; Arvika is a very attractive place to live, work and invest in.	Medium; Arvika is a nice place to live, but less attraction for new residents	Low: social and inequality problems make Arvika not attractive	Medium; Municipality cannot keep up with very high population growth rate
Economy & Lifestyle				
Growth (per capita)	High; and well-distributed	Medium; and well distributed	Medium; large inequalities	High;
Employment	High, with support for competence development, and possibilities to make working lives longer	Medium	Low	High
Entrepreneurship and new businesses	High; it is easy to start and run new enterprises	Medium;	Low; it is difficult to start new businesses, especially for newcomers	High; many new enterprises started
New housing and infrastructure	Medium-high demand for housing and easy to new production in "safe" areas	Medium; good demand for housing, but need to develop supply more	Low; loss of population means that housing demand decreases	High, very high rate of new housing and infrastructure needed,

				but often being built in areas that are unsuitable
Accessibility	High; improved communication and infrastructure	Medium; Stable building of infrastructure, improvements to existing transport infrastructure	Low; rate of accessibility is lower	High; high growth demands better communication and infrastructure
Policies & Institutions				
International cooperation (INTERREG projects, etc)	Very high; More international cooperation; increase in municipal finances make it easier to co-finance EU projects	High; interest in international cooperation, but sometimes not enough time resources in municipality	Low; little interest or will to participate	High
Cross-border labour market (with Norway)	Dynamic; both in-commuting from Norway and out commuting to Norway	Slightly skewed; more workers commute to Norway, loss of tax income	Stalled; Cross-border commuting both ways decreases drastically	Dynamic; but more commuters from Norway to help fill jobs in the rapidly growing society
Flood protection, Flood directive, Sendai	High; flood protection is prioritized, including nature-based solutions	High	Medium; flood protection to secure existing housing and infrastructure	Low; unchecked building and construction means development in too many flood-prone areas
New regulation on climate adaptation in Comprehensive plans	Easy to implement, there is political will and administrative competence	Fairly easy to implement; there is administrative competence, but less political will	Very difficult to implement; no political will and little administrative competence	Fairly easy to implement, but with reliance on technical solutions
Technology				
Digitalization	Increasing rate of digitalization, but not at the expense of personal interactions	Increasing	Stable, but digital access uneven	Increasing, but sometimes at the expense of personal interactions
New developments in renewable energy technology	Increasing, particularly renewable energy	Stable	Decreasing	Decreasing

Environment				
Sustainable resource use	High, waste is diminished and recycled (into partly energy) Household consumption is smart	High-medium	Low	Low, High growth-rate means much more unchecked consumption in society and little emphasis on long-term solutions.
A pollutant-free environment	High, all environments are free of pollutants, particularly schools and working places. Use of dangerous chemicals is reduced. Water quality is high	Medium; still too many fossil fuels being used, water quality improving, but still not optimal	Low	Low; transport and rapid development still reliant on fossil fuels. Chemical use in agriculture and other industries leads to very poor water quality
Climate neutrality "Arvika klimatneutralt 2030"	High; Arvika's vision that energy effectivity is part of all energy use and that all electricity used is renewable is achieved	Medium	Medium	Low

SSP1 Sustainable Värmland/Arvika (based on Värmlandsstrategin and Hållbar Arvika)

In this scenario all three elements of sustainability are respected in both the county and the city. Population trends are rising at a sustainable pace (by 700 persons per year in the whole county and 25 persons per year in Arvika municipality. The increase is due both to citizens living longer healthier lives and to a manageable migration from other parts of Sweden and from abroad. The region and municipality have focused on providing integration measures for its new citizens and these flexible responses have even led to balanced urbanization, whereby population development is fairly dispersed in all municipalities in the county, including Arvika.

Growth in the region and Arvika is high and well distributed, with high employment levels with support for competence development as well as possibilities to extend the working lives of citizens beyond the usual retirement age. Entrepreneurship is high and national tax regulations coupled with a medium-high supply for new housing and commercial real estate in areas safe from natural hazards make it easy to start and run new enterprises. Accessibility by rail and bus is prioritized and becomes more sustainable with higher capacity rail networks to many areas of the county. There is an increasing rate of digitalization for businesses, public authorities and residents, which makes many life functions easier. But this does not occur at the expense of personal interactions in the community.

The educational level grows significantly with several new high schools built and both the county and Arvika see an increase in the level of tertiary-educated citizens. The university in the county seat of Karlstad experiences an increasing student enrollment and increased funding for its programmes. The welfare services provided by the municipalities are able to meet the needs of the growing population and municipal funding to elderly care, child care and social services in cities such as Arvika are effective, with a competent and satisfied workforce. This is complemented by the high percentage of municipal and national funding allocated to integration of newcomers, including asylum seekers - thus boosting the social cohesion of the region. This also leads to high feelings of security for residents, both against crime and against natural hazards such as floods, droughts and wildfires in the cities and the hinterlands, as the municipalities have coordinated measures against natural hazards and more national funding to, for example, climate change adaptation, has been secured.

International cooperation in the region is very high and the increase in municipal budgets in cities like Arvika make it possible to cooperate in and co-finance EU projects such as INTERREG or LIFE. The cross-border labour market with Norway is dynamic and includes both in-commuting from Norway and out commuting to Norway.

Flood protection in the flood risk areas is prioritized, particularly nature-based solutions and “no regrets” measures which have other societal, cultural or recreational functions outside of flood protection. The region and cities such as Arvika are able to participate in sustainable cities networks and in networks to implement the Sendai framework. New

national regulations on climate adaptation plans for the county and municipalities are easy to implement and there is both political will and administrative competence to do so.

New developments in renewable energy technology are increasing, and a growing percentage of the population is now utilizing these energy sources. Resource use has become very sustainable and waste is both diminished and/or recycled (partly into energy). Household consumption has become "smarter". Agricultural practices have also improved with an increase in sustainable fertilization methods and lower polluted run-off from the fields to the watercourses, leading to less eutrophication. Thus the environmental quality improves dramatically on both land and water. The Klarälven waterway is sustainable with a thriving salmon population, without help from humans. The water quality in Kyrkviken in Arvika has improved so much that residents are able to safely swim in the waters. Hydropower in Klarälven and other waterways in Värmland are adapted to a changing climate. The use of dangerous chemicals has been reduced and residencies, schools and working places have become more pollutant-free. Climate neutrality is both the county and Arvika has proceeded according to visions.

In sum, both the county of Värmland and the municipality of Arvika have become attractive places to live, work and invest.

SSP2 Middle of the Road: Business as usual

In this scenario population trends continue to be stable with a medium level of migration from other parts of Sweden and abroad. Urbanization trends also continue to be stable, with smaller cities and hinterlands slightly losing population to the larger cities in the region. Integration policies for newcomers are mainly effective, but municipalities such as Arvika find it difficult to plan for and finance some of the measures when there is a need to act very quickly, thus social cohesion remains relatively stable.

Economic growth in the county is slightly rising and remains well-distributed. Employment levels are stable and are best in the bigger cities, such as Karlstad, as are opportunities for entrepreneurship and new businesses. There is a good demand for housing, but supply is slightly lacking, and thus the desire for new construction in attractive areas, such as those close to water, but which may be at risk for flooding. There are still some risks of natural hazards like flooding from watercourses and lakes, particularly in the hinterlands and building in flood-prone areas remains an attractive strategy for cities such as Karlstad or Arvika as living close to water is seen as a draw to attract residents and businesses. This is important for cities such as Arvika, as while quality of life is high, it is difficult to bring in many new residents due to its size and relative peripheral situation in Värmland county, although infrastructure developments and improvements to existing transport infrastructure help to alleviate this.

The educational level continues at a good level, with a few school closings and the percentage of tertiary-educated population is stable, neither growing nor diminishing. Cities such as Arvika still have some problems meeting the demand for welfare services such

as elderly care or childcare, and trade-offs between municipal budgets for schools and elderly care are implicit. Still social cohesion and integration measures work well. Citizen safety is prioritized, especially flood protection for the communities in Arvika, with the building of the new flood protection dam. However the backside of this new safety with the flood dam is that many feel a false sense of security and thus building in the risk zones may be allowed.

Both the regional authorities (VCAB) and Arvika have a strong interest and capacity to participate in EU cooperation efforts such as INTERREG or LIFE, but sometimes they lack the resources in terms of time and co-funding. The cross-border labour market with Norway is slightly skewed with more workers commuting to Norway, than Norwegian workers commuting into the region. New regulations on climate adaptation and the Sendai framework are fairly easy to implement, although there is still some confusion of what constitutes a "resilient city" and how to ensure this. There is strong administrative competence for this, but slightly less political will to implement the required measures.

In terms of technological developments, the rate of digitalization is increasing throughout the region and in the cities. New developments in renewable energy remain stable and households and municipalities are beginning to think about ways to further improve sustainable resource use. The county is still dependent on too many fossil fuels, and water quality is still not optimal, but is improving. Klarälven has a small salmon population, with help from humans. Klarälven has some adapted hydropower plants, to a changing climate, but smaller watercourses with hydropower in Värmland are left behind. Climate neutrality by 2030 is a goal for the county administrative board (VCAB) and Arvika, but this has not yet been realised .

SSP3 Regional Challenges (Värmland county) and SSP4 A more insular Sweden and Arvika (Arvika)

These two scenarios have several common elements, even though SSP3 was deemed more relevant for the county and SSP4 more relevant for Arvika. Due to regional challenges Värmland county is experiencing declining population and losing residents to other regions in Sweden. The regional challenges have made mediums-sized cities like Arvika more insular to the outside world, with greater inequality among its residents. While migration from abroad is still happening, the general feeling (in the region and nationally) is increasingly xenophobic and many believe that immigration from countries outside of the Nordics should be slowed or even stopped, so that the municipality can take care of its "own" residents first. Urbanization processes have slowed in both Arvika and in the county as a whole. Urban areas in the city centers are stagnating due to low employment rates and a waning support for entrepreneurship and new businesses. It is difficult to start new businesses, especially for newcomers. Many city centres, such as Arvika are becoming more and more empty as new businesses are establishing in the suburbs where rents are lower and parking space more plentiful. In turn the housing market is slightly declining, but growth and new construction of larger homes is also happening outside of the city, where larger homes can be built. This has left pockets of

apartments and smaller dwellings in the older homes in the center that are being bought and rented by immigrants and poorer residents. The centrifugal force is that the wealthy have built on the outskirts of town and this as lead to inequalities in schools and other social services. Digitalization is decreasing slightly in the county as a whole, but is stable in Arvika, although the access is uneven

Much of the new housing and infrastructure being built are in flood zones. Private persons are still mainly responsible for security against natural hazards, although many of the homeowners close to the water feel that the municipality should finance adaptation measures. This causes even more goal conflicts as those with lesser means feel that the municipality should not use their tax-payer money to protect large and expensive houses built in flood zones by expensive hard infrastructure, such as dykes or dams.

More private schools in the outskirts are being built and can attract the best teachers, leaving the schools in the center less well off. In the county as a whole, tertiary education levels are dropping, especially in the rural areas, while in Arvika it remains stable. Social cohesion is reduced as society becomes more stratified and there is little acceptance for integration measures.

The cross-border labour market with Norway has been stalled in the county, including Arvika. Cross-border commuting both ways has been drastically reduced. In line with this there is very little interest or will to participate in EU or national projects. Even national regulations for climate adaptation and international frameworks such as Sendai are difficult to implement. In turn the regional rivalry with other parts of Sweden and the insular feelings affecting some cities like Arvika make it difficult for citizens to be interested in sustainable energy use or measures for a pollutant free environment.

Klarälven has a struggling salmon population, which need a lot of resources and help from humans to survive. Funding for this is difficult and the salmon population is near extinction. Hydropower in Klarälven and other watercourses in Värmland are not adapted to the changing climate, which results in difficulties producing power needed in the county. Water quality in Kyrkviken in Arvika has not improved. Climate neutrality is stalled somewhat. While there are not many proactive projects to reduce carbon emissions, the slightly lower growth rate in the economy has curbed consumption for all but the very richest.

SSP5 High economic fossil-fueled development

In this scenario of high growth, the population is quickly rising in both the county and the municipality of Arvika due to high migration from both within Sweden and abroad and increased disposable incomes which allow families to have more children. Even though the death rate has not decreased, due to increased diseases associated with higher pollutants in the air and water systems, this has not dramatically affected the population trends. Värmland county has become highly urbanized as newcomers to the region are attracted to the job opportunities that the cities provide. However this has led to regional

disparities with several shrinking smaller cities, and even medium-sized cities such as Arvika are affected to some extent.

Although economic growth is very high, social and territorial cohesion are weakened as growth and employment are focused to the urban areas, at the expense of the hinterlands. Employment is generally high, as is the rate of entrepreneurship and the number of new start-up businesses. This has also fueled a strong demand for new housing and transport infrastructure, although these are often being built very quickly and in areas that may not be protected from flooding, wildfires, landslides and other natural hazards that are increasing due to the rapidly changing climate. Digitalization is increasing, with more and more goods and services being provided via digital technology. However this is starting to have an effect on the social relations of the communities, as personal contacts for many, particularly older people, are becoming fewer and fewer.

The education rate is high, with new schools being built to keep pace with the population increase. Tertiary education levels are also on the rise. Welfare services also need to meet this rise, and although they are provided at a satisfactory level, most of these services have been taken over by private companies with varying degrees of effectiveness. Social cohesion is weakening and integration of newcomers is a priority in order to fulfill the demand for jobs, but not sufficient enough to truly integrate them into the communities. Unchecked building and construction means that much development is ongoing in areas that are prone to flooding, landside and wildfires, thus increasing the consequences of a natural hazard, and making the community less safe, despite measure to reduce the probability of such hazards by “hard” protection, such as flood walls.

International cooperation is high as both the county and Arvika have the funding to explore participation in many types of EU-projects. However most of these projects are focused on supporting high growth and entrepreneurship and projects that take up environmental and social issues are downplayed. The cross-border labour market with Norway is dynamic, but more commuters from Norway are needed to help fill the jobs created by the rapidly growing society. The focus on implementing the Paris Agreement has switched from mitigation to adaptation and thus climate change adaptation measures are fairly easy, and necessary, to implement, although there is a strong reliance on technical solutions, rather than transformative adaptation.

With the high increase in the use of fossil fuels to drive the economy, the environment has become less healthy. The high growth rate means much more unchecked consumption with little emphasis on sustainable and long-term thinking. Transport within the county is mainly via road and personal cars. Chemical use in agriculture and other industries has led to very poor water quality. For instance the water quality in Kyrkviken in Arvika is so poor that it is not possible to fish or engage in any water sports for fear of contamination.

Klarälven has a struggling salmon population, which need a lot of resources and help from humans to survive. Hydropower in Klarälven and other watercourses in Värmland

are not adapted to the changing climate. Resources used for fossil fueled power instead. Climate neutrality has not been realized.

3.4 Fluvius and North Brabant regions (Deltares)

3.4.1 Process summary

For the Dutch cases, we decided to focus on SSP 1 & 5 as these are believed to cover the solution space for the future development of the country. Current statistics show that the Netherlands performs badly within the EU with regards to implementing and using renewable energy sources as part of its total energy production (Eurostat, 2019). Additionally, contemporary Dutch politics are also not fully committed to implementing climate mitigation measures, as there is still a lot of debate going on, particularly as to how to operationalize policies. As such, SSP 5 will therefore be seen as a continuation of these current trends. SSP1 on the other hand will be used to explore the possibility that the decision is made to turn the wheel around and above-mentioned problems are addressed.

Filling in the element tables was based on the so-called 'Delta-scenarios '(Wolters et al., 2018), and then specifically the ones 'Rest' and 'Steam'. Additionally, general and widely available knowledge with regards to policies and institutions in the Netherlands has been used. Finally, the scenario specifications of Flensburg, also part of the EVOKED project, has been used as a reference, mainly due to the similarities between Germany and the Netherlands.

3.4.2 Local narratives

Table 6 Scenario narrative elements of Fluvius and North-Brabant regions

Elements	**SSP1: Sustainability – Taking the green road**	**SSP5: Fossil-fueled Netherlands – Let the economic engine roar!**	**Specifics for Fluvius-region**	**Specifics for the Eastern part of North-Brabant**
Demographics				
Population growth	Decline	High growth	SSP1: Decline SSP5: Most likely decline or stay stable	SSP1: Decline SSP5: High
Migration	Low/medium	High	Won't really play a role in this region	SSP1: low/medium SSP5: low/medium
Urbanization	Low increase	High increase	SSP1: Low increase SSP5: Low increase	SSP1: Low increase SSP5: High increase
Human Development				
Education	High There is an universal access to higher education; focus on sustainability and international programs	High There is an universal access to higher education	Higher education is not located in this region, as such potential students will have to travel to nearby University (of Applied Sciences) in Groningen or Zwolle.	Higher education institutions are found nearby in Nijmegen, Eindhoven and Den Bosch
Health investments	High; Well organized, universal access to healthcare institutions	High; Well organized, universal access to healthcare institutions	Similar for both locations. Potentially a slightly further travel time for people in Fluvius-region.	
Social cohesion	High	High	Similar for both locations	
Societal participation	High	High	Similar for both locations	
Household-level adaptation	Adaptation through structural measures as well as BWN measures, additionally also focus	Adaptation mostly through technical structural measures	Similar for both locations	

	on communal cooperation and preparation			
Economy & Lifestyle				
Growth (per capita)	Medium	High	SSP1: Low/medium SSP5: Low/medium	SSP1: Medium SSP5: High
Inequality (between households)	Strongly reduced	Strongly reduced, although some inequalities persist between regions	Similar for both locations	
International trade	High	High	Does not play a role	Plays a slight role due to vicinity of Eindhoven
Globalization	Strongly globalized in combination with also a focus on local produced goods as well.	Strongly globalized, increasingly connected world market and trade	Does not play a role	Plays a slight role due to vicinity of Eindhoven
Policies & Institutions				
International cooperation	Effective; The Netherlands are well embedded in global politics and maintain cross-border relations with neighboring states as well as European states in the EU. This position will be further strengthened in the future.	Effective; The Netherlands are well embedded in global politics and maintain cross-border relations with neighboring states as well as European states in the EU.	Does not really play a role in this region	Potential role due to vicinity of Eindhoven. Additionally, also international cooperation needed due to river management of the Rhine and Meuse.
Environmental policy	Integrative policies that cover multiple problems and disciplines, strict regulation regarding pollutants and emissions, decentralized policies for local issues	Environmental policy focusing on limiting and prevention of environmental pollution through technical means.	Similar for both locations	

Institutions	Decentralized institutions, region-crossing where needed (e.g. water boards), steering from a national level if needed, focus on nature/environmentally friendly solutions	Decentralized institutions for local issues, region-crossing where needed (e.g. water boards), steering from a European or national level if needed, focus on solutions that improve economic growth	Similar for both locations	
Technology				
Development & transfer	Rapid, digitalization	Rapid, digitalization, automatization	Similar for both locations	
Energy tech change	Directed away from fossil fuels; towards renewables and energy efficiency	Directed towards fossil fuels (oil and gas); renewable energy sources are not as actively pursued	Similar for both locations	

SSP 1: Sustainability – Taking the green road

The first scenario sees a shift in the Netherlands towards sustainability and a society in which inequalities are reduced due to effectively functioning local and regional institutions and high investments in healthcare and (higher) education. Especially education is a key element in these developments as international oriented programs, giving attention towards sustainability and universal accessibility, help raise citizens that have a sustainable outlook themselves. Furthermore, the investments in health care will be mostly made to support the growing elderly population in the Netherlands. Additionally, the population decline that started in the Netherlands at the beginning of the millennium in certain regions will expand further. This will lead to a drain of the rural areas, while more citizens will move towards cities. As such, urbanization will somewhat increase but part of this process is also due to the replacement of the elderly population living in the cities. Cities in this scenario will move towards containing more green space, and high-quality housing which incorporate mitigation measures such as renewable energy. Finally, the population will also be cohesive, and due to raised awareness will be prepared and work together towards a better future.

On the topic of globalization and international trade, the Netherlands will maintain its position in international trade due to the strategic locations of the Port of Rotterdam, as well as Schiphol Airport, and possibly more international airports. However, at the same time, environmental awareness will also lead to the consumption of more locally produced goods which to a degree offset the emissions made by the international trade. However, the biggest contribution to reducing CO2 emissions will be the movement towards renewable energies, as well as making current energy-using processes more efficient. Potentially, the environmental awareness would also lead to a higher use of the already existing public transport network in the Netherlands as well as an increase in digitalization and home-office work which reduces the amount of movements made. Finally, international cooperation, in which the Netherlands is already firmly embedded, in relations between geographical neighbors, in the EU and globally, will help to increase the sustainability footprint. This, since the Netherlands needs these contacts (especially European) due to the rivers that run through the country and therefore require international collaboration to limit flood risks. Additionally, in order to address environmental issues, local governments also play a role in designing and implementing measures that limit pollution and emissions and help contribute to a healthy living environment in the cities with addition of enough blue-green infrastructures and connecting nature areas in the surrounding areas with the areas in the cities itself.

The Netherlands portrayed in this scenario is a country that looks at the future through a sustainable lens, implementing sustainable ideas from a national to a local level, and from the governmental stakeholder to businesses and citizens. Measures that need to be taken are done on a building-with-nature manner and add value to their surroundings, and significant steps are made to making the Netherlands CO2-neutral around 2050, through the employment of renewable energy measures.

SSP 5: Fossil fueled Netherlands – Let the economic engine roar!

This scenario sees a shift in the Netherlands that focusses on an increase of the population, as well as a growing economy. In this scenario, there is also less inequality as is c the currently case, although regionally there may be differences (e.g. North and the East of the Netherlands will experience less growth and economic wealth in relation to the Western part). Additionally, the economic growth also leads to enough money being available for keeping higher education available and accessible for the Dutch population. This in turn also delivers a steady supply of highly educated people for the Dutch and international industries. Furthermore, the economic wealth also leads to a high-quality healthcare.

In the cities of the Netherlands, the focus is on economic growth. This also lead to high emissions of CO2 which in turn have increased the impact that climate change has in, especially urban areas. To this end, part of the finances of the Dutch government are used to implement spatial measures that help to lessen this impact. As such, the focus is on technical measures. Additionally, Dutch citizens also take measures themselves, although these are also more technical in nature. Problematic however is the increasing need of housing due to the high growth of the Dutch population (both naturally as through immigration). This also brings pressure on the still existing nature in the Netherlands as rapid urbanization and industrial agriculture decreases the biodiversity, and nature areas are splintered, and fractured parts spread throughout country. The remaining nature is monitored by regional and national governmental stakeholders, and pollution is trying to be prevented through technical means.

Finally, as mentioned earlier, the focus in the Netherlands is on economic growth. This is mostly done through the international trade (e.g. Port of Rotterdam; Schiphol Airport) in which the Netherlands serves as distribution center for the rest of Western Europe. This status is maintained by having good international cooperation and advancing globalization to maintain a free-trade market, while capitalizing on opportunities to increase the proportion of trade that flows through the Netherlands. To this end digitalization and automatization are also used excessively. Additionally, the economy in the Netherlands is fueled by a high-tech service industry that makes use of the earlier mentioned highly educated population. However, due to this economic growth less effort is put in increasing the use of renewables. Instead, efficient use of the remaining fossil fuels is the focal point of technological advancements. Although we do see a slight movement towards renewables as fossil fuel prices are becoming unsustainable in the future, this is not actively pursued and used at the time. Partly due to the spatial needs for these kinds of energy within an already full country, as well as Not In My Back Yard (NIMBY) feelings from local groups of citizens.

4 Population projections

The population projections that we developed for the different case studies are based on the coastal SSPs of Merkens et al. (2016), who extended and refined the basic SSPs for coastal areas to account for the generally faster development of coastal population compared to inland. They developed spatially explicit population projections with a spatial resolution of 30 arc-seconds (approximately 1 km at the equator) which are based on the population projections of KC and Lutz (2017) and the urbanisation projections of Jiang and O'Neill (2017). Further, Merkens et al. (2016) analysed observed differences in population growth pattern between coastal and non-coastal areas and for urban and rural zones for each country. They modified the observed growth differences for each SSPs corresponding to the narratives they developed and used these differences to regionalise population projections in 5-year time increments from 2000 to 2100 in all five SSPs. These data were not directly utilised in this report as the base year for the population projections differed (2000 for the coastal SSPs; 2018 for this report).

We employed the Global Administrative Areas (GADM) Version 2.7 dataset to define the spatial extent of the study sites and used the coastal SSPs to assess the projected total population for each study site in 5-year increments for the years 2015 to 2100. In a next step, we calculated the annual population growth rate, by assuming a constant growth rate for each 5-year increment. These growth rates include the national population trends, trends in urbanisation and assumptions on coastal migration for each SSP. As the share of coastal and inland areas and urban and rural zones differs for all study sites the growth rates differ as well. We then used the latest census population estimates (e.g. 1st of January 2018 and the 31st of December 2017 for the Flensburg case study) as baseline population and employed the annual population growth rate, as calculated from the data of Merkens et al. (2016) for each case study. For the case study of Arvika we used the calculated population growth rates of Värmland. For the Netherlands, we calculated separate growth rates for each municipality.

SSP1 shows increasing population for Värmland and Larvik. For Flensburg the population increases until 2060 and declines to the 2018 levels by 2100. The study sites in the Netherlands show heterogeneous growth patterns. Population in Hoogeveen, Oss, Meierijstad and Uden is projected to increase considerably. For Meppel Bernheze and Steenwijkerland population is projected to increase slightly whereas population declines for De Wolden, Midden-Drenthe and Westervelt. Population projection in SSP2 do not differ considerably from SSP1. In SSP3 population is declining in all study sites and will reduce by 50% or more for De Wolden, Midden-Drenthe, Westervelt and Flensburg. Under SSP4 Larvik is the only study site facing population growth. For Värmland population is projected to grow until 2070 and declines until 2100 to 2018 levels. The population in most study sites in the Netherlands and in Flensburg declines by 10% to 25% below the 2018 levels. SSP5 shows the highest population projections for all study sites. The population of Larvik and Värnland doubles and grows by about 50% for Hoogeveen, Meppel, Bernheze, Oss, Meierijstad, Uden, Steenwijkerland and Flensburg. For De Wolden, Midden-Drenthe and Westervelt the population is projected to decline (as in all

other SSPs). The results of the population projections for all case studies and for every SSP are shown in Tables 7-11 in Appendix 1.

5 Reflections and next steps

All EVOKED partners have developed a set of local scenarios for every case study, following the step-by-step process described above. The combination of a top-down (Steps 1-4) with a bottom-up approach (Steps 5-6) has resulted in sets of scenarios that are locally relevant and accepted by the potential end-users. At the same time, the developed scenarios are consistent with the global scenarios used as boundary conditions (i.e. SSPs) and therefore comparable to other downscaled scenarios developed in different regions or in a different context. Despite the distinct local context of each case study, the scenarios developed across case studies are similar in terms of the SSPs that were selected. In all case studies there was a clear preference for a local SSP1 to be developed, while three of the project partners developed local extensions for SSP2, SSP3 and SSP5. The choice of scenarios appears to reflect current discussions in climate policy and the general political landscape, with society being torn between sustainable solutions, the use of fossil fuels, and the increasing tendency to protect regional markets.

The process of co-developing local scenarios with stakeholders also has some drawbacks. The quality of the stakeholder feedback largely depends on the stakeholders' background knowledge and participation. Only few stakeholders had previous experience in the field of scenario development and analysis. Exploring plausible future socioeconomic developments until 2100 can be rather abstract to stakeholders, who needed time to fully immerse in the storylines discussed. Therefore, it is very important to prepare the stakeholder workshop thoroughly and to facilitate comprehension by employing visualization techniques such as figures, graphs, animations, and posters. Also, exercises in small groups have been particularly useful as these result in more lively discussions that help participants to engage in the topic, especially if the group of stakeholders is very diverse.

In the next phase of Work Package 2, the developed narratives and population projections will be used as a basis for assessing population exposure and vulnerability to the potential impacts of climate change. As the developed scenarios allow for exploring a wide range of societal futures and the resulting plausible future climate change impacts, they are an important basis for supporting adaptation planning in each project case study.

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Appendix 1: Population projections for local scenarios

Table 7 Project case study population projections under SSP1

Region	2018	2020	2030	2040	2050	2060	2070	2080	2090	2100
Arvika	26054	25763	27924	29878	32072	33833	35691	37081	37583	36033
Värmland	280339	277207	300455	321487	345094	364046	384032	398987	404393	387712
De Wolden	23917	23330	20990	18507	16111	13834	12115	10475	8780	7757
Hoogeveen	55677	56187	58640	60741	62207	63517	64568	64889	64035	62197
Meppel	33410	33631	34927	35978	36703	37370	37864	37824	37348	36268
Midden-Drenthe	33172	32670	29290	25867	22433	19023	16700	14352	11967	9646
Westervelt	19152	18637	16335	14031	11730	9430	7893	6358	4824	3836
Bernheze	30550	30776	31873	32771	33424	33964	34402	34417	33911	32929
Oss	90951	91672	95393	98406	100627	102543	104059	104377	103052	99972
Meierijstad	80148	81122	85893	89947	93164	96085	98306	99359	98601	96262
Uden	41725	42293	44989	47352	49267	50937	52257	52930	52633	51420
Steenwijkerland	43768	44069	45546	46874	47685	48375	48929	48997	48282	46774
Larvik	46801	47444	52172	56510	60852	64911	69011	71292	72677	72026
Flensburg	88519	90171	95235	98401	100325	100842	99868	97272	92672	86566

Table 8 Project case study population projections under SSP2

Region	2018	2020	2030	2040	2050	2060	2070	2080	2090	2100
Arvika °	26054	25729	27632	29492	30858	32878	34422	35804	35101	35603
Värmland	280339	276842	297315	317327	332027	353764	370380	385244	377681	383082
De Wolden	23917	23538	20602	18155	15768	13457	11659	10069	9265	7699
Hoogeveen	55677	56098	58021	59101	59831	60536	60964	61296	61440	60786
Meppel	33410	33689	34635	35467	35953	36274	36585	36899	37019	36628

Midden-Drenthe	33172	32306	28677	24131	20576	18055	14667	12304	11053	9684
Westervelt	19152	18766	15949	13453	11175	9115	7376	5858	5097	3798
Bernheze	30550	30744	31652	32286	32558	32839	33123	33314	33314	32940
Oss	90951	91615	94728	96789	98121	99208	100266	101002	101125	100193
Meierijstad	80148	81018	85186	88433	90764	92784	94595	96009	96692	96361
Uden	41725	42192	44388	46049	47218	48204	49053	49659	49839	49485
Steenwijkerland	43768	44044	45306	46253	46646	47089	47564	47726	47885	47353
Larvik	46801	47545	52171	56777	60533	64717	67920	71165	72538	73323
Flensburg	88519	89294	92389	94422	95384	95300	94467	93039	90719	87405

Table 9 Project case study population projections under SSP3

Region	**2018**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
Arvika °	26054	26364	26934	26663	26614	26268	24079	23146	21272	19407
Värmland	280339	283670	289803	286897	286365	282641	259085	249046	228889	208820
De Wolden	23917	23279	19953	16561	13728	11084	8649	7441	5687	4658
Hoogeveen	55677	55883	55676	54347	51919	49079	46376	43507	40229	36802
Meppel	33410	33533	33178	32265	30900	29188	27479	25792	23928	21839
Midden-Drenthe	33172	32241	27418	22531	17727	13957	11251	8791	7249	5826
Westervelt	19152	18549	15457	12366	9824	7507	5411	4415	3092	2318
Bernheze	30550	30604	30359	29474	28118	26560	24964	23373	21557	19711
Oss	90951	91210	90937	88578	84688	80146	75563	70854	65562	59994
Meierijstad	80148	80657	81767	80879	78325	74972	71378	67396	62688	57725
Uden	41725	42027	42738	42370	41126	39369	37488	35358	32878	30207
Steenwijkerland	43768	43860	43461	42246	40260	37901	35793	33356	30884	28147
Larvik	46801	47385	49012	49687	49406	48441	46722	44883	41787	38662
Flensburg	88519	88350	85709	81532	75828	69318	62935	56619	50348	44396

Table 10 Project case study population projections under SSP4

Region	2018	2020	2030	2040	2050	2060	2070	2080	2090	2100
Arvika °	26054	26460	27916	28555	29686	30240	30501	28682	27900	25894
Värmland	280339	284713	300376	307252	319424	325377	328191	308612	300198	278621
De Wolden	23917	23348	20190	17666	15127	12742	10368	8754	7617	5924
Hoogeveen	55677	55932	56751	56924	55952	54974	53242	51555	49088	46154
Meppel	33410	33558	34204	34274	33930	33248	32360	31477	30214	28421
Midden-Drenthe	33172	32219	27341	23574	18751	16021	12288	10751	8294	6754
Westervelt	19152	18559	15521	13240	10742	8681	6404	5102	4122	2822
Bernheze	30550	30674	31131	31115	30648	29983	29189	28210	26961	25438
Oss	90951	91468	93257	93576	92557	90672	88447	85684	81983	77368
Meierijstad	80148	80924	83775	85261	85431	84668	83398	81421	78394	74303
Uden	41725	42099	43539	44177	44091	43504	42600	41364	39588	37309
Steenwijkerland	43768	43992	44814	44820	44148	43269	42095	40635	38862	36716
Larvik	46801	47679	51354	54055	56305	58038	57939	57358	55719	53114
Flensburg	88519	89177	91227	91803	90795	88272	84775	80352	74944	68672

Table 11 Project case study population projections under SSP5

Region	2018	2020	2030	2040	2050	2060	2070	2080	2090	2100
Arvika °	26054	25836	29143	32469	36368	40897	45320	49560	52685	55584
Värmland	280339	277996	313577	349363	391313	440053	487641	533260	566886	598080
De Wolden	23917	23612	22087	20095	18599	17344	16017	14832	13521	12245
Hoogeveen	55677	56200	59620	63008	66632	70791	74792	78558	81198	83220
Meppel	33410	33861	36448	38945	41752	44993	48348	51383	54037	56104

Midden-Drenthe	33172	32289	28905	25427	22110	19898	16679	15517	13302	12074
Westervelt	19152	18774	17064	14827	13118	11625	9917	8638	7145	5865
Bernheze	30550	30860	32924	35069	37353	39955	42597	45075	47090	48672
Oss	90951	92044	98758	105581	112906	121168	129592	137227	143716	148764
Meierijstad	80148	81386	88651	96161	104068	112930	121921	130168	137166	142741
Uden	41725	42248	45412	48480	51651	55111	58463	61307	63426	64738
Steenwijkerland	43768	44299	47399	50534	54080	57958	62020	65612	68823	71251
Larvik	46801	48068	54733	62436	71186	80971	90853	99870	107511	113857
Flensburg	88519	90450	98138	104785	111312	117563	122527	125911	127205	126571

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