MANUAL FOR PLANNERS

Manual for planners with analysis on the usability and suitability of the GIS tools and other applications for marine and coastal planning purposes

Deliverable report of Coast4us project D.T1.5.1

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Contents

Introduction

The publication in your hands is the manual for planners with analysis of the usability and suitability of the GIS tools and other applications for marine and coastal planning purposes, which were used and also developed during the Coast4us project by partners from different countries along the coast of the Baltic Sea.

An overview of different applications used by planners and tips about which method is best to use in the future are given in this manual. Among the methods that will be touched upon are mathematical modelling for creating GIS layers, planning IT tools, LEA, and others.

This manual includes several examples of what tools were used at different planning stages and some thoughts about the importance of different tools in mapping and planning.

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1   Different types of tools and their variable usage in planning stages

A selection of tools used in the Coast4us project by partners from different countries is described in this chapter. The tools used vary from online planning tools and mathematical modelling to planning laboratories and economic analysis.

1.1   LEA (Local Economic Analysis)

In the Coast4us project, Linköping University and the organisations Coompanion and All of Sweden shall live were involved in using a tool called LEA (Local Economic Analysis) for rural development. LEA was used in the Östergötland area.

Local Economic Analysis is a way to contribute to rural development by highlighting how conscious choices of the local population can create jobs and production in an area. The goal of LEA is to relocate the economy, find out where the resources are and get them to circulate more locally. There are two connected reasons to carry out a LEA. The first reason is to find out about the resources in the area. The second reason is to create awareness of where the local economy is and strengthen it. The end result is a more localized economy since it is possible to know where to find it. One of the most important aspects of implementing a LEA is to have a starting point in knowledge-raising.[1]

This is done as follows:

(1) The community group decides to make a LEA, an area is defined and statistics from Statistics Sweden are requested,
(2) The statistics are processed by the village community,
(3) The local situations are added in an effort to understand the local economy,
(4) A process is activated to find alternative economic development paths, and
(5) A report is written and follow-up activities are initiated.

The main goal in the Coast4us project was to find tools and methods for the involvement of local stakeholders in planning processes at an early stage and overall. In the case of LEA usage, it can state that the goal was achieved. The tool was useful and it can be used to achieve a local commitment in the long term and gain a positive local commitment to development processes.

In principle, the method of LEA is to put together a local plan document based on specific geography, a village or defined rural area. Strengths, weaknesses, areas of development, and future strategies are discussed. The local planning document contains facts in the form of a variety of statistics. Based on the statistics, interpretation is made of what the figures mean by filtering it through local knowledge. The plan takes shape and it is important that it is rooted in as many people as possible affected by it. It is of no value if only a handful of people stand behind it. If it has the legitimacy of the local population, it is a powerful tool for local development and a very good starting point for conversations with, for example, the municipality, leader areas or other partners to develop the village.

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[1] *Source: G-J. Hospers, J- Syssner, "Dealing with Urban and Rural Shrinkage: Formal and Informal Strategies", 2018*
https://www.researchgate.net/publication/322697545_Dealing_with_Urban_and_Rural_Shrinkage_Formal_and_Informal_Strategies
Chapter 8, page 109

LEA and local development plans are well-known and well-used tools for local development. The methods have, of course, been developed and adapted based on each case. Target groups are people who live and work within a specific geography. Within Coast4us, among the target group were also officials and politicians, primarily the municipality, to highlight the benefits of working in this way to bring local knowledge and commitment to planning work.

This tool could be used by local groups that are well rooted in the community. The main obstacle for using the tool might be not having a broad foundation or a clear sense of ownership locally. There is a continual need for a transparent process.

The main benefit of using the LEA tool is to have a local commitment and access to local knowledge. Using this tool gives a place identity and builds pride in the local community.

1.2 Eco-mapping and Maptionnaire

1.2.1 Overview of eco-mapping as a tool

Eco-mapping is a tool for mapping how the landscape is used and what needs exist. The idea is that the local population/nature user visualizes his/her knowledge of natural resource utilization and assigns different values on, for example, a map, while taking into account different interests, possible conflicts and the needs of joining the landscape in a sustainable way.

Different tools for eco-mapping:

- Maptionnaire
- Open Space method
- SWOT-analyses
- Causal loop diagram (CLD)

Maptionnnaire is a digital map tool that can easily and cost-effectively contribute to gathering local knowledge from the participants and wishes for municipal development.

The workshop days are meant to use the Open Space method, which aims to have participants set the agenda and suggest issues, topics, places, challenges and opportunities to discuss and map with connections to social, cultural, economic and ecological values in the area.

SWOT analysis is a proven tool for early involvement in the planning process through an inclusive approach where the relevant actors discuss together space conditions, i.e. what strengths, opportunities, weaknesses and threats exist in different thematic areas.

To identify and pedagogically demonstrate any conflicts of interest within the area, the final tool used is the CLD method. The method is based on earlier performed workshops creating transparent "Causal loop diagrams", which can be described as a thought-maps or system of how the various interest groups present and desired future operations affect each other. The structural overview is an aid to distinguish problems or conflicts and is also a tool for identifying where and how measures may need to be implemented.

Sund and Mariehamn area in Aland used these tools in practice during Coast4us project.

The goal was to try new methods and tools in a planning process, based on the concept of local collaboration. It is extremely important to involve local people early in a planning process to get planned things anchored and make them easier to implement. At the same time, we can exchange knowledge about the importance of different ecosystem services and biodiversity, especially in sensitive coastal zone environments.

By the end of the project, the goals of trying and testing new methods was achieved. We have also gained a great deal of knowledge and implemented several different things with positive response, such as ditch walks, workshops, online surveys and the collaboration with Nabben wetland.

1) **Eco-mapping**, a tool to seek knowledge of different values in a landscape using maps and interviews/meetings with locals and businesses, municipalities, NGOs and others. Eco-mapping was carried out with the IPBES concept (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) as the basis since conservation of biodiversity and ecosystem services is extremely important to consider in the coastal zone.

Consultants were used to set up the tool and the main target groups where NGOs, different associations, farmers, locals, and municipality.

2) **Maptionnaire**, an online tool to get local information more easily. Locals can go online and on a map pinpoint relevant areas and answer questions of interest. Easy for everyone and only takes a few minutes.

This is a tool, which was set up by consultants, but can be used by everyone with an interest of the green areas in Mariehamn city.

The outcome and usefulness

Each tool has given new knowledge about how to interact with different target groups and why it is so important. Working with a digital tool like Maptionnaire was a great way to map people's desires, especially in a time when we couldn't have public meetings because of the corona virus. Local representatives received over 400 responses in the Maptionnaire survey.

Eco-mapping was a great way to get people to share their views and to identify the shortcomings they have seen when it comes to planning / government decisions in the past. The eco-mapping process is more time-consuming than the Maptionnaire process both for planners and the general public.

1.2.2 Recommendations for future use of the tool

Both tools, Maptionnaire and Eco-mapping, can be used for any kind of planning when you need the knowledge and opinions of locals, NGOs, associations, municipalities, politicians (everyone). The Eco-mapping method gives a better chance for dialogue and the Maptionnaire tool gives easy answers fast.

Authorities, municipalities and others who will make decisions that affect sustainable coastal zone planning should use these tools.

The main obstacles of using the tools are lot of procurement procedures by the authorities, planning and work has been required to distribute information in the media and on websites. It takes work and patience to involve many in one process.

These tools' main benefits are that they provide good local collaboration and early implementation, leading to greater consensus on necessary planning and the importance of preserving ecosystem services. It also provides better opportunities to carry out things without appeals and dissatisfaction.

1.3 Mathematical modelling as a tool in the planning process

TalTech used in this project mathematical modelling as a tool for helping planners. This is one option to get future scenario predictions, so that planning decisions would be easier to do.

The principal method used within the project was numerical modelling of the water movement (advection and diffusion) in the Baltic Sea and, more precisely, around the area of interest – Saaremaa island. The model engine consisted of GETM (General Estuarine Transport Model) that is an open source software and freely available from www.getm.eu. GETM solves numerically primitive (not simplified) equations of tracer advection and calculates the vertical mixing via GOTM (General Ocean Turbulence Model). Biogeochemistry of the system was modelled using ERGOM model (Ecological Regional Ocean Model; see: *Neumann, T., Fennel, W., Kremp, C.: Experimental simulations with an ecosystemmodel of the Baltic Sea: a nutrient load reduction experiment. Global Biogeo-chemical Cycles, 16 (3). doi:10.1029/2001GB001450, 2002*). The model is maintained and developed further by the researchers in the Institute of Baltic Sea Research (IOW, Germany).

All the setups for different assessments were developed by TalTech (set-ups of the model made by Germo Väli) and possible target groups were the decision makers in the Saaremaa municipality. The tool itself is rather complicated and is maintained and further developed at TalTech.

Modelling was used to generate flooding prediction GIS layers for planners to suggest better sustainable restrictions in the coastal area, which would suit both for local residents, but which could also take into account nature changes due to climate change in the future.

All those model setups are now usable at TalTech High-performance computing (HPC) centre.

1.3.1 Overview of mathematical modelling tool used in project

TalTech used mathematical modelling tools in the project and within the project three different model setups around Saaremaa were developed – (a) coarse resolution model for the entire Baltic Sea to assess the impact of sea level change around the island, (b) fine scale resolution model to assess the impact of Väike Väin dam to the water exchange between the northern and southern part of the strait, and, (c) medium scale resolution model to assess the impact of fish farming in the north-western coastal areas of Saaremaa. Three tools were required as the scales of the impact were significantly different in each of the cases. In the task to describe sea level change, one has to look at the entire Baltic Sea over long periods in order to get good statistics about the behaviour of maximum sea levels. In the case of the dam, one has to look with fine resolution to resolve the possible openings in the dam. In case of fish-farming, multi-year analysis with medium resolution is required to detect any changes in the water quality around Saaremaa.

Outcome and usefulness

Developed modelling tools have helped to predict the potential sea level change to the coast of Saaremaa and to make scenario calculations regarding the impact of the dam openings and aquaculture development. Thus, the tools based on numerical modelling were applied in different planning phases. The first task was related to the phase of creating GIS layers. Assessing the impact of the dam openings and fish farming created background material to select possible development scenarios.

1.3.2   Recommendations for future use of the modelling tool

The tool can be used by people who have some background in computational fluid mechanics and especially with state-of-the-art numerical models (NEMO, GETM, ROMS, etc.).

The biggest obstacle is that they can only be used at HPC centre or on computers with large memory and computational power available.

The main benefit of using modelling tools is, that they can simulate possible future scenarios and give quantitative indication for decision makers what future scenario would be most sensible.

1.4   A planning tool for small villages developed by Riga Technical University

Riga Technical University (RTU) has developed Indicators for Analysing Village Territories, where combining and analysing GIS layers makes it possible to determine the needs of the population. Additionally, they analysed the possibilities of using GIS layers for the development of the territory at the village level. Based on groups of the indicators, RTU developed a prototype of the tool for collecting analytical and GIS layers for village territories. The results are described and published as a separate scientific paper (Kalinka, M., Geipele, S., Pudzis, E., Lazdins, A., Krutova, A., Holms, J.,: Indicators for the Smart Development of Villages and Neighbourhoods in Baltic Sea Coastal Areas. Sustainability 2020, vol 12(13)).

One of the results is, for example, indicator groups influencing village planning, which was developed by the RTU scientists (see Figure 1).

Figure 1 Indicator groups influencing village planning, by RTU 2020 (source https://doi.org/10.3390/su12135293 23.11.2020)

For creating the groups of the indicators, an expert method for collecting information and analysing the data sources and their possibilities to use for village GIS tool was used.

The target groups are local communities and government.

The outcome will be the analytical and geospatial information to give full information of the village, including cartographical, analytical, statistical, social and economic information. The tool gives and shows the real situation in the village.

Riga Technical University has developed a GIS prototype. The future works is creating the application tool for village to including the data sources. For example, Figure 2 shows the data sources for indicators, which was also developed by the RTU scientist, including M. Kalinka, S. Geipele and U. Krutova.
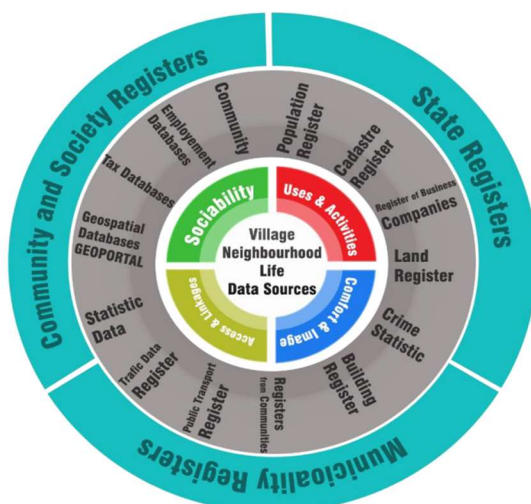

Figure 2 Data sources for indicators, by RTU (source https://doi.org/10.3390/su12135293 , 23.11.2020)

The main obstacle is the data availability, as not all data are open data.

The main benefits – the GIS tools are 3D dynamical tools including the infrastructure layers, social and economic layers. The tool works best if a village has full data information. The pilot territory for testing the tool was Tuja, Latvia.

The information about the model and all results are published in a scientific publication, which is available in MDPI database: https://doi.org/10.3390/su12135293

1.5   Web-based planning portals as an effective online tool

In all Coast4us partner countries, Sweden, Latvia, Åland and Estonia, there are web-based national planning portals available. The Estonian system is still quite new and has not fully replaced existent regional systems yet. In Estonia, still more and more municipalities are compiling their comprehensive plans and other plans in online GIS systems, because these systems are more convenient to use for authorities and for public as well. In Sweden, Åland and Latvia, there are national web-based planning portals of comparable type and purpose, which collect, compile and provide information necessary for spatial planning on a national basis. The purpose of these planning tools is to facilitate access to and searching for information necessary for planning processes. In Latvia, there is even a legally binding requirement on the use of this portal for planning processes, as it also can be used to create necessary documents.

For more detailed information and links to the different systems are given in the following paragraphs.

1.5.1   Planning portal used in Sweden

www.Planeringskatalogen.se

In Sweden, 'planeringskatalogen' is a public webtool with a search engine for information necessary for decision making in spatial planning. The purpose of the webtool is to compile all information produced by national administrative authorities which is relevant for community planning processes.

The webtool does not store the documents or files itself, but it stores information about the documents which build a basis for decision making processes. Beyond information provided by the producer of the files, other necessary information is added by editors in order to make the information available in a structured and searchable way. There are national editors who are responsible for the management of national information, and regional editors who are responsible for regional and local files. These editors collect new information files and evaluate if they are relevant for community planning, add information in the webtool and review all information at least once a year.

This webtool is very useful for everyone working with community planning as it helps to find relevant basis information for decision making for a certain area. The strengths of the webtool are that it gathers information from different producers in one place, and that it has a search function. National and regional administrative authorities use it as a platform to provide and disseminate their basis information for decision making.

The webtool has several search and filter functions. The filter function includes geographic areas to search within, legal aspects and specific subject fields. Available files are e.g. GIS-layers, Web Map Service (WMS), different documents or websites. The WMS can be previewed in the embedded map

view directly in the webtool but not the GIS-layers. With this webtool all relevant basis information for decision making becomes easily accessible which makes community planning more effective.

1.5.2 Planning portal used in Aland

https://www.kartor.ax/

'Landskapsregeringens kartportal' is a public webtool where planners and decision makers can find relevant information produced by administrative authorities on Åland. Landskapsregeringen is responsible for the webtool and makes sure that the information and data is up to date.

The webtool is rather new and still under construction, but the main purpose of the tool is to collect relevant information and data in one place. The decision makers and planner can use the information in the webtool as a foundation for different decisions. New data is added by the GIS responsible at Landskapsregeringen.

Everyone who is working with planning on land or at sea have good use of the webtool. It is especially useful for municipalities and other administrative authorities.

You can choose to either look at web map applications or search and download different data. The webtool contains different GIS-layers, WMS and WFS services of different subjects of interest. It is possible to preview the different layers in the webtool without downloading it first.

1.5.3 Planning portals in Latvia

https://tapis.gov.lv/

'Teritorijas attīstības plānošanas informācijas sistēma' ('TAPIS') is the main web-based information system for every level of spatial development planning in Latvia. The purpose of the spatial development planning information system is to ensure the compilation and public accessibility of spatial development planning documents of all levels and of information related to spatial planning. This tool ensures access to data used for the development of spatial development planning documents.

TAPIS provides 2 functions:

1) Tools for developing and creating planning documents
2) Tools for searching and viewing documents, and participation in the public consultation

The TAPIS workspace for planners provides the following functions:

- supporting the development/creation process of spatial development planning documents
- drawing up, publishing and maintaining data on the text and graphical parts of the spatial development documents of all planning levels
- the exchange of data with other national information systems
- public consultation/involvement
- receiving of electronic services

TAPIS is part of national geoportal *geolatvija.lv* (https://geolatvija.lv/geo/#/). Everybody can easily search for and receive text and graphical information regarding development spatial planning. Proposals can be submitted electronically for public consultations on the planning documents and one can sign up for notifications on documents of interest.

In the official state services portal *latvija.lv* (https://www.latvija.lv/), official documents and statements prepared directly from TAPIS can be accessed.

According to law every person involved in planning process has to use TAPIS. Every official or authoritative planning document has to be created in and/or uploaded to this system. Also, community members can use this webtool to follow planning processes or to find e.g. information, permissions or restrictions for certain areas.

Using the workspace for professional planners, TAPIS can be used to create complete planning documents including spatial information.

The following functions are available in TAPIS:

- searching by address, territory, cadastral parcel, creator of plan; name of plan
- showing document status -initial, public consultation, approved
- planning level – national, municipal, local
- embedding maps in a website
- sign up for notifications about planning process in territories of your interests
- get information about land use decisions
- switching on/off different GIS layers
- access to different planning documents
- WMS

1.5.4   Planning portals in Estonia

Estonia has web-based map portal: https://geoportaal.maaamet.ee/eng/Web-Maps-p35.html and detailplans. A lot of electronic data is publicly available at Maa-amet geoportal. It contains different GIS-layers, WMS and WFS services of different subjects of interest, which can be downloaded for personal or professional use.

The national web-based system is quite new. Collecting of detail plans started in 2017, so many municipalities have their own system that they use every day. For example Saaremaa: https://www.saaremaavald.ee/en/kaardirakendus or Tallinn: https://tpr.tallinn.ee/.

In the Coast4us project, Saaremaa municipality was using for idea gathering in the beginning of the planning process online webpage solutions. They had an online tool ArcGIS web app, an IT solution to gather local residents' ideas on a webpage, where residents could indicate what could be done better in the area and planners could use the results for compiling comprehensive plan.
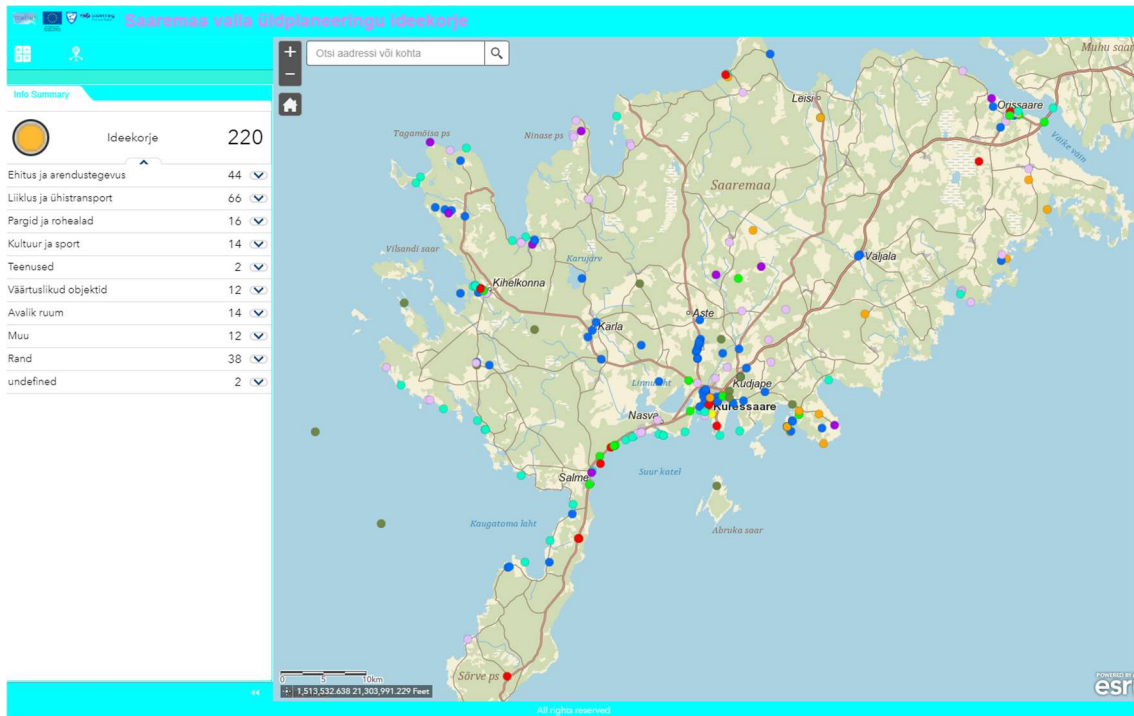
*Figure 3 Saaremaa Municipality used an online ArcGIS web app for their idea collection from local community (*https://saaremaavald.maps.arcgis.com/apps/webappviewer/index.html?id=107c836b88324a07867f528d2b110d09   *, screenshot taken 29.06.2020)*

During the whole planning process Saaremaa municipality used the ArcGIS tool and it was used to produce online layers for public usage on all levels, this work is ongoing but the Saaremaa municipality planning portal can be found on the following public webpage https://gis.saaremaavald.ee/portal/apps/webappviewer/index.html?id=c56db72cde9d40f68cb6f3ca7c04743b .
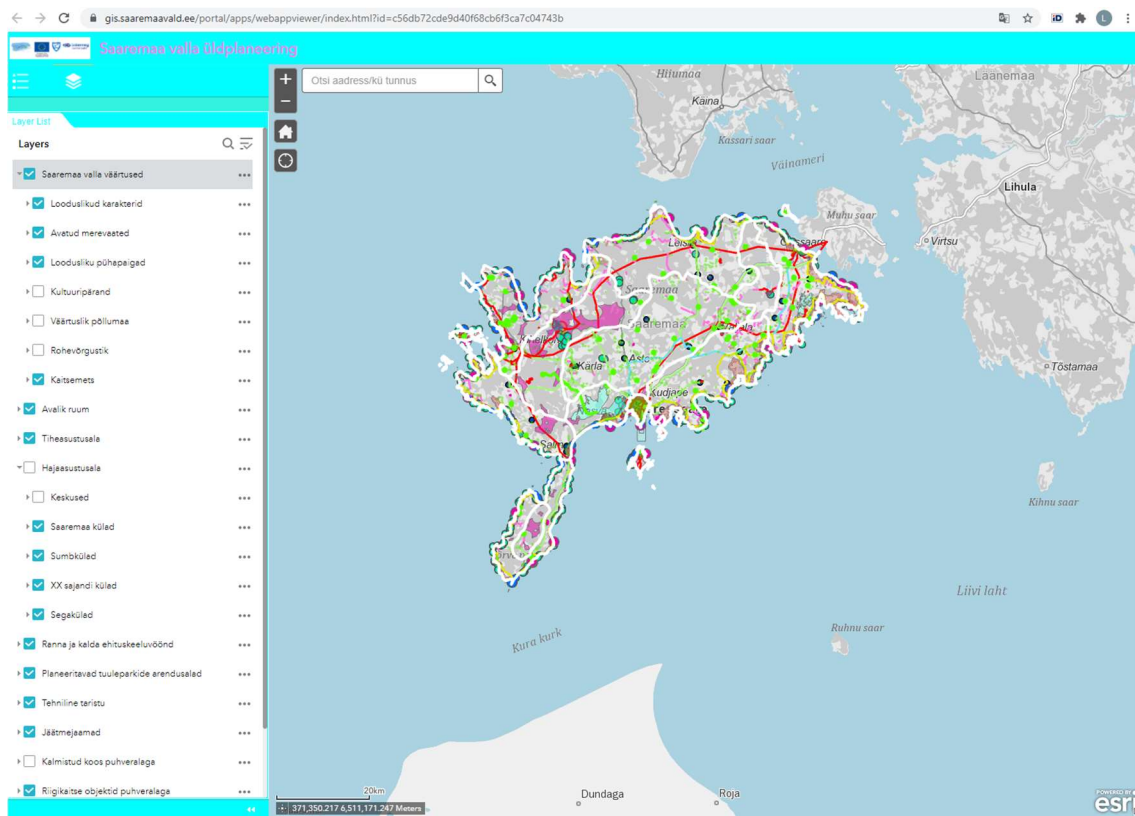
Figure 4 Saaremaa municipality comprehensive plan online maps (source https://gis.saaremaavald.ee/portal/apps/webappviewer/index.html?id=c56db72cde9d40f68cb6f3ca7c04743b, screenshot taken 04.09.2020)

1.6 Planning laboratory as a tool

More involvement from locals can be achieved by setting up a planning laboratory to introduce ongoing planning processes. This method was used in Latvia and Sweden, the following describes how this tool was used in the Coast4us project.

1.6.1 Description of the mobile planning tool used in Valdemarsvik, Sweden

Valdemarsvik municipality used new methods and alternatives to involve more people and share the information and plans. This was more time-consuming than the normal way to do the planning, but the goal was to get more commitment for the plan and thus reduce risk for appeals, which in the end can make the total time equal or less than normal procedure.

The tool to get more community involvement was using the Mobile planning laboratory.

Valdemarsvik had a number of events in the pilot area in order to collect input from all kind of people.

These events had a more or less open invitation for all people, and during the events a plan was presented where everyone was able to give feedback and ideas. The first event was more to collect ideas and the following was to get feedback on proposed ideas. The municipality also informed about ongoing work during a big festival to get even more people involved.

In addition to those open events, the plan was also presented to school children to get their perspective on the area.

The reason for all this was to facilitate and enable discussions between different types of stakeholders with different views, ages, and interests. This will also give potential opponents a chance to learn more about other opinions during the discussions, and thus not only "blame" the municipality in the end.

The municipality could act more proactive instead of being reactive.

On top of input from different stakeholders, additional knowledge was used:

- Additional GIS layers (sea level etc)
- More investigations and inventories made

The municipality set up the tool and arranged all meetings and laboratories. Target groups for the meetings were municipality, all types of stakeholders, and all people in or around the area, including day visitors.

Outcome and usefulness

The mobile planning laboratory tool was helpful. At least some of the events were successful. When using it next time, it may be slightly adjusted. It may be good also to think about more digital events.

The main reason to use this tool would be to handle conflicts of interests better, where people meet and can discuss. Also, it allows municipalities to get more background information and knowledge before setting the plan, which is a more sustainable way of working. Mobile planning labs help the municipality to better explain why things were included and excluded from the plan.

1.6.2 Description of the planning laboratory tool used in Carnicava, Latvia

In Coast4us, an information centre concentrating on the planning in the centre of Carnikava was constructed next to the council building on Stacijas Street (Figure 5). It was open to public in August 2020.

The information centre will provide information on the nature protection plan of the nature park "Piejūra", tourism activities of the county, and development projects planned. It is open to public and well received.

Figure 5 Planning laboratory in Carnikava (https://www.facebook.com/Carnikavasnovads/, visited 06.10.2020)

The main goal with this planning laboratory was achieved, as this project has increased the activities in Garupe village. Activation has raised the awareness of inhabitants that they can influence and promote the developments in their village.

Garupe village pilot plan priority activities under implementation were the following:

Electricity in Lielā street (pilot activity within Coast4us) and pavement of Lielā street (pilot activity within Coast4us) were done.

Wooden path through nature park to the coast (project application approved by Agriculture Support Service, funded by European Fisheries and Maritime Fund and Carnikava municipality).

In the election of a new board for a local cooperative, four times more people than usual participated– there were 146 participants. This shows that people are aware that the new board should be active in local development. All project activities were well received by public and the mobile laboratory as a tool was useful for information spreading.

All project results will be available in information centre (planning laboratory) and will be used by inhabitants, entrepreneurs, representatives of municipality, as well will be interesting for visitors and tourists.

1.6.3   Recommendations for future use of the tool

This tool should be mostly used by municipalities, but could also be used for other organisations when new a plan should be made for a place (How to develop an office, how to use a sports area, how to use a nature reserve etc).

In Valdemarsvik's case, the biggest obstacle was to get all stakeholders involved. Day-travellers were not represented as much as the permanent visitors, younger people were not represented as much as middle-aged or elderly people etc.

Also, the whole planning was very time consuming and involved more people from the arranging organisation (municipality). This was both for arranging the laboratories, but also to handle all incoming ideas and proposals.

It is also difficult to communicate to all involved parties in a good way, to give feedback on all incoming proposals etc, since those where much more than a normal planning procedure got.

It is hard to inform in a good way to get the right expectations from all people involved

The main benefit of the tool is that more of the community was included in the process, more people were involved and more information was shared. Also, input from more sources was received, which will give a wider perspective. Another benefit of the tool is that relations between the public and the municipality improved.

2 GIS as a tool for planners

A geographic information system (GIS) is a framework for gathering, managing and analysing data. Almost countless number of organizations in virtually every field, including governments related to sustainability, water, natural resources etc., are using GIS to make maps that communicate, perform analyses, share information, and solve complex problems around the world. GIS technology tools are used for understanding and collaboration.[2]

In Coast4us, one major part of the project was that partners would use GIS possibilities to collect, use, and share information. In the following, examples of GIS tools used in the project are given. The emphasis is on the cases where new GIS layers were generated.

2.1 Saaremaa municipality GIS layer for possible flood risk areas

The pilot area for applying GIS as a tool was the largest island in Estonia - Saaremaa, which is mostly flat and therefore prone to floods due to sea level rise. The constructed GIS layers of possible flood risk areas are based on modelled maximum sea level heights during period 1968-2015 in the coastal zone and LIDAR-based high-resolution digital elevation model (DEM) by the Estonian Land Board. The created layers were composed to present current and future climate scenarios, which allowed assessment of the re-occurrence (return periods) of maximum sea level.

Following GIS layers of flood risk areas were created:

1. Possible flood risk areas with present maximum sea level heights at return periods 10, 20 and 50 years;

2. Possible flood risk areas after 100 years when global sea level rises 80 cm with maximum sea level heights at return periods 10, 20 and 50 years;

3. Possible flood risk areas after 100 years when global sea level rises 100 cm with maximum sea level heights at return periods 10, 20 and 50 years.

Purpose of the GIS layer

Constructed GIS layers show where flooding could happen and are used in the planning process by Saaremaa municipality and other related decision makers:

1) In building area planning to avoid unnecessary development in risk areas;
2) Recreational area planning;
3) To help making better decisions in dealing with flooding;
4) To support emergency responders (evaluating risks);
5) To show different interaction of combined flooding sources (for example sea and rivers).

Similar flood risk area layers have been done by the Estonian Ministry of the Environment (https://www.envir.ee/et/uleujutused), but these are not based on numerical modelling and local measurements, also they are concentrated on overall Estonian flood risk areas and not in specific

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[2] Used material: https://www.esri.com/en-us/what-is-gis/overview

smaller scale areas. The tool applied in this project was to predict the potential changes in the sea level depending on the local characteristics of topography and coastline.

Data and methods

The development of the GIS layers consisted of multiple steps – sea level measurements using water level gauges, bathymetry measurements at Väike Väin strait, compilation of different external data sources (LIDAR-based DEM, Baltic Sea and Saaremaa area sea level and wind data, historical bathymetry data) and finally long-term modelling of global and local sea level changes. The GIS layers of the modelling results were compiled using ArcGIS (by ESRI) and Quantum GIS (by QGIS Development Team) software.

In order to produce the GIS layers, numerical modelling was performed and the final results from the model were converted to GIS layers.

The visual of the GIS layer
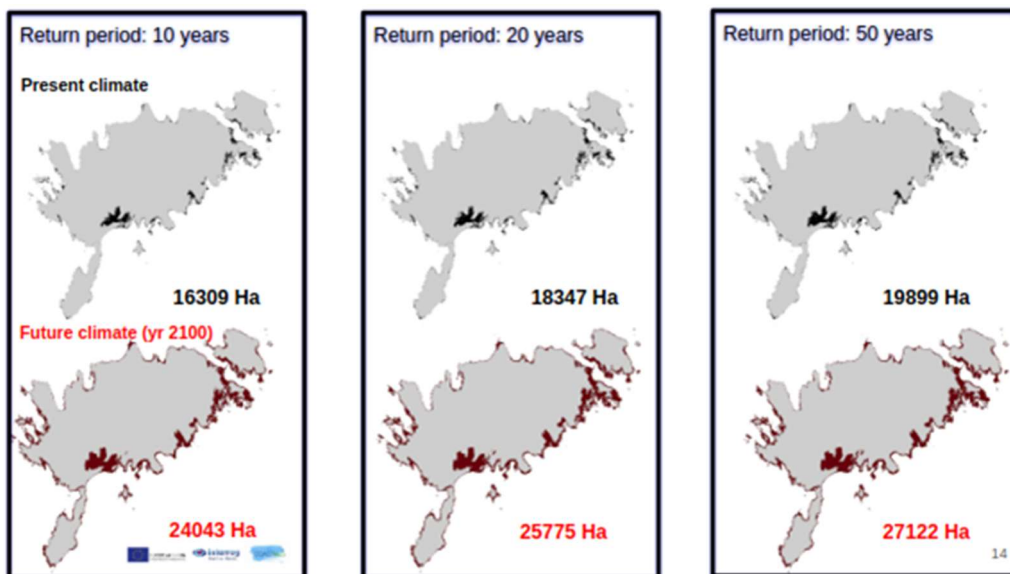
Figure 6 Possible flood risk areas at present and future climate scenarios when global sea level rises 80 cm with maximum sea level heights at return periods 10, 20 and 50 years.
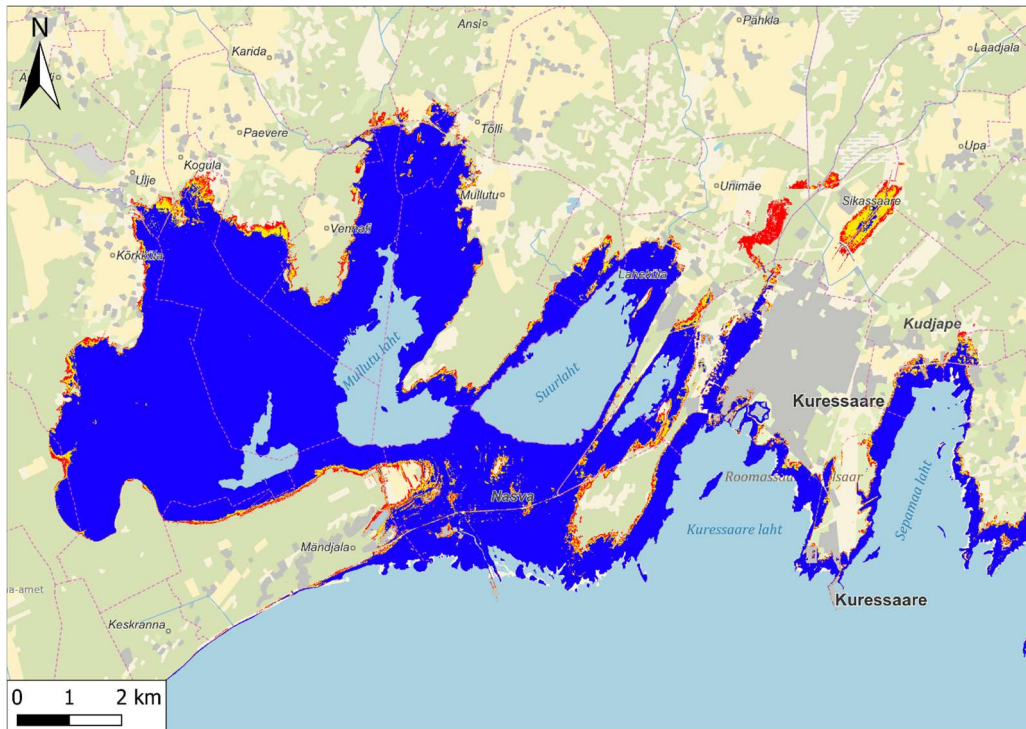
Figure 7 Possible flood risk areas in Kuressaare area when global sea level rises 80 cm with maximum sea level heights at return periods 10 (blue), 20 (yellow) and 50 (red) years.

Usage and recommendations

Saaremaa Municipality has used this predicted flooding area GIS layer in re-evaluating coastal exclusion zones in Saaremaa Island.
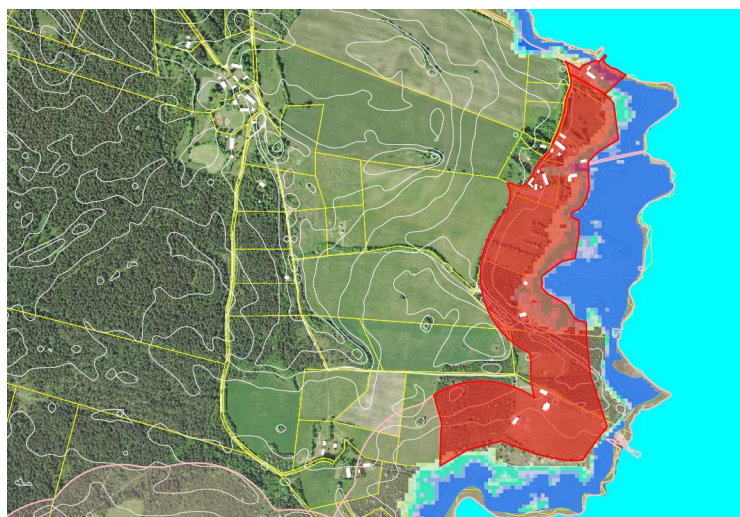

Figure 8 Illustration of building exclusion zone planning with GIS results, red indicates the area, where building restriction is needed according to the modelling results

Modelling and composing maps of different scenarios is always a good starting point for making decisions. Whether it is a building risk assessment or emergency system development, it allows one to see what may happen and prepare for the future.

2.2 Government of Aland GIS layer to develop green planning

From the Maptionnaire process a GIS layer of Mariehamn city was generated. The layer shows all the places where people like to spend time and what they do there, as well as places where people want a change and what kind of change they desired.

Purpose of the GIS layer – The layer was needed to further develop the green areas in Mariehamn and to get the opinions of the locals. Mariehamn city will later use the results in the GIS layer to develop a green plan for management of the green areas in Mariehman city.

Similar layers did not exist before this project. This knowledge was crucial for developing a good green plan for an area.

Data and methods – Mapping of local knowledge and opinions was used as source of data, other relevant background information was included.

Great emphasis was not placed on GIS work in Åland since there is already a good map data portal. However, they emphasized testing new tools to gain new knowledge areas and new ways of local collaboration. The municipality outsourced GIS experts, who produced the necessary maps from GIS databases.

The GIS layer visualisation

In the following, a description is given of the visualisation of people's favourite green areas, favourite spots where people go and development sites in Mariehamn area as a result of Maptionnaire.
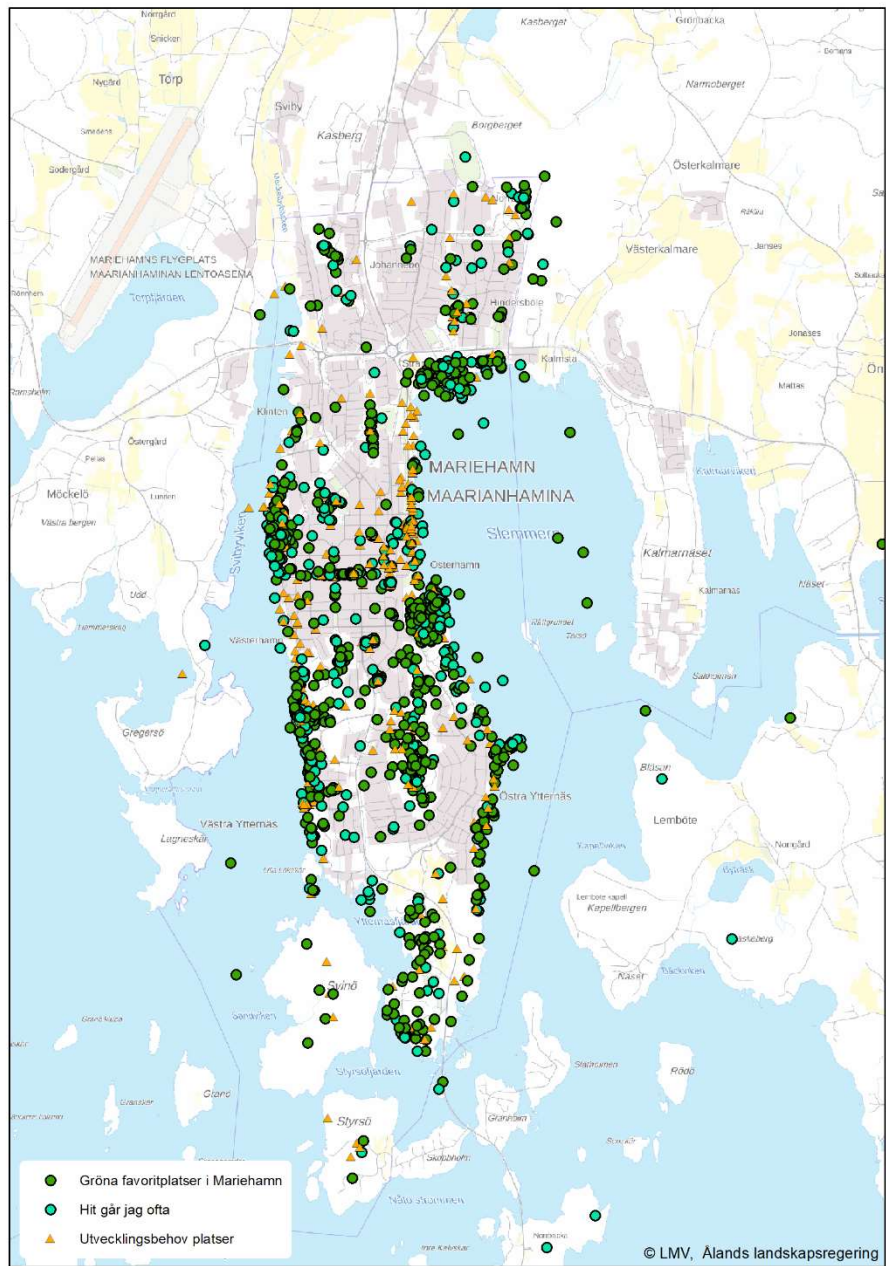
Figure 9 A result GIS map of Mariehamn showing peoples favourite greensnspots and development areas

Usage of GIS layers and recommendations

The GIS layer will be used in the project as an example of what can be done and where to develop the green areas in Mariehamn. Mariehamn city will later make the green plan based on the results in the GIS layer.

User-friendly GIS tools, such as Maptionnaire online map portal or Ecomapping in local small groups, work very well if you involve local people in different decision-making processes and planning. They can share their knowledge to help implement sustainable coastal zone planning where valuable ecosystem services are preserved in the long term. It is a way of considering the IPBES concept's decision model (this was included in Coast4us application), ie it is important to take advantage of local

knowledge in sustainable coastal zone planning. It is a way of seeking to fulfil the marine strategy's ecosystem approach. Coastal zones are valuable environments, we need their ecosystem services to have long-term sustainable communities that provide us with fish (without harmful substances), healthy bathing environments, recreation and tourism. Preserving ecosystems, establishing green and blue infrastructure in different environments contributes to the preservation of biodiversity, is part of climate adaptation (eg management of stormwater through green surfaces and flexible wetland solutions) and reduces emissions of eutrophic substances. We need healthy aquatic environments in our coastal communities.

Maptionnaire is a perfect tool for people to give their opinions on things quickly, easily, and anonymously, as long as you get the information about the process out to the public.

2.3 CAB Östergötland GIS layers – sea level rise estimations layer, layer *Potential shore meadows at year 2100*layer *Ecosystem services in the archipelago of Östergötland and others*

- **GIS layer for sea level rise estimations**

CAB Östergötland used GIS as a tool to generate a GIS-layer that shows which shore meadows in the archipelago of Östergötland are at risk of being flooded by sea level rise and disappear in the future. It also shows how much of today's shore meadow areas are at risk and at what sea level.

The GIS-layer covers the whole archipelago of Östergötland so it can be used by all the three Swedish pilot areas in Coast4us project.

Purpose of the GIS layer – There was a need for a sea level rise GIS layer because shore meadows are areas of high ecological value that should be considered by planners in the planning process. The location of today's shore meadows, the identification of areas that are at risk of disappearing, and the expected extent of a probable disappearance (due to future sea level rises) are useful basic data for planning. This data is valuable for decision processes on which shore meadows to take into extra consideration and protect from exploitation.

There were no existing GIS layers explicitly showing shore meadows. There is an existing national GIS layer for classification of nature, but this includes all types of nature and you have to know the classification code for shore meadows to be able to filter this information. The analysis of shore meadows at risk of future sea level rise had not been done before.

Data and methods:

- Selection of shore meadows from classification of meadows and pasture in protected areas
- National elevation data (Lantmäteriet, NNH grid 2x2) for the area of county of Östergötland
- Today's average sea level (Lantmäteriet fastighetskartan Vatten)

The GIS tool, which were used are: ArcGIS-tools as Reclassify, Raster Calculation and Union.

Four GIS layers with different sea level range (0-02m, 02-04, 04-06, 06-1m) were created from elevation data and today's average sea level.

Firstly, today's average sea level was converted from polygon to raster. Then, with the reclassify-tool and the whole county of Östergötland as extent, every cell representing sea got value 0 and other cells got value 1. This raster was combined with the elevation raster by raster calculation-tool with the phrase "elevation * sea". The result is one combined raster where sea has elevation 0 and land gets elevation value from elevation data.

With the Raster calculation-tool, a raster for every sea level range was made with the values 0,2m, 0,4m, 0,6m and 1m. Cells in the sea got these values and cells on land got 0 as value. Then we compared every raster of that four ones with the combined raster of elevation and sea using the Raster calculator-tool. The result is a raster for every sea level range with cells that are lower (value 0) than elevation or higher (value 1) than elevation. The cells with value 1 was extracted and converted to polygons, this is the areas that may be flooded.

An overlay between areas of flooding in different sea level range and shore meadows was done to see how much of which shore meadows is at risk to disappear.

An evaluation of existing data of meadows and pasture was necessary to find the best data to use. The GIS-analysis includes several steps of raster calculation and one process for every sea level range. Since there are different scenarios of sea level rises and all of them are uncertain, we chose to analyse and show results from different sea level ranges instead of scenarios.
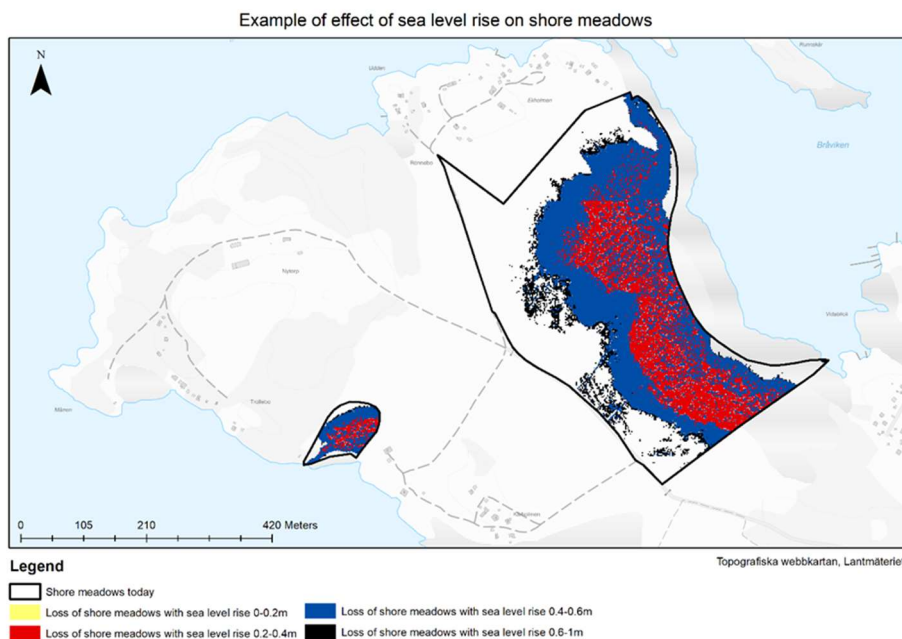
Figure 10 Illustration of sea level rise on shore meadows in Östergötland area

Usage of GIS layers and recommendations

The created GIS layers were used to investigate possible future wetland and phosphorus areas. This was much easier done with our new layer, and it will be much easier for municipalities to create their own local measurement plans in their own catchment areas. We can also create layers with areas that

are important to preserve for biodiversity from these newly created layers. Norrköping municipality has asked for this layer, but we do don't know if they have used it yet.

Planning can be done much easier with the right layers, it will save both time and money for local stakeholders. As long as other pilot areas have the required data, they could easily do the same analysis.

Hold yearly seminars in how to use these layers to make sure that the information is distributed. It is good do take into consideration that it is uncertain when and how much the sea levels will rise in the future, but IPPC is certain that it will rise.

- **GIS layer *Potential shore meadows at year 2100***

The created GIS layer and the pilot area where it is applied

This GIS-layer describes areas that have the conditions to evolve to shore meadows at year 2100. It is based on sea level rises which have been estimated by the Swedish Meteorological and Hydrological Institute (SMHI). It shows areas that have the same conditions as today's shore meadows except for the water saturation and distance to the sea shoreline.

The GIS-layer covers the whole archipelago of Östergötland so it can be used by all the three Swedish pilot areas.

Purpose of the GIS layer

Shore meadows are areas of high ecological value which planners need to consider in the planning process. The GIS layer "Effect of sea level rise on shore meadows" showed that some shore meadows will disappear with future elevated sea levels. This GIS layer on potential shore meadows in year 2100 can be used to plan for new shore meadows in order to conserve and create new shore meadows as areas of high ecological value.

The analysis of potential shore meadows with future sea level rise had not been done before.

Data and methods

Data that was used:

- Land use data
- Selection of shore meadows from classification of meadows and pasture in protected areas
- National elevation data (Lantmäteriet, NNH grid 2x2) for the area of county Östergötland
- Slope data
- Modelled average sea level at year 2100

An analysis of the criteria for today's shore meadows was done and used to find areas that could become shore meadows in the future. The criteria include that it has to be farmland or open areas with vegetation today, the slope must not be greater than 13,5 °, elevation must not be higher than 12 m over sea level and distance from the coastline must not be greater than 650 m.

By extracting areas matching these criteria from land use data, elevation data, slope data and then distance from modelled average sea level at year 2100 we got a result of areas that could become shore meadows in the future.

Common ArcGIS-tools like clip, erase, buffer and intersect.

<u>Process of creating the GIS layer</u>

First an analysis on existing shore meadows to see what criteria is needed. Then areas that match these combined criteria are extracted.

<u>Scenarios or other considerations (time scale, etc.)</u>

The data for average sea level at year 2100 is based on IPPC's highest scenario RCP8,5. This is an uncertainty that has to be taken in consideration when using the result. The sea level could become higher or lower and the time when it occurs can differ from the scenario.

The likelihood of future shore meadows decreases with grater slope and longer distance from coastal line. So even if the result show areas where shore meadows could occur, it is more likely that they will occur in flat areas close to the coastline.

The result does not include todays shore meadows, they are excluded (see Figure 11).

Other variables that future shore meadows depend upon are area ground sheet, plant life, and animal life, these variables are not included in the analysis. It is recommended to visit the areas to get the whole picture before planning.
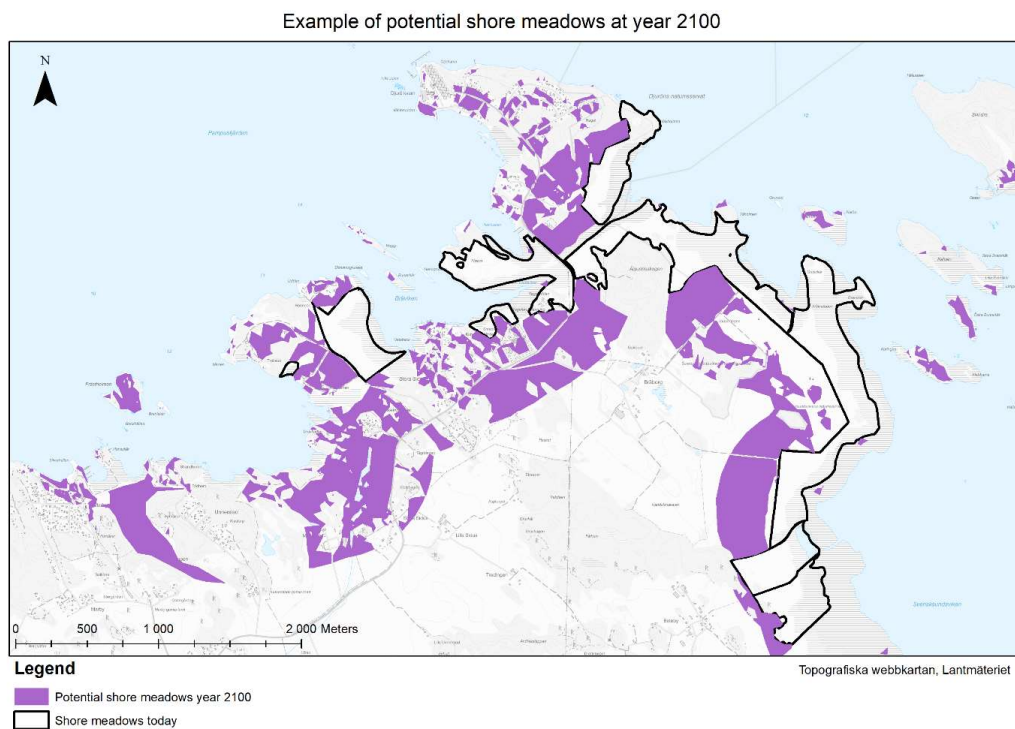
Figure 11 Potential shore meadows in 2100 in Östergötland area

Usage of GIS layer and recommendations for planners

As long as other pilot areas have the required data, they could easily do the same analysis. The results would be valuable for all coastal areas.

It is important to take into consideration that the shown areas of future shore meadows should not be considered as exact due to the uncertainty of future sea level and other variables that not are included in this analysis.

- **GIS layer *Ecosystem services in the archipelago of Östergötland***

The GIS-layer describes a valuation of the different habitation areas on land to decide each area's degree of ecosystem services.

The GIS-layer covers the whole archipelago of Östergötland so it can be used by all the three Swedish pilot areas.

Purpose of the GIS layer

The value of nature as ecosystem services is needed basic data so that planners can evaluate different interests in the planning process. There were no existing GIS-layers of ecosystem services in the archipelago of Östergötland.

Data and methods

Land use data was used. The method used is based on a previous analysis that the company Aquabiotas did for another coastal area in Sweden. The national land use cover was used and made to a raster. Cells were given the same ecosystem service values as in Aquabiotas method for the different land-use types. Lowest value is 0 and highest 25. Deciduous and coniferous forests get in this method high values of ecosystem services.

Common ArcGIS-tools like reclassify raster was used.

Process of creating the GIS layer

An extent of the area for archipelago of Östergötland was used to extract land use data to a smaller dataset. The cells in the raster were given other values with the tool reclassify according to Aquabiota's values. You can find the values in the last column in following tables, see Figure 12 and Figure 13.

Marktyp	Procent av ytan i kustområdet	Livsmedel	Vattenförsörjning	Biotiska råvaror (t ex fiberråvara)	Bioenergi	Renare luft	Lokal och regional klimatreglering	Global klimatreglering	Främjar biologisk mångfald	Biologisk kontroll av skadegörare	Bullerreducering	Vattenreglering	Pollinering	Friluftsliv och rekreation	Hälsa (t ex motion)	Landskapskaraktär (kultur- och naturarv)	Turism	Försörjande	Reglerande	Kulturella	summa
Lövskog	23.3%	1		1	1	2	2	2	2	1	2	2	1	2	2	2	2	3	14	8	25
Barrskog	8.9%	1		2	2	2	2	2	1	1	2	2	1	1	2	1	1	5	13	5	23
Blandskog	2.9%	1		1	1	2	2	2	2	1	2	2	1	2	2	1	1	3	14	6	23
Urbana grönområden	3.4%	1				2	2	1	2	1	2	2	2	2	2	2	2	1	14	8	23
Strandnära betesmark	8.7%	2		2		1	1		2	2	1	1	2	2	2	2	2	4	10	8	22
Vattendrag	0.03%	1	2				1	1	2	1		2	1	2	2	2	2	3	8	8	19
Frukt och bärodling	0.1%	2			1	1	1	1	2	1	1	1	2	1	1	1	2	3	10	5	18
Naturlig gräsmark	0.04%	1		1		1	1		2	1		1	2	2	2	2	2	2	8	8	18
Betesmark	2.7%	2				1	1		2	2	1	1	2	1	1	2	1	2	10	5	17
Sjöar och dammar	0.2%	1	2				1		2	1		2		2	2	2	2	3	6	8	17
Estuarier	0.1%	2		1			1	1	2	1		1		2	2	2	2	3	6	8	17
Kustlagun	0.2%	2		1			1	1	2	1				2	2	2	2	3	5	8	16
Gles stadsstruktur	9.5%					1	1		1		2	1	2	1	1	1	1	0	8	4	12
Myrar	0.8%			1	1		1	2				2		1	1	2	1	2	5	5	12
Saltpåverkade våtmarker	1.1%						2	2	1			2		1	1	2	1	0	7	5	12
Limnologena våtmarker	0.1%						2	2	1			2		1	1	2	1	0	7	5	12
Idrotts- och rekreationsområden	1.7%	1					1		1				2	2	2	1	2	1	4	7	12
Åkermark	17.4%	2		1	1	1			1	1			1	1	1	1		4	4	3	11
Hedmark	0.8%	1							2			1	1	2	1	2	1	1	4	6	11
Övergångstad. skog/buskmark	15.0%	1			1	1	1	1	1		1	1	1				1	2	7	1	10
Berg i dagen och blockmark	1.1%								2					2	1	2	1	0	2	6	8

Figure 12 Table of values for ecosystem services on land (in Swedish)

Ekosystemkomponent	Försörjande ekosystemtjänster	Reglerande ekosystemtjänster	Kulturella ekosystemtjänster	Steg 1b. Slutliga ekosystemtjänster
blåstång ≥ 10% tg	0	1	0	1
blåstång ≥ 25% tg	0	1	0	1
Höga undervattenskärlväxter ≥ 10% tg	0	1	0	1
Höga undervattenskärlväxter ≥ 25% tg	0	1	0	1
axslinga ≥ 10% tg	0	1	0	1
blåmussla ≥ 10% tg	0	1	1	2
blåmussla ≥ 25% tg	0	1	4	5
borstnate ≥ 10% tg	0	0	1	1
borstnate ≥ 25% tg	0	0	1	1
bandtång ≥ 10% tg	0	1	0	1
Östersjömussla (Macoma balthica) > 0 ind./m2	0	0	1	1
Områden med högre sannolikhet att fungera som lekområden för abborre (typ grunda vikar)	4	1	4	7
Områden med högre sannolikhet att fungera som lekområden för gädda (typ grunda vikar)	4	1	4	7
Områden med högre sannolikhet att fungera som lekområden för mört (typ grunda vikar)	0	0	1	1
Områden med högre sannolikhet att fungera som lekområden för sik	4	0	4	7
Tillhållningsplatser för gråsäl	0	0	1	1
Tillhållningsplatser för knubbsäl (östersjöbestånd)	0	0	1	1
Områden med ett årsmedel på >5 000 individer övervintrande fåglar (2004 – 2013)	0	0	4	4
Områden med ett årsmedel på >10 000 individer övervintrande fåglar (2004 – 2013)	0	0	4	4
Enl. RAMSAR kriterier internationellt viktiga områden för vigg och salskrake (övervintring)	0	0	4	4
Övervintringsområden för alfågel, medel konc.	0	0	1	1
Övervintringsområden för alfågel, hög koncentration	0	0	1	1

Figure 13 Values for ecosystem services at sea (in Swedish)

Scenarios or other considerations (time scale, etc.)

Since there are plenty of deciduous and coniferous forests in the archipelago of Östergötland most of the area gets high values (see Figure 14).
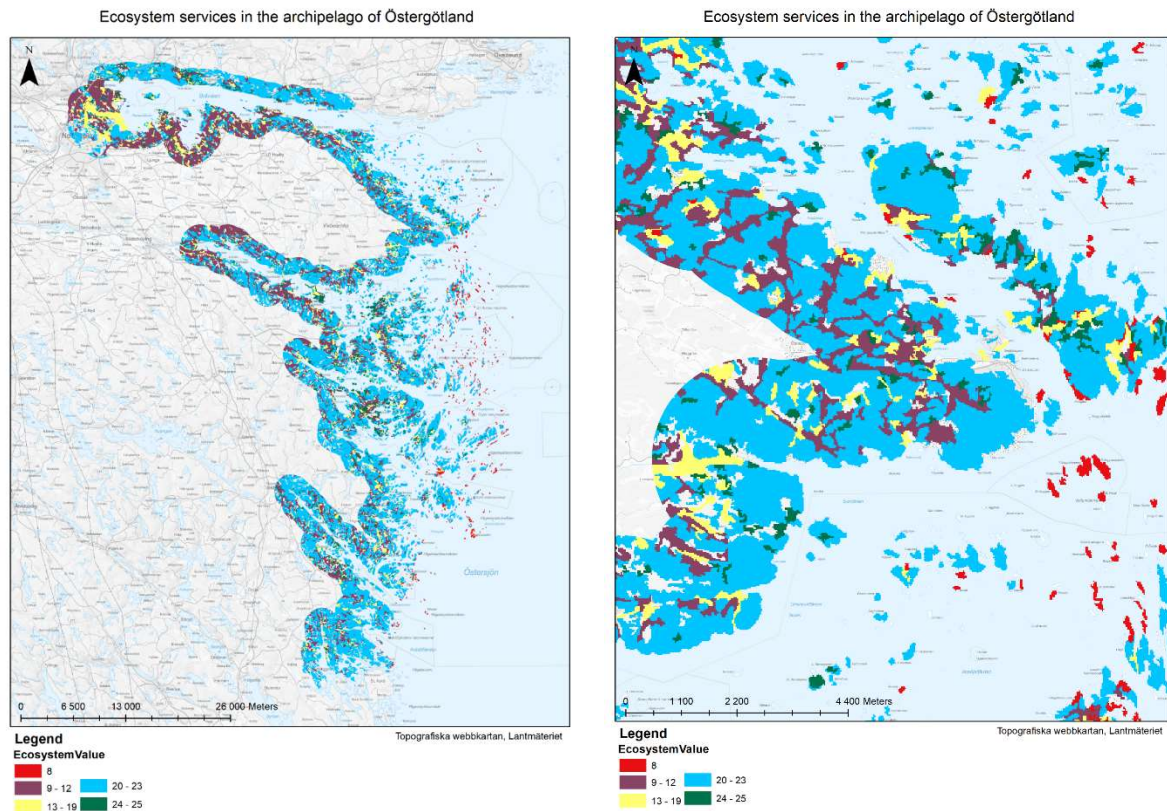
Figure 14 Ecosystem services GIS visualisation maps in Östergötlan archipelago area

Recommendations for the future

As long as other pilot areas have the required data, they could easily do the same analysis.

There were even more ecosystems services that are not included in this report, because they might need some other approach than GIS analyses. For example, the recreational value of swimming in clean water.

- **GIS layer for *Modelling of marine habitats***

Purpose of the GIS layer – The GIS layers show where different marine types of habitats are located. Submersed vegetation was simulated for the coastal area of Östergötland.

Data and methods – The distribution range of marine species and groups of species have been modelled (see Figure 15). The model0020is based on inventories and factors like depth and secchi depth.

Submersed vegetation is dependent on light for photosynthesis, thus the amount of light at the bottom of the sea is important for vegetation coverage. A map of high resolution secchi depth has been used in the model to make the vegetation coverage as precise as possible.

Use of GIS layers and recommendations – The GIS layers show where different marine habitats occur. Some of these habitats are important to protect. These areas are important habitats for the biological life of the Baltic Sea and should be considered in the planning process.

Rumslig modellering baserad på inventeringsdata från 2611 stationer. Områden med osäker förekomst visas i grå färg. Antal korrekt klassade stationer av förekomst respektive icke-förekomst anges inom parentes, varav antal stationer klassade som osäker förekomst/icke-förekomst inom hakparentes. Utvärderingen är baserad på totalt 2448 stationer.

Blåstång

Land

Fucus vesiculosus

>= 1% (489 [29] av 626 stationer, AUC: 0.95)
>= 10% (AUC: 0.96)
>= 25% (AUC: 0.95)
>= 50% (AUC: 0.89)
Ingen förekomst (1349 [151] av 1822 stationer)
[Osäker förekomst] (180 stationer)

Rumslig modellering baserad på inventeringsdata från 2611 stationer. Områden med osäker förekomst visas i grå färg. Antal korrekt klassade stationer av förekomst respektive icke-förekomst anges inom parentes, varav antal stationer klassade som osäker förekomst/icke-förekomst inom hakparentes. Utvärderingen är baserad på totalt 2448 stationer.

Kräkel

Land

Furcellaria lumbricalis

>= 1% (490 [38] av 614 stationer, AUC: 0.93)
>= 10% (AUC: 0.95)
>= 25% (AUC: 0.97)
>= 50% (AUC: 0.97)
Ingen förekomst (1496 [99] av 1834 stationer)
[Osäker förekomst] (137 stationer)

Figure 15 Example visualisations of Marine habitats modelling results GIS layers. Spatial modelling was based on inventory data from 2611 locations. Areas with uncertain occurrence data are shown in gray. The number of classified locations are in parentheses, of which the number of areas with uncertain occurrence data are in brackets. The map is based on a total of 2448 locations.

- **CAB GIS layer for *Fish reproduction areas***

Purpose of the GIS layer – The information is needed to be able to determine the location of important areas for fish reproduction.

Data and methods – Inventories of fish were carried out at 40 locations in the coastal area of Östergötland to identify important locations for fish reproduction (see Figure 16). The results are analysed and classified as high or low importance for fish reproduction.

Use of GIS layers and recommendations – The areas that correspond with high occurrence of fish reproduction are of high importance to protect. These areas are important habitats for the fish population of the Baltic Sea and should be considered in the planning process.
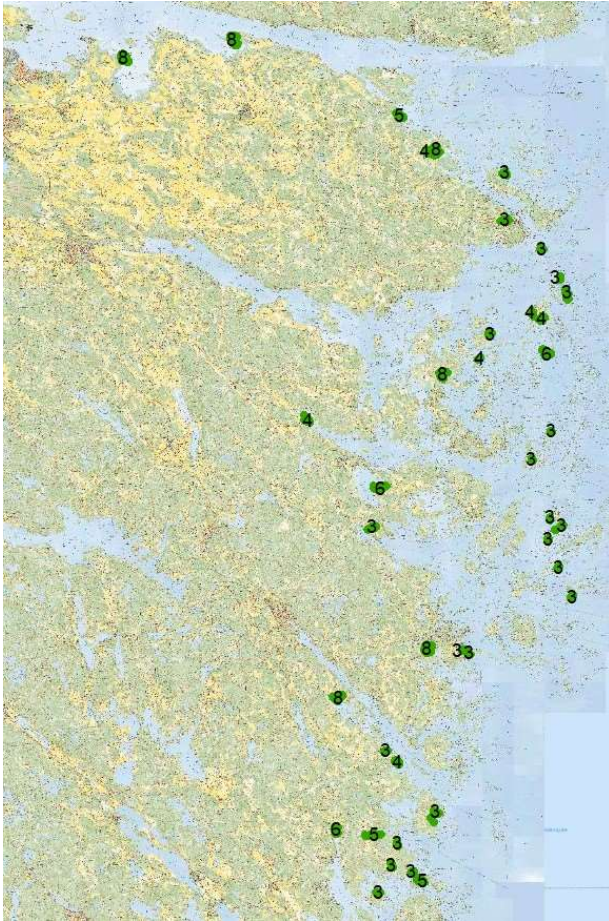
Figure 16 GIS layer visualisation of fish reproduction areas in Östergötland coastal area

- **CAB GIS layer for *Local water management plans***

Purpose of the GIS layer – The local water management plans show where in the local catchment area additional measures are needed to reach the water environmental standards set by the Water Framework Directive.

Data and methods – Local water management plans were carried out for the pilot areas. In all pilot areas 1) the environmental problems were identified, i.e. eutrophication, 2) the needed actions, i.e. reduction of nutrients, were calculated and analysed, and 3) measures were suggested to help the waterbodies reach the water environmental quality standards. This was carried out through GIS work, water analyses and field work in the pilot areas (see Figure 17).

Use of GIS layers and recommendations – To meet the requirements of the Water Framework Directive, and the water environmental quality standards, a plan for measures is needed for each water body. These plans should be considered in the planning process so that adequate space is set aside for the measures needed in the catchment area.

Figure 17 GIS layer visualisation of Arkösund catchment area

2.4   Valdemarsvik municipality spatial planning GIS layers

Purpose of the GIS layers:

1. Base map - A base map is standard in all Swedish detailed planning. The base map consist of different geographical information, such as height curves, property boundaries, existing building etc. The base map for Ekön is created by Metria AB

2. Nature value inventory - useful for determining sustainable land use in areas with regards to the nature values on Ekön. The Nature value inventory was created by a Consultant called Ecocom.

3. Sea level rise +2,70 m - Useful for predicting consequences in regards to Rising sea levels and create a proposal that is in accordance with these Changes. GIS-data was delivered by CAB.

4. Storm water investigation - Useful for illustrating the storm water solution in regards to proposed cottages. This data was created by a Consultant called ÅF.

5. Detailed development plan layer - this layer is the final Product of all the information gathered through the process. By analysing all existing GIS data the municipality create a plan using a software called Geosecma for ArcGis.

Data and methods – The method to gather needed data was making an inventory on site and also digital analysis of the area. The municipality used Geosecma in order to create the planning proposal (see Figure 18 and Figure 19).
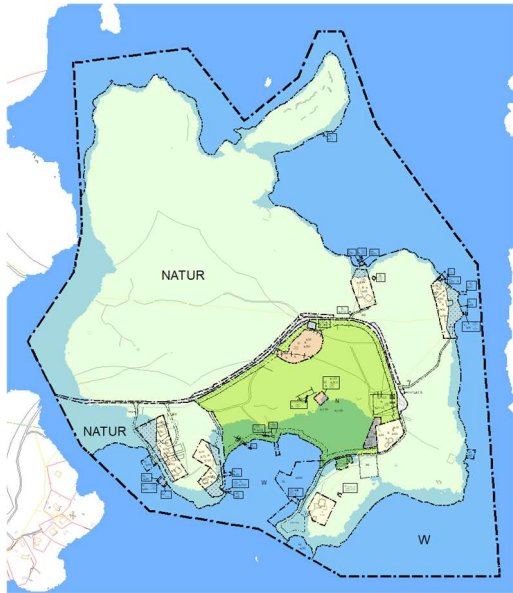
Figure 18 Water level rise prediction in Valdemarsvik
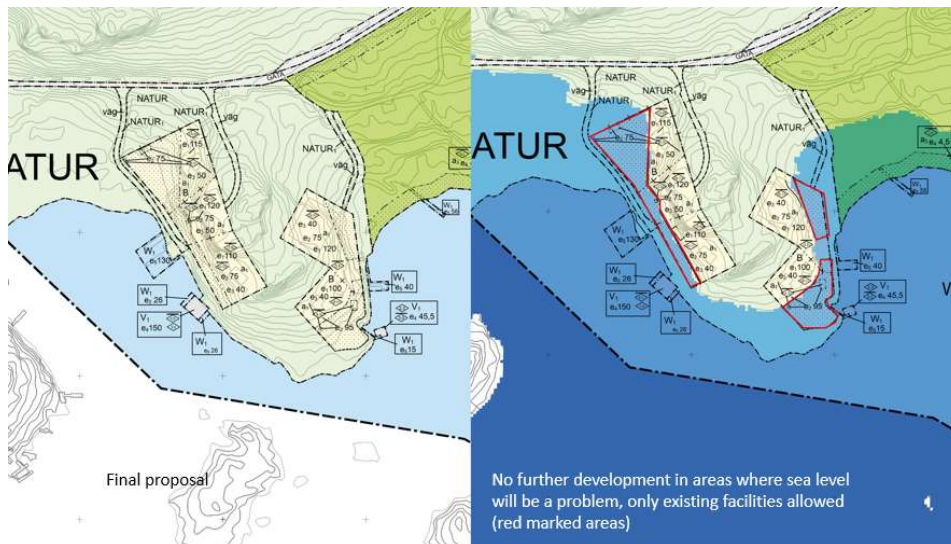
Figure 19 A visual of Valdemarsvik GIS layer as a base for spatial plan, which gives clear indication where planning cannot take place due to future sea level rise

Usage of GIS layers and recommendations

The main use of GIS was generating a spatial plan based on GIS layers.

The main recommendations for using GIS as a tool is to use all kinds of input and use it as much as possible. By involving more people, you get more information about where interesting places are and what they are used for today, and this can enhance the plan. (i.e. places where people have spontaneous campfires can have an organised campfire installed). Adding all information on GIS layers will make this and future plans much more rigid and correct.

2.5 Bergön 3D GIS model of the island

Purpose of the GIS layers – Bergön island's goal in was to laser scan the island and generate a GIS 3D-model of the island, which could be used in further planning process. This goal was achieved.

Data and methods – Data from laser scanning was used to produce a GIS 3D-model over the project area (island). The 3D-model was made accessible on the web for anyone to use – zoom, rotate, pan, tilt etc. It was draped with a high resolution ortophoto. The model was used for planning development of the island in detail. Together with contours, 0,5 m interval, the dramatic and varied topography was visualised. Visibility/views from the island was roughly estimated from the model.

Bergön used a consultant who producing the GIS 3D-model from laser scanning data and ortophoto (see Figure 20).

The outcome was a 3D model, which is a useful material because it can be used online and one must not be on the island to see the full scale of the island itself.

Figure 20 GIS 3D visual of the Bergön island, source http://3d.falo.se/radar_bergon3/

Usage of GIS layers and recommendations

This tool should be used by anyone involved in planning development, especially for the dialogue-process. Future development of the site might be added to the 3D-model.

The main obstacle while using the tool is that special experts need to set up and add features to the model, but when running anyone can use it.

The main benefit of the tool is that one can gather around the virtual model and make decisions together. The 3D-model helps the memory from having been at the site and people who haven't been there might get a good look.

2.6 Norrköping municipality cultural GIS layer

The main target was reached as Norrköping's existing cultural GIS layer in the database, containing information about buildings and their history, has been improved and supplemented with newly surveyed objects in the pilot area around Arkösund.

Purpose of the GIS layer – The GIS layer was needed for city planners, detail planning, and comprehensive planning. The building permits department use this data in their daily work. It is accessible through our internal web map platform (see Figure 21 and Figure 22).

Similar GIS layers existed but data was supplemented with newly surveyed objects and there was some effort put in to making the presentation and user interface easier for users and surveyors.

Data and method – Existing cultural data layer from the database was used as the input data. Field surveys and interviews on location were performed to complete the existing material.

Tools used in this part of the project were the following: FME (Feature Manipulation Engine, swiss-army-knife for data processing), QGIS (Open Source GIS-tool), a self-developed field survey web application, Excel, SpatialMap CSM (commercial web map platform).

The main thing while creating the GIS layer was the adjustment of data to fit the existing data model using excel and FME.
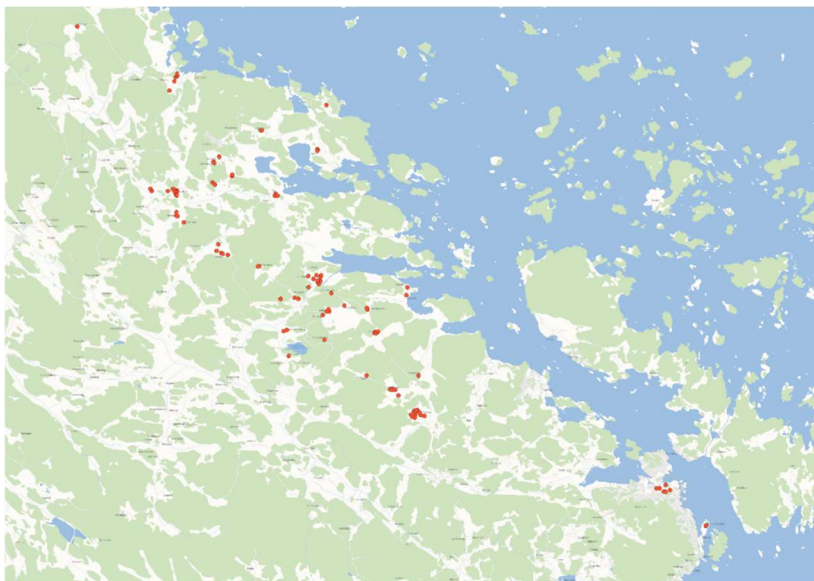
Figure 21 Inventory of the historic buildings in the Arkösund area

Figure 22 Map of Jonsberg, Arkösund and some new objects as a result of the project

The idea of the new configuration of the presentation of the GIS layer in the web map is to gather four different data sources into one layer/presentation to make work easier for the planners, investigators, and consultants (see Figure 22).

- o The classification of buildings depending on historical, cultural, environmental or artistic importance. 5 different classes available. See the 5 bottommost rows in legend above.
- o Buildings with monumental status and their sanctuary. Decided by Länsstyrelsen, Sweden. (row 1 in legend)
- o Buildings with monumental status and with uncertain sanctuary in decision. (row 2 in legend)
- o Real Estate where question was raised about monumental status. (row 3 in legend)
- o Area evaluated as especially valuable from historical, cultural, environmental or artistic point of view. Protected by Swedish law: PBL ch8, 13§.(row 4 in legend)

Usage of GIS layers and recommendations

Experiences of creating this GIS layer can be summed up in following points:

- Generally, try to make the data as accessible as possible, then it will be used.
- Try to gather culturally related data in one source if possible. Easier to manage and maintain.
- Facilitate for the administrators by collecting and presenting data in one layer/one presentation.

2.7 Carnikava municipality GIS layers (project layer, infrastructure and vegetation layers)

In the Coast4us project, Carnikava municipality created GIS layers – Projects; Street; road infrastructure – Road signs; Road signs; horizontal signs; Road survey and problems; Driveways; Vegetation and improvement – Amenities and Engineering communications – Communication networks. These layers did not exist before the project and were uniquely generated during this project.

Previously there existed the following GIS layers - Engineering communications – Lighting; Household sewerage; Rain sewerage and Water supply; Municipal data; Protection zones; Address; Functional area.

Purpose of the created layers

The layer *Project* was needed to update all the information about projects- what has been done and what is planned- in Carnikava county in one GIS layer. The layer provides basic information about specific projects.

The layer *Street, road infrastructure* ensures compliance with Cabinet Regulation No. 1052 "Procedure for Registration and Accounting of Municipal Roads and Streets" and preparation of the planned reports.

The layer *Communication networks* was needed for convenient and transparent information about communication networks.

The layer *Vegetation and improvement* ensures effective planning and monitoring of the territory improvement.

Data and methods used

In the layer *Projects,* information was entered about the most significant and topical projects in Carnikava region. Information about the projects and their current issues for supplementing the GIS layers was analysed and used.

In the layers *Street, road infrastructure* and *Communication networks,* the information was taken from the topographic map.

In the layer *Vegetation and improvement,* the information was entered according to the spatial guidelines of the territory survey and improvement.

QGIS program, digitization and mapping was used for project input.

<u>Process of creating the GIS layers</u>

- 30 objects with descriptive information have been added to the GIS layer *Projects* (see Figure 23 and Figure 24).

- In the GIS layer *Street, road infrastructure,* 400 roads *were* added (see Figure 25), including information on road maintenance and inspection works (see Figure 26), and a street register was created .
- In the GIS layer *Communication networks,* all current information about the communication network in Carnikava region was entered (see Figure 27).
- In the GIS layer *Vegetation and improvement,* lawns, sidewalks, and public transport stops were added(see Figure 28). A register was created with bench types, waste bin types and site equipment types (see Figure 29) and a layer was created for the visual guidelines of the amenity (see Figure 30).

In the GIS layer *Projects,* one can add and edit information about object address, title, date of realization, the actual date of realization, realization status, type of project, building permit number and date, project theme. Authority specialist can enter information about project customer, project builder, project construction supervisor and project author supervisor, also information about source of funding, its total amount, financing agreement and distribution of funding between funders. Authorities can enter information about public consultation about object. Also, attachments can be added such asimages, documents, and links.
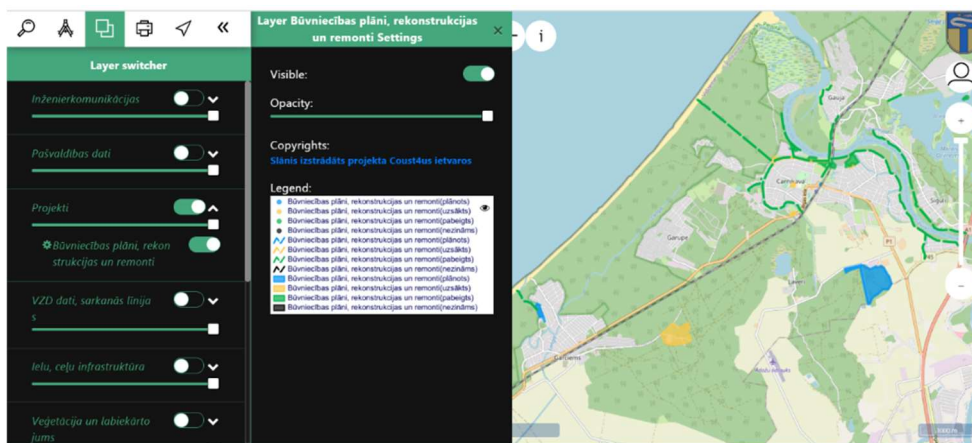
Figure 23 GIS layer Projects in Carnikava county.
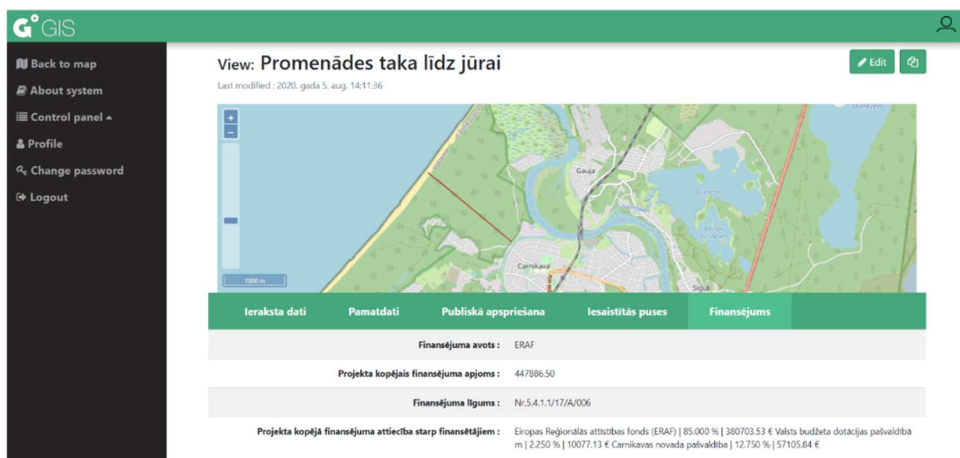
Figure 24 GIS layer Projects information about object "Promenādes taka līdz jūrai"

In the layer *Street, road infrastructure,* one can add and edit information about street names, type of pavement, last survey, condition, road group, the village name where the street is located, and length.
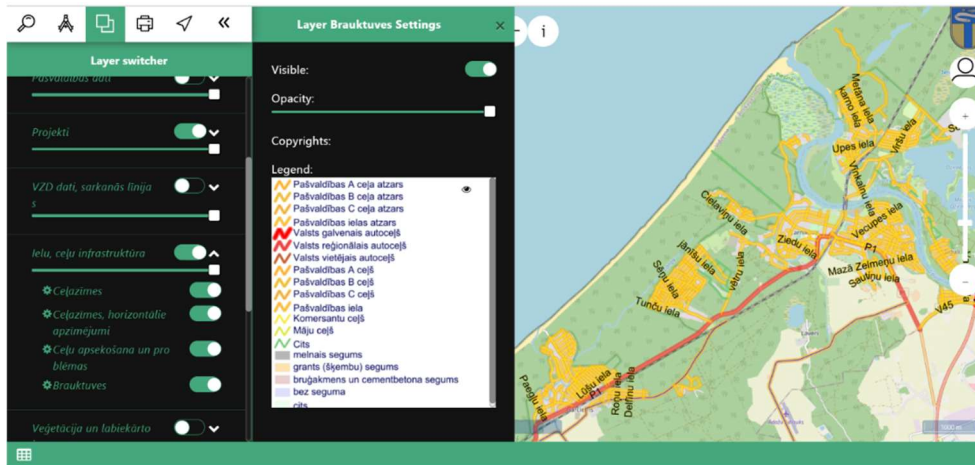
Figure 25 GIS layer Street, road infrastructure in Carnikava county

Figure 26 GIS layer Street, road infrastructure – road inspection and maintenance logbook

In the layer *Communication networks,* one can add and edit information about video cameras, switch cabinet, switching equipment, communication cables, communication cable brands, and types of equipment.

GIS layer - "Communication networks" in Carnikava county
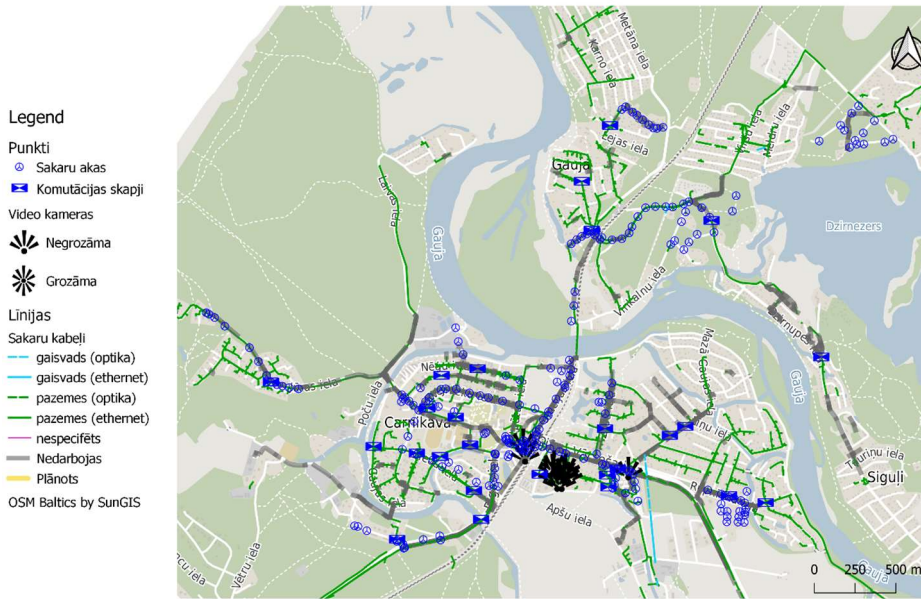
Figure 27 Layer Communication networks in Carnikava county

In the layer *Vegetation and improvement – Amenities* one can add and edit information about lawns, flower beds, flower pots, active recreation areas, field equipment, sidewalks and road curbs, sidewalks, bicycle lanes, bicycle sheds, benches, waste bins, and public transport sheds.

Figure 28 GIS layer Vegetation and improvement in Carnikava county

Figure 29 GIS layer Vegetation and improvement - register of types field equipment in Carnikava county
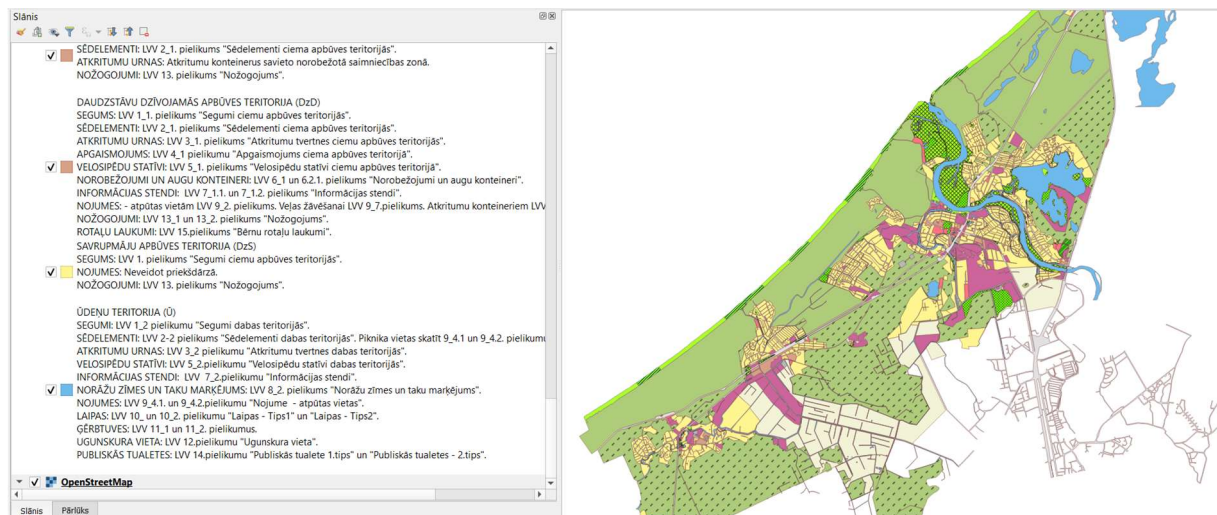
Figure 30 GIS layer Vegetation and improvement - Visual guidelines for the amenity by zones in Carnikava county

Use of GIS layers and recommendations for the future

GIS layers provide the necessary information about the progress of the project to municipal employees and provide basic information to the public about the completed projects in the region. The GIS layer *Projects* is displayed on the screen in the information centre. The layer *Projects* ensures informing the public about the development of Carnikava county. The layers *Vegetation and improvement*, *Communication networks*, *Street, road infrastructure* ensure efficient municipal data management and facilitate access to information.

The possibility and need to create a map of a geospatial information system should be considered in order to ensure the creation of different layers and the availability of information to the public.

3   Results and recommendations

There are many different tools that can be used by planners during the different phases of planning. Each tool could give new knowledge about how to interact with different target groups and why it is so important. In the Coast4us project, various tools were used, and here we discuss the general pros and cons of their use.

While using **LEA as a tool** in planning, it could be used by local groups that are well-rooted in the community. The main obstacle for using the tool might be not having a broad foundation and a clear sense of ownership locally. Continually, there is a need for a transparent process.

The main benefit of using the LEA tool is to have a local commitment and access to local knowledge. Using this tool gives a place an identity that builds pride in the local community.

Interaction with target groups during the planning process via a digital tool like **Maptionnaire** was a great way to map people's desires, especially when public meetings can't be held because of the coronavirus. Local representatives received over 400 responses in the Maptionnaire survey, proving it to be a very productive tool for public involvement.

Eco-mapping was a great way to get people to share their views and identify the shortcomings they have seen regarding planning/government decisions in the past. The eco-mapping process is more time-consuming than the Maptionnaire process both for planners and for the general public.

The main obstacles to using the tools are many procurement procedures by the authorities, planning and work is required to distribute information in the media and on websites. It takes work and patience to involve many parts in one process.

The main benefit, however, is that eco-mapping and Maptionnaire provide good local collaboration and early implementation, leading to greater consensus on necessary planning and the importance of preserving ecosystem services.

TalTech used **mathematical modelling** as a tool for helping planners. Developed modelling tools have helped predict the potential sea level change at the coast of Saaremaa and make scenario calculations regarding the impact of dam openings and aquaculture development. This tool based on numerical modelling was applied in different planning phases.

Mathematical modelling as a tool is very good and precise, but a challenging aspect is that this tool needs skilled professionals who have some background in computational fluid mechanics and especially with state-of-the-art numerical models (NEMO, GETM, ROMS, etc.). The biggest obstacle for extensive use is that it can only be used at HPC (high-performance computing) centre or on computers with large memory and computational power available.

The main benefit of using modelling tools is that the models can simulate possible future scenarios and give quantitative indications for decision-makers what future scenario would be most sensible.

Riga Technical University has developed a **GIS prototype for small village planning**. The next step is creating the application tool for villages by including the data sources. The main obstacles to using this GIS prototype planning tool is that the data sources often needed in such planning are not open to the public. However, the main benefit of the tool is that it contains 3D dynamics, including infrastructure layers, social and economic layers. Still, the tool works best if the village has all the needed available data input.

In Sweden, Åland, Latvia, and Estonia, national **online web toolboxes** for planners are available, where planners can get national public data, usually by using WMS of WMF servers (www.Planeringskatalogen.se; https://www.kartor.ax/; https://tapis.gov.lv/; https://geoportaal.maaamet.ee/eng/Web-Maps-p35.html). Using publicly available data and connecting that with their own generated data, area-specific online web tools can be generated via using special GIS programs, for example, ArcGIS online. In the Coast4us project, Estonia and Latvia generated new web-portals for their project areas:

- Saaremaa municipality comprehensive plan for public viewing: https://gis.saaremaavald.ee/portal/apps/webappviewer/index.html?id=c56db72cde9d40f68cb6f3ca7c04743b
- Carnikava and Salacgriva municipalities: https://gis.carnikava.lv/ and https://gis.salacgriva.lv/

These online web toolboxes and portals are all very good and can widely be used. As most of the data is available online and can freely be downloaded, then the main task for a local municipality is to find and hire a GIS specialist who is fluent in, for example, the ArcGIS Pro program, and it is not difficult to generate public online tools for multi-purposes.

Another tool that was used in this project was the **planning laboratory**, that was executed differently in different places. For example, in Carnikava Latvia, an actual planning information centre was built, where people could gather and look at the current and future plans. In Valdemarsvik Sweden, several full-day events took place using a pop-up tents and sharing planning information materials with the local community. These events brought together local people, introduced the new plans in the area, and asked opinions about the planning ideas.

The main benefit of the planning laboratory tool is that more of the community can be included in the planning process – more people involved and more information shared. Also, input from more sources can be achieved which will give a wider perspective. Another benefit is that the relationship between the public and the municipality can be improved. The main reason to use this tool would be to handle the conflict of interests better, by providing space where people can meet and discuss.

However, on the challenging side, it can be stated that the whole process from making this laboratory and preparing such an event is time-consuming and it will need proper preparation time to reach stakeholders and later on to track their views on the matter.

A relevant part of Coast4us planning activities involved the use of a **geographic information system (GIS)** multifunctional tool. GIS is a framework for gathering, managing and analysing data. Nowadays, countless organizations, including local municipalities, use GIS as an everyday tool in their work. GIS is used to make visual and understandable maps that communicate, perform analysis, share information

and can therefore point out possible conflict areas for planners. The main benefit of using GIS as a tool is that online maps are easily viewable and sharable. Even though ArcGIS program or other similar programs need some skills to produce the necessary maps – like for example about the water level in the coastal area, nature zones, roads, infrastructure or historic culture areas in the region – once the maps are done it is easy to share the different layers and views with the wider audience and stakeholders. In Latvia, for example, high-quality publicly accessible maps including information that was previously not so easily available were generated.

GIS online tools have capabilities not only to view the maps but also to ask for input from the public. For example, Saaremaa municipality used an online GIS website to ask public about their ideas for the comprehensive plan. During the process, people could access the online maps of the region and add points of interest with description to the site. Similarly, Åland produced, using the Maptionnaire process, a GIS layer about Mariehamn city showing all the places where people like to spend time. Like in the Saaremaa case, the spots were put on the map by people via an online version.

GIS has a great variety of uses Besides making current situation maps, future prediction scenario maps can also be made. The visualisations (for example, water level rise scenarios) can give valuable information to planners such as where and why, for example, restrictions can be added or taken off.

A unique possibility of the GIS tool is the 3D visualisation of the area, which gives an even more vivid and nice view of the area. In the Coast4us project, a good example of this was the Bergön island visualisation, which included the whole island.

In conclusion, GIS as a tool has one small challenging aspect but has many great benefits. The only disadvantageous thing is that it takes some time to gather the base data and to generate the maps by a specialist who is good in GIS programs (like in the ArcGIS program). However, the program is not very hard to handle and with good intentions it can be mastered easily, especially as it is a very versatile program and modern planners use it daily.

Therefore, the GIS tool has mostly the benefits and can be used to generate good and understandable visualisations about the current situation and possible future scenarios in 2D or even in 3D. A valuable recommendation to future GIS users is to gather culturally related data, nature data and all other necessary data in one source, if possible. It is much easier to manage and maintain the data and to generate various maps later. Also, always check for national information available online that can be combined with your data to make new maps.

The main advantage is that the generated maps can easily be shared online and used for public involvement. GIS, as a tool, can be recommended for all planners for making their work more effective and easier.

It can be said that there is a wide variety of tools for planners to use nowadays to make their work easier and the outcome easier to explain and, thus, be understood by stakeholders. Although the range of tools is wide, most of them in some way available online and GIS possibilities for mixing different tools might give the best results. This is the new age of modern planning of a sustainable future.

Used materials

- Bergön island 3D model http://3d.falo.se/radar_bergon3/
- ESRI official website https://www.esri.com/en-us/what-is-gis/overview
- G-J. Hospers, J- Syssner, "Dealing with Urban and Rural Shrinkage: Formal and Informal Strategies", 2018 https://www.researchgate.net/publication/322697545_Dealing_with_Urban_and_Rural_Shrinkage_Formal_and_Informal_Strategies Chapter 8, page 109
- https://geoportaal.maaamet.ee/eng/Web-Maps-p35.html
- https://www.facebook.com/Carnikavasnovads/ , visited 06.10.2020
- Kalinka, M., Geipele, S., Pudzis, E., Lazdins, A., Krutova, A., Holms, J.,: Indicators for the Smart Development of Villages and Neighbourhoods in Baltic Sea Coastal Areas. *Sustainability 2020, vol 12(13), viewed 23.11.2020, https://doi.org/10.3390/su12135293*
- Landskapsregeringens kartportal https://www.kartor.ax/
- Neumann, T., Fennel, W., Kremp, C.: Experimental simulations with an ecosystemmodel of the Baltic Sea: a nutrient load reduction experiment. Global Biogeo-chemical Cycles, 16 (3). doi:10.1029/2001GB001450, 2002
- Saaremaa municipality comprehensive plan https://gis.saaremaavald.ee/portal/apps/webappviewer/index.html?id=c56db72cde9d40f68cb6f3ca7c04743b , visited 04.09.2020
- Saaremaa municipality idea gathering https://saaremaavald.maps.arcgis.com/apps/webappviewer/index.html?id=107c836b88324a07867f528d2b110d09 , visited 29.06.2020
- Teritorijas attīstības plānošanas informācijas sistēma ('TAPIS') https://tapis.gov.lv/
- www.Planeringskatalogen.se