REGINA

Remote communities & resource-based industries

REPORT 2017:1

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Cover photo: Calum Davidson, June 29 2016,
Flying over Easter Ross in June, Nigg and Cromarty

REGINA project
Nordic co-operation is one of the world's most extensive forms of regional collaboration, involving Denmark, Finland, Iceland, Norway, Sweden, and the Faroe Islands, Greenland, and Åland.
Nordic co-operation has firm traditions in politics, the economy, and culture. It plays an important role in European and international collaboration, and aims at creating a strong Nordic community in a strong Europe.
Nordic co-operation seeks to safeguard Nordic and regional interests and principles in the global community. Common Nordic values help the region solidify its position as one of the world's most innovative and competitive.

The Nordic Council
is a forum for co-operation between the Nordic parliaments and governments. The Council consists of 87 parliamentarians from the Nordic countries. The Nordic Council takes policy initiatives and monitors Nordic co-operation. Founded in 1952.

The Nordic Council of Ministers
is a forum of co-operation between the Nordic governments. The Nordic Council of Ministers implements Nordic co-operation. The prime ministers have the overall responsibility. Its activities are co-ordinated by the Nordic ministers for co-operation, the Nordic Committee for co-operation and portfolio ministers. Founded in 1971.

Nordregio – Nordic Centre for Spatial Development
conducts strategic research in the fields of planning and regional policy. Nordregio is active in research and dissemination and provides policy relevant knowledge, particularly with a Nordic and European comparative perspective. Nordregio was established in 1997 by the Nordic Council of Ministers, and is built on over 40 years of collaboration.

Stockholm, Sweden, 2017

Contents

Executive Summary

LAND USE PLANS range from an overall strategic document for a municipality or a region, to a detailed plan describing development of a specific locality. Land use planning also provides foresight by identifying options for how a future vision may be achieved through land use development. In this context, land use planning is also understood as a process, involving public authorities, private sector actors, and of course, the political sphere.

Within land use planning, information is used to add knowledge to the process - as input that supports decision making and as output that documents processes into concrete "plans". Geographic information systems (GIS), and the data they use, are often fundamental tools of local land use planning. These applications are wide ranging, with different programmes addressing diverse sectors and themes and delivering both insight into current land use patterns and foresight into expected or desired outcomes.

Such a wide range of tools and possible uses means that knowing what is available for local planning is a complex issue. At the same time, planning departments in relatively small municipalities, five of which are participating in the REGINA[1)] project, often have less well-developed GIS knowledge base due to their lower availability of human and capital resources. In response, this report provides a general guidance for these types of municipalities that want to learn more about their options for land use planning using GIS. As part of the REGINA project, we focus on northern and Arctic communities facing the development of large-scale natural resources-based industries alongside existing economic and socio-cultural activities. Information is provided based on four key topics:

1. Spatial data types and data sources
2. GIS tools
3. Local competencies of REGINA partner municipalities
4. Land use foresight planning – GIS and stakeholder participation

1) REGINA (Regional Innovation in the Nordic Arctic and Scotland with a Special Focus on Regions with Large-Scale Projects) is funded by the Northern Periphery and Arctic Programme 2014–2020. For further information, please visit www.reginaproject.eu.

Spatial data types and data sources

In Europe, the European Environment Agency (EEA) is an important source of open data on land use, including the CORINE land cover (CLC) dataset, an ongoing project to provide land cover for all of Europe at a resolution as fine as 100 m. Also, the INSPIRE Directive aims to create a new EU-wide spatial data infrastructure. It is based on the spatial data infrastructures of the 28 member countries, addressing 34 spatial data themes needed for environmental applications, including land use. This enables the sharing of spatial environmental information among public sector organizations and better overall access to spatial information across Europe.

The data delivered to INSPIRE is produced by national or local institutions. Municipalities and national agencies thus have an important role in the production of materials used by INSPIRE but the benefits also flow the other way: the INSPIRE Directive has significantly improved the development of spatial data in many EU countries. For example, municipalities in Finland are obliged to deliver the following spatial data (Paikkatietoikkuna, 2016):

- Addresses
- Land registers (together with the National Land Survey of Finland)
- Real-time town/city plans
- Master plans
- Buildings/constructions
- Building prohibitions
- Air quality survey points

Spatial data from national sources is important for local planners and GIS experts working on land use issues. However, local municipalities are also important developers of spatial data, including building distributions and usage, as well as the identification of areas pertaining to various development objectives (e.g. land ownership, zoning and the issuance of development contracts). These datasets are used to inform local stakeholders, and they specify the conditions governing local development opportunities. Other types of local

datasets often include information on transportation and traffic as well as recreational services.

A major emerging source of spatial data is open-source and web-based data. For example, OpenStreetMap, a community-driven and fully scalable web-map of the world, is based on local knowledge of land use, transport, services and points of interest. It not only powers map data on thousands of different websites, mobile applications and hardware devices, but also acts as a repository for the basic underlying spatial data. Another example is the emerging availability of locally crowd-sourced data through digital platforms that simultaneously improve participation processes in the development of land use plans.

GIS tools

Spatial data from international, national and local open sources is applied through the integrated use of various GIS, design and statistical tools. Foundational platforms include: GIS mapping software such as ArcGIS, QGIS (an open-source and collaboratively developed set of GIS tools) and MapInfo; design and illustration software such as AutoCAD or Adobe Illustrator; and data management software such as Microsoft Excel or PostgreSQL. A common feature of these tools is that they use spatial data in a highly integrated way, often bringing together data from various sources for individual land use planning projects.

In addition to these global solutions, many local authorities also use custom made GIS platforms that are often developed in a national context. Examples of this include GISLine in Norway and NunaGIS. While these platforms have provided significant added value through time, the trend towards more and more international tools being developed with more modern technologies has put pressure on the relevance of these more traditional and basic platforms. Municipalities in the REGINA project face this challenge and are thus pursuing the use of more modern platforms such as QGIS and specific digital platforms that include GIS for stakeholder engagement. These participatory platforms create a user interface through which stakeholders can input information about their use of local land and services, or their views on proposed land use development plans. This information is then gathered as place-specific data and summarized in maps and stakeholder participation reports that planners can use when considering different intervention options.

Local competencies of REGINA partner municipalities

Each of the municipalities in the REGINA project has a well developed set of land use plans in place. This includes main planning documents such as comprehensive plans, as well as master plans for specific areas and thematic plans for issues such as transport, natural resource development, nature and wildlife, etc. However, these plans differ depending on how spatial data is applied, both in terms of spatial evidence provided in maps, as well as the presentation of the land use development plans themselves.

Each municipality was evaluated concerning which GIS platforms they use, how much of their GIS work is outsourced, how they envision future development of their expertise and to what extent GIS results are disseminated digitally. Notable findings include:

- One of the municipalities has already tested a participatory GIS platform for gathering stakeholder input in planning processes, and another has procured a license with intentions to apply it in the near future.
- Municipalities typically use rather outdated software, including nationally constructed platforms that limit integration with emerging innovative GIS platforms.
- Municipalities tend to use GIS to produce maps that are used in reports such as planning documents. The use of maps for digital communication is much more limited.
- Due to the small size of the municipalities, GIS work for various types of plans and strategies is often outsourced to consultancies.
- The municipalities have the ambition to further develop their internal competencies even bearing in mind their small size and limited resources.

Land use foresight planning – GIS and stakeholder participation

Land use foresight is a process for investigating, and providing information about future land use and impacts of possible land use decisions on society, the economy and the environment. It comprises a range of analytical tools and approaches that have been introduced above, as well as traditional practices including social and environmental impact assessments. Zoning and development plans, which may have a major impact on the environment and community, must be assessed for their environmental and social impact. These assessments are often done in conjunction with risk and vulnerability analyses for the planning area. The assessment process should explain the assessed alternatives and be relevant to the decision that will be taken. However, three key limitations of impact assessments are:

- potential bias, in that they are generally conducted by the industrial actor that hopes to invest in a development;

- they are conducted prior to the development of projects, so unforeseen social or environmental impacts (realized only during or after a project) cannot be evaluated; and
- they are not followed up with the monitoring needed to manage potential social or environmental conflicts. This is particularly important given that many large-scale natural resource projects have time horizons measured not in years but in decades.

With these limitations in mind our main finding regards the importance of land use planning as a participatory process involving stakeholders. This involves creating dialogue and gathering opinions in order to produce a plan that has the best chance of success in its local milieu. It also involves monitoring and following-up on initial opinion gathering to ensure that negative societal impacts of land use development are resolved effectively, and that good practices can be learned and transferred accordingly.

Digital platforms for stakeholder engagement have emerged as a highly effective way to involve stakeholders (including the public) in planning processes. For example, online surveys and questionnaires are a basic type of digital platform. Another more interactive approach are the aforementioned development of web-based GIS platforms that can be used to gauge stakeholders' reactions to both current land use situations, as well as future plans. As such, they act as a form of foresight tool that can not only engage with local stakeholders but also provide foresight on the potential social and economic impacts of development plans. The capability of these platforms to analyse data (both visually and statistically) makes them particularly attractive for planners. They also offer the opportunity for planners to engage with local stakeholders earlier in the planning process than traditional public consultation periods, and to articulate more clearly how public input can contribute to the development of plans.

In the REGINA partner municipalities, the Finnish platform Harava (www.eharava.fi/en/) has been introduced in Sodankylä (FI), and the Norwegian platform Barnetråkk (www.barnetrakk.no/) has been applied in Alstahaug (NO). Both municipalities see opportunities for further use of such tools, as do other local partners (as reported during a project seminar in August 2016). Additional existing platforms for participatory GIS exist, including the Bästa Planen (The Best Place) tool (http://dialog.spacescape.se/hagsatraragsved/) developed by the Swedish consultancy Spacescape, as well as the CityPlanner tool (https://cityplanneronline.com/site/index.php/crowdsourced-urban-planning/) developed by the Swedish consultancy Agency9.

Finally, in order to help partners to monitor the social impacts of large-scale projects, REGINA is developing the SIMP (Social Impact Management Plan) Toolbox. This provides several recommendations, including a comprehensive survey template, which can also be applied in the context of land use foresight processes. It also provides guidelines on the use of map-based digital platforms for citizen engagement, which are further detailed in the following main report.

Introduction

IN ITS MOST BASIC form, a land use plan describes the current conditions and/or a strategic vision for an area. However, land use planning can take on a wide range of forms and functions. For example, a master plan can function as an overall strategic document to guide planning activities as whole, and therefore may include little by way of detailed spatial data or mapping. At a more local level, "comprehensive plans" will often be created to guide the development of a given area, and "detailed plans" can be even more specific; for example, detailing the conditions governing activities such as the procurement of contracts with developers (see further Section 2). Some land use plans may be issue-based, describing the legal principles governing whether and how land may be used for a specific purpose. Land use plans can also provide foresight by identifying, often by back-casting, ways in which a future vision may be achieved through land use changes and the social, economic and environmental impacts they cause. Just as there are many types of plans, so too can planning systems (particularly the division of responsibility between levels of government and the role of different plans and strategies in relation to each other) differ between countries.

Geographic information systems (GISs), and the spatial data they use, are often the starting points and fundamental tools of local land use planning. GIS applications are wide ranging, addressing diverse sectors and themes and delivering both insight into current land use patterns and foresight into expected or desired outcomes. Equally wide ranging are the GIS tools (i.e. programmes and applications) and spatial data that can be applied to support land use planning.

With the diverse uses and tools of GISs in mind, this document provides general guidance for relatively small municipalities seeking to learn more about land use planning using GISs. As part of the REGINA project,[2] we focus on northern and Arctic communities facing the development of large-scale natural resources-based industries alongside existing economic and socio-cultural activities. We provide an overview of key spatial data types and data sources, as well as GIS tools. We then take stock of the local competencies of our partner municipalities, what GIS technologies are in use and trends in competency development and innovation. We also dig deeper into the issue of land use foresight, to determine how land use planning (in terms of both tools and processes) can facilitate improved local social acceptance of large scale industrial development from all societal groups.

Section 1 provides an overview of spatial data availability and GIS tools for local land use planning in selected partner countries. Section 2 provides examples of local land use planning in selected partner municipalities participating in the REGINA project, showing how GISs and spatial data are used to plan local development. Section 3 focuses on how land use foresight analyses can support planning, including by facilitating meaningful stakeholder and public consultation. Lastly, Section 4 draws together the main conclusions and suggests important future actions for local improvements in land use planning and associated GIS competencies.

2) REGINA (Regional Innovation in the Nordic Arctic and Scotland with a Special Focus on Regions with Large-Scale Projects) is funded by the Northern Periphery and Arctic Programme 2014–2020. For further information, please visit www.regina-project.eu

1. Spatial data and GISs

Spatial data

Basic spatial data typically comes from one of four main sources: European institutions, national datasets, local datasets and the private sector.

In Europe, the European Environment Agency (EEA) is an important source of open data on land use, including the CORINE land cover (CLC) dataset, an ongoing project to provide land cover for all of Europe at a resolution as fine as 100 m. Datasets for 1990, 2000, 2006 and 2013 have already been created (EEA, 2016). The collection of CLC data from national sources allows the EEA to provide consistent information on urban development, as well as sectoral coverage such as forestry and agricultural land use.

The European Union (EU) INSPIRE Directive aims to create a new EU-wide spatial data infrastructure. It is based on the spatial data infrastructures of the 28 member countries and addresses 34 spatial data themes needed for environmental applications, including land use. This enables the sharing of spatial environmental information among public sector organizations and better overall access to spatial information across Europe. INSPIRE is based on the following common principles (European Commission, 2016).

- Data should be collected only once and kept where it can be maintained most effectively.
- It should be possible to combine seamless spatial information from different sources across Europe and share it with many users and applications.
- It should be possible for information collected at one level/scale to be shared with all levels/scales.
- Geographic information needed for good governance at all levels should be readily and transparently available.
- It should be easy to determine what geographic information is available, how it can be used to meet a particular need and under what conditions it can be acquired and used.

INSPIRE and the role of local and national data: The cases of Finland and Norway

The data delivered to INSPIRE is produced by national or local institutions. Municipalities and national agencies thus have an important role in the production of materials used by INSPIRE. The benefits also flow the other way: the INSPIRE Directive has significantly improved the development of spatial data in many EU countries, including Finland. For example, municipalities in Finland are obliged to deliver the following spatial data (Paikkatietoikkuna, 2016).

- Addresses
- Land registers (together with the National Land Survey of Finland)
- Real-time town/city plans
- Master plans
- Buildings/constructions
- Building prohibitions
- Air quality survey points

Tables 1 and 2 provide a complete overview of the sources of INSPIRE data in Finland and Norway, respectively. Nationally, spatial data portals are usually developed to gather data and information from different sources. For example, one the main portals to provide access to spatial data for municipalities in Finland is Paikkatietoikkuna, the Finnish "geoportal" for spatial data, and this was developed by the National Land Survey (in cooperation with other spatial data providers) in order to implement the INSPIRE Directive. Other key organizations and web portals in Finland include:

- Avoindata.fi, an open-access portal for data sharing (upload and download functionalities) and operability, supported by the Ministry of Finance;
- Liiteri, an open-access portal for sharing data on the built environment, supported by the Finnish Environment Institute (SYKE), which is responsible for producing open data and information for an ecologically, economically and socially sustainable society;

- KuntaTietoPalvelu (the Municipal Information Service), by the Association of Finnish Local and Regional Authorities;
- SotkaNet, by the National Institute for Health and Welfare (THL); and
- the Agency of Rural Affairs.

The Finnish Environment Institute (SKYKE) and the Norwegian Environment Agency are key actors in the handling of spatial data about land use. In Sweden, Lantmäteriat is responsible for the INSPIRE Directive and has developed the Geodata portal for accessing spatial data (www.geodata.se). In Greenland, the state-owned company Asiaq (Greenland Survey) has primary responsibility for spatial data.

Table 1: Finnish institutions producing and managing spatial data

Spatial data group	Organization (in English)
Addresses	Municipalities; Population Register Centre
Administrative units	Finnish Transport Agency; National Land Survey of Finland
Biogeographical areas	Finnish Environment Institute; Finnish Museum of Natural History
Buildings	Population Register Centre; National Land Survey of Finland; municipalities
Species distribution	Natural Resources Institute Finland; Finnish Museum of Natural History
Energy resources	Finnish Meteorological Institute; Natural Resources Institute Finland; Geological Survey of Finland
Follow-up devices and places of the environment	Finnish Environment Institute; Finnish Meteorological Institute; municipalities
Climate	Finnish Meteorological Institute
Ocean geography	Finnish Meteorological Institute
Geology	Finnish Environment Institute; Geological Survey of Finland
Habitats and biotopes	Forest Centre
Health and safety of the population	National Institute for Health and Welfare
Altitude	Finnish Transport Agency; Finnish Environment Institute; National Land Survey of Finland
Hydrography	Finnish Transport Agency; Finnish Environment Institute; National Land Survey of Finland
Land use	Municipalities; regional councils; National Land Survey of Finland
Mills and industrial facilities	Statistics Finland; National Land Survey of Finland; municipalities
Mineral resources	Geological Survey of Finland
Place names	National Land Survey of Finland
Orthographic imagery	Finnish Environment Institute; National Land Survey of Finland
Population distribution	Statistics Finland

Properties	National Land Survey of Finland; municipalities
Protected areas	Municipalities; National Board of Antiquities; Finnish Environment Institute
Public goods and services	Finnish Transport Agency; Statistics Finland; National Land Survey of Finland
Regions and reporting units	Municipalities; Finnish Environment Institute; Finnish Transport Agency; Finnish Safety and Chemicals Agency
Natural areas at risk	Finnish Environment Institute; Geological Survey of Finland
Sea areas	Norwegian Mapping Authority
Atmospheric characteristics	Norwegian Meteorological Institute
Soil	Norwegian Environment Agency
Statistical units	Statistics Norway
Transportation networks	Institute of Transport Economics; Norwegian Centre for Transport Research

Table 2: Norwegian institutions producing and managing spatial data

Spatial data group	Organization (in English)
Addresses	Norwegian Mapping Authority
Administrative units	Norwegian Mapping Authority
Agriculture and hydroponics facilities	Statistics Norway
Biogeographical areas	Norwegian Environment Agency
Buildings	Norwegian Mapping Authority
Species distribution	Norwegian Environment Agency
Energy resources	Norwegian Water and Energy Directorate
Climate	Norwegian Meteorological Institute
Ocean geography	Norwegian Mapping Authority; Institute of Marine Research
Geology	Geological Survey of Norway
Habitats and biotopes	Norwegian Environment Agency
Health and safety of the population	Norwegian Institute of Public Health
Altitude	Norwegian Mapping Authority
Hydrography	Norwegian Water and Energy Directorate
Land cover	Norwegian Environment Agency
Land use	Norwegian Environment Agency
Mills and industrial facilities	Statistics Norway
Mineral resources	Geological Survey of Norway
Place names	Norwegian Mapping Authority

Orthographic imagery	Norwegian Mapping Authority; Geological Survey of Norway
Population distribution	Statistics Norway
Properties	Norwegian Mapping Authority
Protected areas	Norwegian Environment Agency
Public goods and services	Norwegian Mapping Authority; Statistics Norway
Regions and reporting units	Municipalities; Norwegian Environment Institute; Institute of Transport Agency
Natural areas at risk	Norwegian Environment Agency
Sea areas	Norwegian Mapping Authority
Atmospheric characteristics	Norwegian Meteorological Institute
Soil	Norwegian Environment Agency
Statistical units	Statistics Norway
Transportation networks	Institute of Transport Economics; Norwegian Centre for Transport Research

Example: Spatial data in Greenland

Spatial data management in Greenland is unique in at least two regards. First, no land in Greenland can be "owned" privately. It is common property, and "right to use" contracts replace traditional notions of ownership. Second, Greenland's historical relationship with Denmark has created a special division of labour between Greenlandic and Danish institutions responsible for providing spatial knowledge.

The government-owned company Asiaq (Greenland Survey) was established over 50 years ago to serve technical companies and government authorities by providing local knowledge related to physical (non-living) development. It is owned by the Greenland Government, but operates as an independent commercial business. By providing spatial data (including mapping) and planning competencies, it supports the planning of mines, infrastructure, dams and reservoirs. Further details are available at http://www.asiaq.gl/.

One of Asiaq's main spatial data initiatives has been the development of NunaGIS. NunaGIS is an online atlas of maps from across Greenland, designed to ensure easy public access to high-quality spatial data, and so enable continuous public involvement in planning processes. It is possible to view national maps as well as more detailed maps of different municipalities. By zooming in, viewers can also access aerial photos of towns and villages. It is possible to access geographical information related to land stock, buildings, roads, national planning directives, animal monitoring, land allotments, licences, etc. Further information and access to the system are available from www.nunagis.gl/en.

In addition to Asiaq, the Greenland Nature Institute researches and advises the government on issues relating to living resources, animals, plants and the environment in and around Greenland. Its specific aim is to promote the sustainable exploitation of living resources and the protection of the environment and biodiversity. Its advice is independent of special interests and prepared based on scientific evidence from research. One focus of its monitoring activities is exploited species, including yearly population surveys for commercial fishery species. Monitoring takes place through international cooperation, as most fish stocks are beyond national frontiers. The institute has three academic departments: the Department of Mammals and Birds, the Division of Fish and Seafood and the Department of Environment and Mineral Resources.

Statistics Greenland, the central authority for official statistics in Greenland, provides the data needed for analyses of social development, for political and administrative decisions and for planning and social science research. The main task of Statistics Greenland, under the Ministry of Finance, is to collect, process and publish statistics on social conditions in Greenland.

Although Home Rule was established in Greenland in 1979, there are still close ties between the above Greenlandic institutions and related institutions in Denmark. These include the Danish Geodata Agency, the Danish Metrological Institute and the joint Geological Survey of Denmark and Greenland, which has a primary focus on energy and mineral resources, the natural environment and the climate.

Development of local data for land use planning

Spatial data from national sources is important for local planners and GIS experts working on land use issues. These organizations provide datasets such as administrative borders, land use/land cover, definitions of special areas, such as parks or environmentally protected areas, and topographic information. However, local municipalities are not only users of spatial data; they are also important developers of spatial data. Typical examples include datasets reporting building distributions and usage, as well as the identification of areas pertaining to various development objectives (e.g. land ownership, zoning and the issuance of development contracts). For example, Figures 1 and 2 show how NunaGIS provides locally relevant datasets concerning natural resource exploration and sheep farming in South Greenland. These datasets are in turn used to inform local stakeholders, and they specify the conditions governing local development opportunities. Similar locally built datasets often include information on transportation and traffic as well as parks and recreational services.

Another major emerging source of spatial data is open-source and web-based data. For example, OpenStreetMap, a community-driven and fully scalable web-map of the world, is based on local knowledge of land use, transport, services and points of interest. It not only powers map data on thousands of different websites, mobile applications and hardware devices, but also acts as an open and accessible repository for the basic underlying spatial data. Another example is the emerging use of locally crowd-sourced data to improve participation processes in the development of land use plans (see, for instance, the description of Harava in the discussion of land use planning in Sodankylä below, as well as Section 3 on land use foresight tools).

Applying spatial data: GIS tools

Spatial data from international, national, local and open sources is applied through the integrated use of various GIS, design and statistical tools. These include: GIS mapping software such as ArcGIS, QGIS (an open-source and collaboratively developed set of GIS tools) and MapInfo; design and illustration software such as

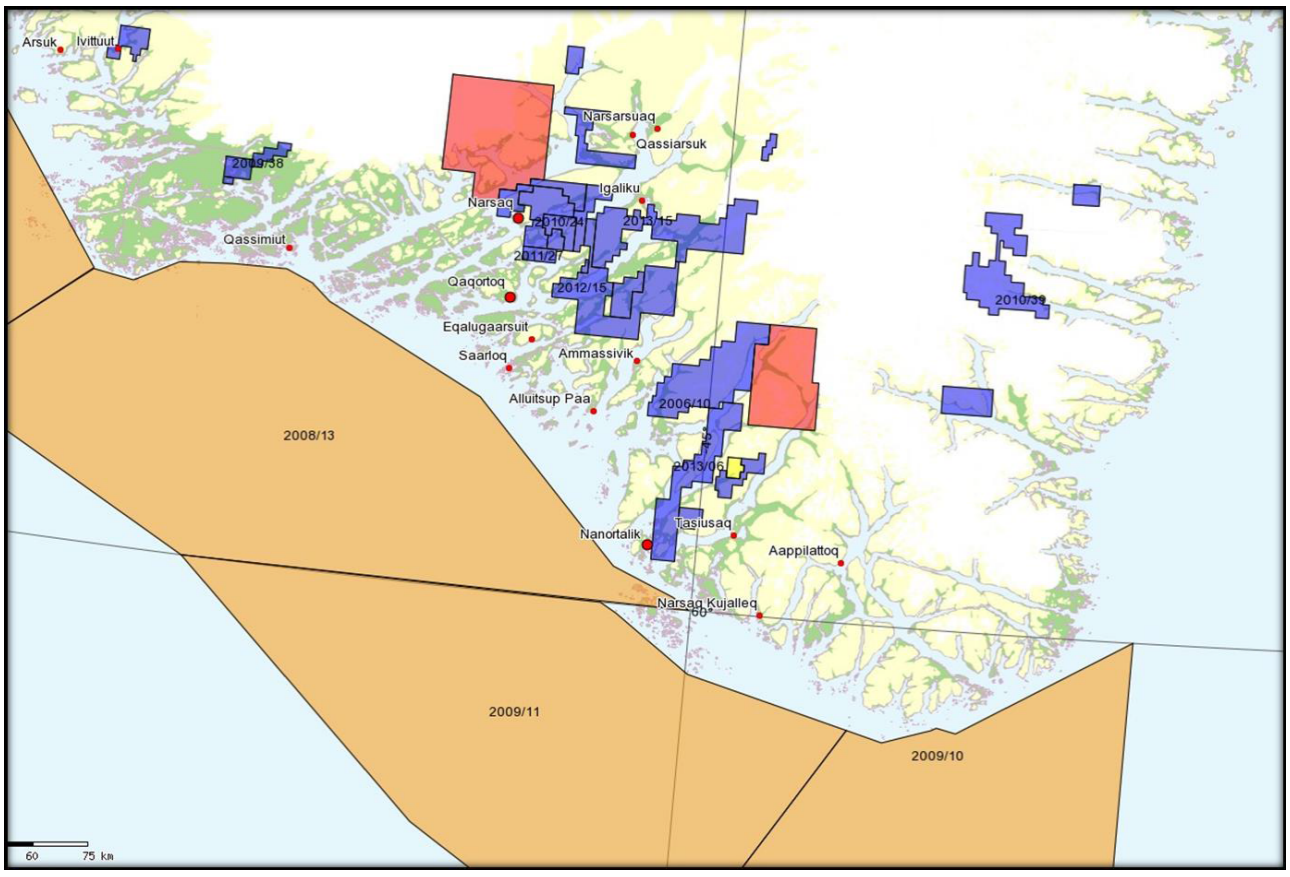

Figure 1: *Land use map of South Greenland showing the licensing of 23 prospective areas for onshore mining, as well as three maritime oil licensing contracts. Source: http://kujalleq.nunagis.gl/.*

AutoCAD or Adobe Creative Suite; and data management software such as Microsoft Excel or PostgreSQL. One common feature of these tools is that they use spatial data in a highly integrated way, often bringing together data from various sources for individual land use planning projects.

Another common feature of GIS tools is that they are often used in tandem with highly refined and scientifically developed models (either packaged with the GIS software or available as application extensions). For example, Figure 3 shows Nordregio's recently completed work using crowd-sourced data coupled with data from national sources to identify attractive urban areas based on the level of service accessibility (Weber et al., 2016). Another example is integrated land use and transport modelling, which helps forecast residential, business and transport development and their impacts on society, the economy and the environment (see for instance Nordregio, 2014).

Further developments include online GIS platforms for promoting public participation in planning processes. Often, these GIS platforms create a user interface through which stakeholders can input information about their use of local land and services, or their views on proposed land use development plans. This information is then gathered as place-specific data and summarized in maps and stakeholder participation reports that planners can use when considering different intervention options.

However, many of these data sources and technologies are being developed and applied in the context of large urban areas, which begs the question of how they can be downscaled for use in the context of rural, northern and sparsely populated communities. Also, the wide array of datasets, software tools and analytical methods represents a highly complex knowledge base for practitioners to navigate when choosing which solutions to apply in their local context. Therefore, the next section describes the spatial data and land use planning situation for selected local partners in the REGINA project. Following that, we consider opportunities for the use of new data and GIS applications for land use foresight analyses.

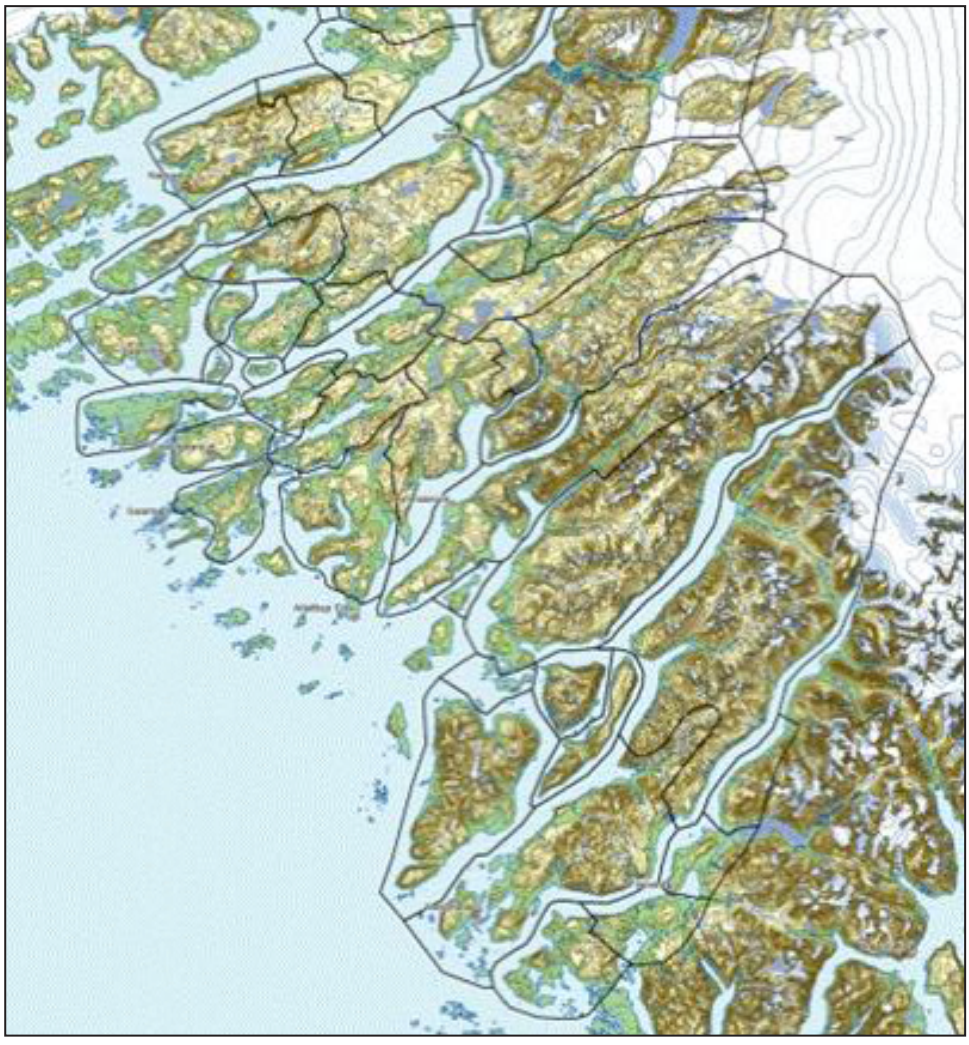

Figure 2: *Locally produced land use map showing the subdivision of part of South Greenland into sheep grazing areas. Source: http://kujalleq.nunagis.gl/.*

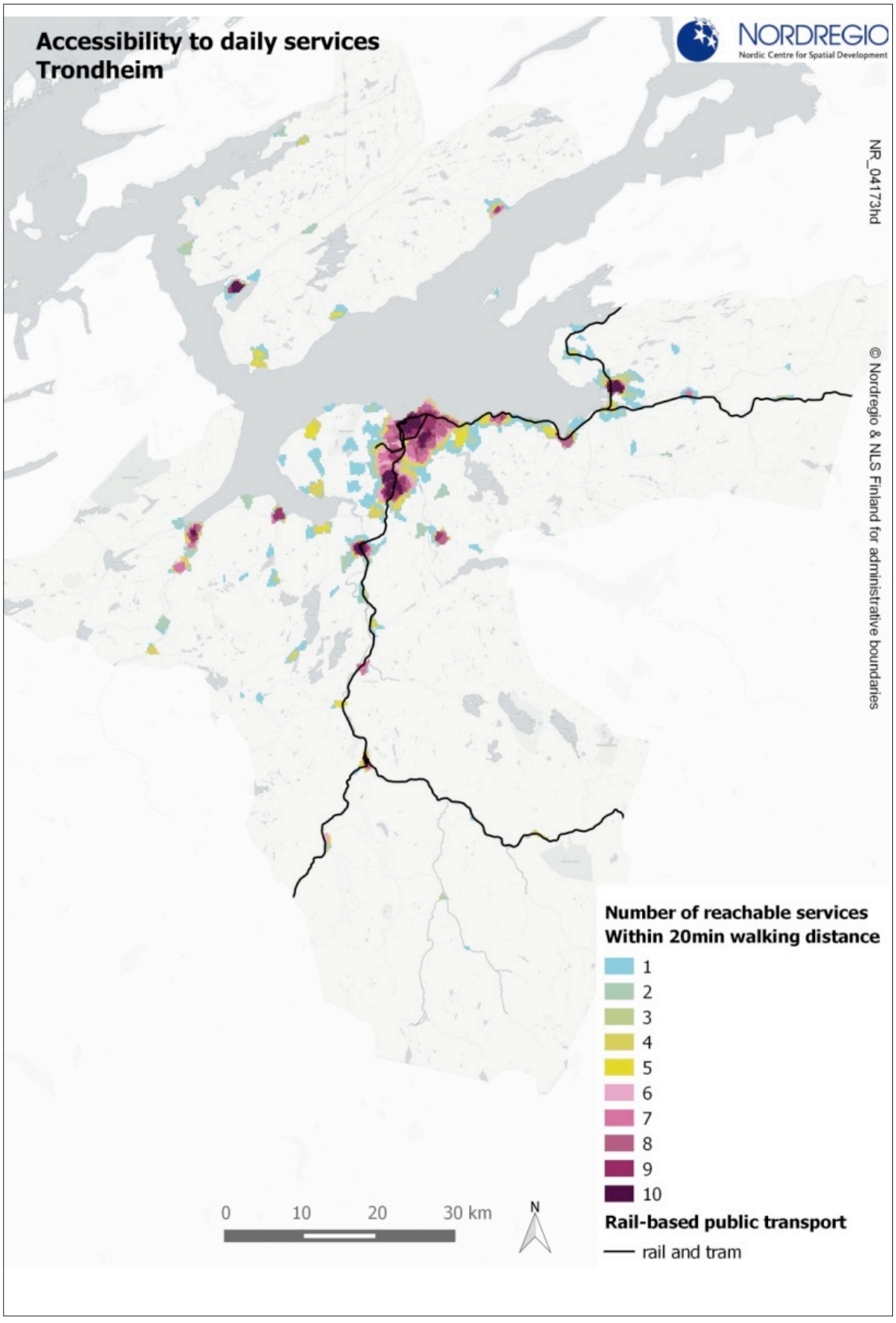

Figure 3: *Analysis of urban attractiveness based on service accessibility in Trondheim, Norway. See the source for additional details on the methodology and analytical results. Source: Weber et al. (2016).*

2. Examples of local land use planning

THE FOLLOWING SECTIONS provide an overview of municipal land use planning in selected local partner areas. This yields a clearer picture of the current state of spatial data and GIS usage in northern, sparsely populated municipalities, particularly those facing large-scale industrial developments. Each overview comprises three components:

1. a discussion of the primary land use master plan for the municipality, as well as any important "comprehensive" or "detailed" local plans governing development;

2. a review of the ways in which GISs are used to support local planning, based on information from the municipality;

3. a summary of the municipality's GIS competencies, including plans for their development.

Storuman, Sweden

Overview of key land use plans (*below*)

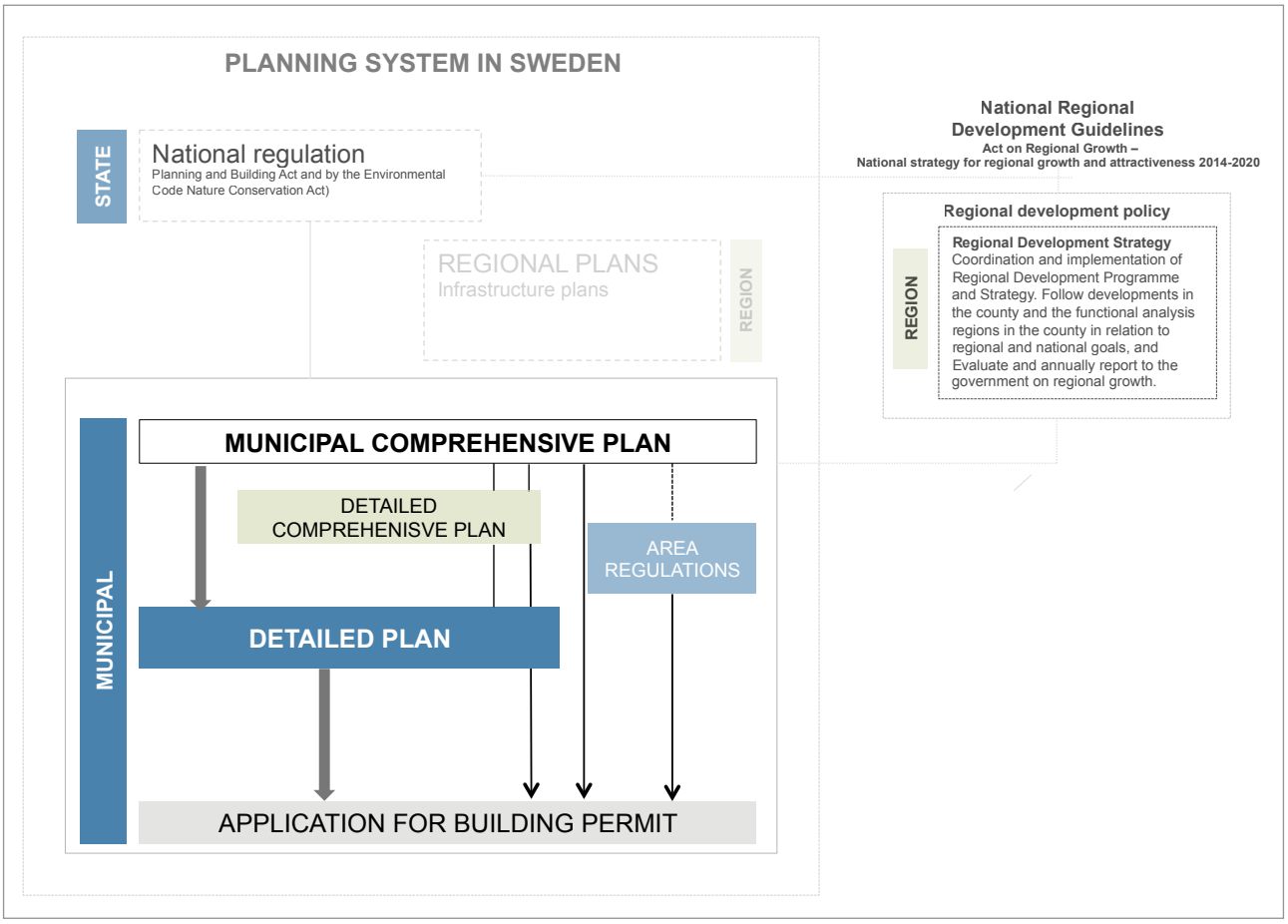

Figure 4: *Overview of spatial planning in Sweden.*

As shown in Figure 4, spatial planning, including land use, within Storuman's Municipal Comprehensive Plan (Översiktsplan för Storumans kommun), which is developed by the Environment and Planning Board of the municipality. This plan is non-binding, but includes guidelines on future land use development and describes the intended long-term strategic developments within the municipality. In Storuman, the current Municipal Comprehensive Plan was drafted in September 2010. It provides information about various economic activities, as follows.

- Industrial activities, including mining (pp. 27–33): The ambition is to establish favourable conditions for mining and local materials processing industries. It is argued that mining creates an opportunity to strengthen local business and increase the number of jobs in the municipality, but mining must be conducted with fair consideration of other businesses and the environment. The municipality also aims to offer good housing and services for workers employed in the mining industry and their families.

- Wind power (p. 33): One full-time equivalent (FTE) job is created per 5–7 wind power stations (14–20 FTEs are created in Blaiken Vind). The municipality has approved a comprehensive plan for wind power, in cooperation with the Sorsele municipality. The aims are to increase the production of renewable energy, contribute to national environmental objectives, take advantage of the job opportunities wind power can provide and to educate within the field of wind power.

- Hydroelectric power generation and usage (pp. 34–36): No additional hydroelectric power station can be built because of environmental constraints. However, the existing plants can be streamlined and their management operations centralized.

- Forest industry (pp. 38–39): Forested land within the municipality should be managed such that it generates a good and sustainable economic return, since the forest industry is of major importance to the municipality. Simultaneously, the biological diversity and cultural and social values of the forest should be preserved.

Detailed comprehensive plans for communities within the municipality, and thematic strategic plans that impact land use, are also created as needed. Examples of detailed comprehensive plans that complement the Municipal Comprehensive Plan in Storuman include the following.

- The 2011 detailed comprehensive plan for Hemavan (Fördjupad översiktsplan för Hemavan 2011) aims to strengthen the future development of the tourist centre in Hemavan to benefit the whole municipality.

- The 2011 detailed comprehensive plan for the Stensele locality in Storuman (Fördjupad översiktsplan för Storuman – Stensele 2011) aims to strengthen the development of the municipal centre to benefit the whole municipality. High priority is given to residents' future livelihoods, sustainability and the quality of life in the municipality.

- The municipality commissioned ÅF Infrastructure AB to produce a comprehensive plan for Tärnaby in 2014 (Masterplan för Tärnaby 2014). The objective was to provide a vision of the exploitation of Laxfjället mountain for tourism purposes, including examples of development areas for housing, as the basis for decisions about further development of the municipality.

- A strategic plan for tourism development (Strategisk plan för utveckling av turismen) was developed by the municipal director and published in June 2010 (revised May 2011). The strategy was coordinated with Färdledaren (comprising representatives from all municipalities in the county and Västerbotten Tourism) and the Hemavan Tärnaby PR association. Tourism is a major world industry and offers great development potential for Storuman. Tourism is the dominant industry in the mountainous area of Hemavan Tärnaby, and also has great significance across the municipality and wider region.

- Guidelines for housing in Storuman municipality over 2014–2018 (Riktlinjer för bostadsförsörjning i Storumans kommun 2014–2018) were published in June 2014. They were developed to ensure universal access to housing. The accessibility of good housing and living environments is important for Storuman's competitiveness, as the community's long-term survival depends on attracting positive net migration and encouraging residents to stay.

- A broadband strategy for Storuman municipality over 2015–2020 (Bredbandsstrategi för Storumans kommun 2015-2020) has the purpose of this strategy was to create a structured approach to development of a broadband network to meet existing and forecast demand up to 2020. In municipal comprehensive planning, broadband is addressed in the same way as other strategic issues.

GIS tools and data used in Storuman

A review of the above documents identified key examples of GIS use. These generally belong to one of the following three categories.

1. They present the current state of land use, including detailed planning areas, permits for operation, land ownership or national government interests (see Figure 5).

2. They present area(s) scheduled to undergo some form of development (see Figure 6).

3. They present options for land use development based on strategic development objectives (see Figures 7 and 8).

Figures 5 and 6 illustrate very basic applications of GISs. A base map is either digitized from print maps, created internally or obtained from national sources, and then simple shapes are drawn on the map to identify land use plans or development conditions. This highlights the communicative role of maps in land use planning. In this role, maps are used to display land areas and key parameters related to the planning and governing of land use, but are not an integral part of the planning process per se.

Apart from this basic communicative role, digital maps and GISs have a more direct role when they are:

- hosted in digital format online, via a mapping portal, for use by stakeholders and local residents;
- used directly as part of a planning process with stakeholders; or
- supplemented by the use of spatial analysis, within the GIS, to model development issues.

Storuman has not previously undertaken land use modelling using GIS spatial analysis and currently does not have an online web-map portal, either to display a collection of maps and related plans or as an interactive web-map service.

Figures 7 and 8 show maps as they may be used directly within a planning process, as occurs when GISs

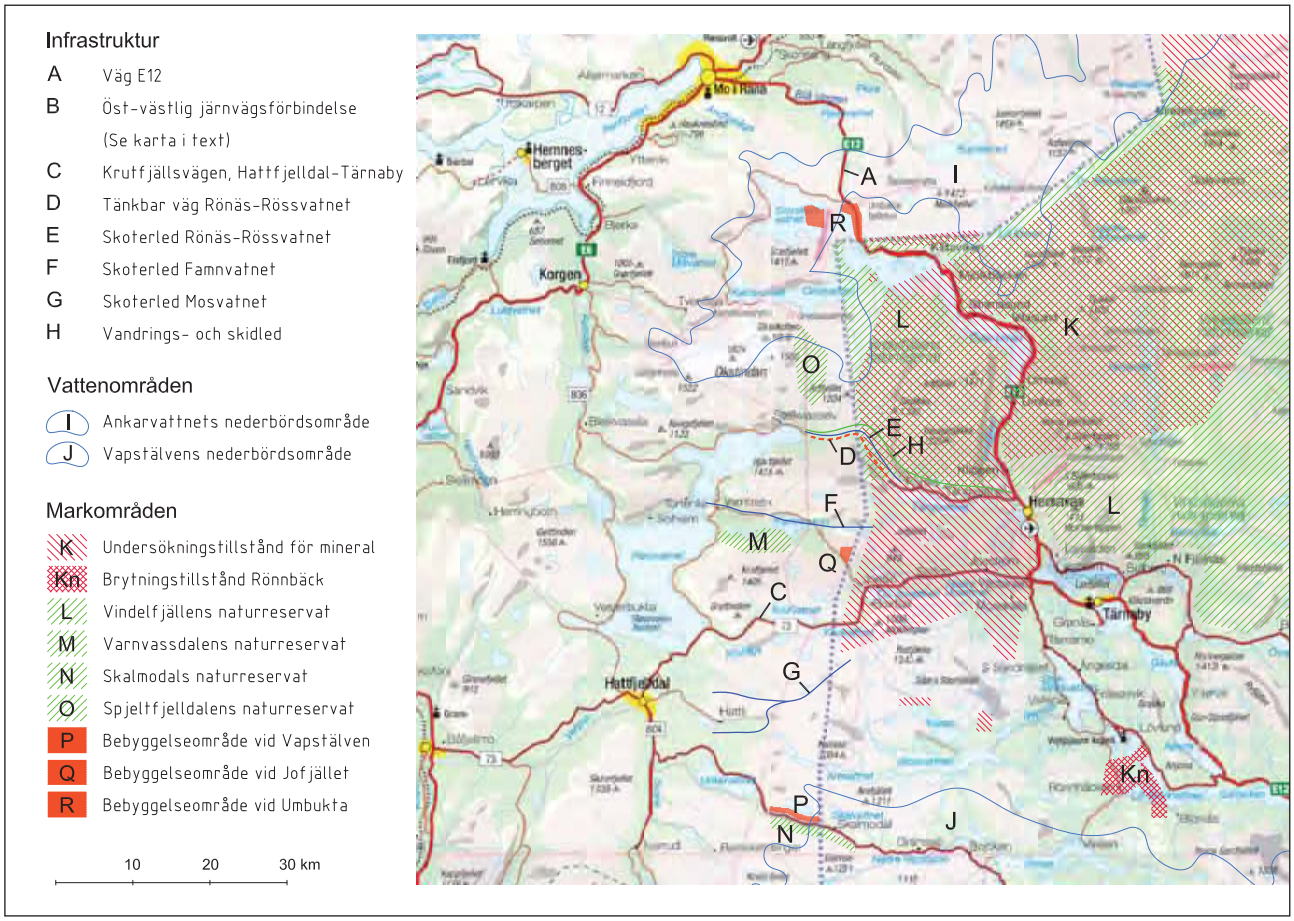

Figure 5: *Map showing the main land use areas in the Hemavan Tärnaby area of Storuman. Note the identification of specific areas for settlement (bebyggelse) as well as permits for mining operations (Brytningstillstånd Rönnbäck) and for mining exploration (Undersökningstillstånd för mineral). Source: Storumans kommun, 2010.*

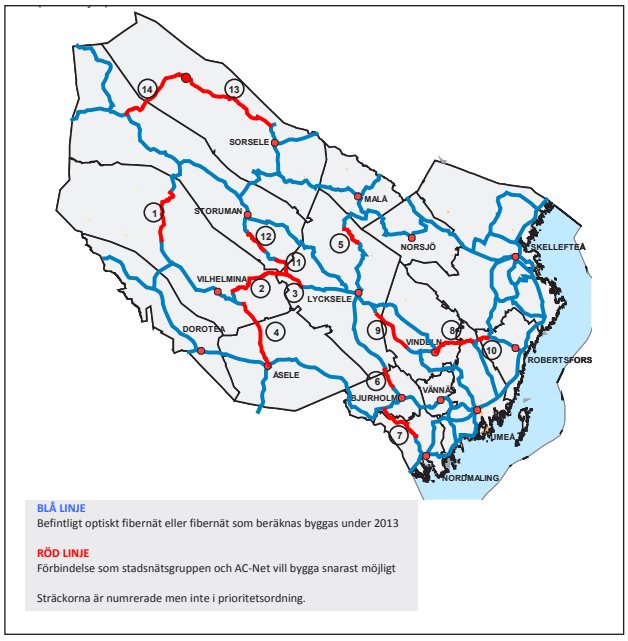

Figure 6: *Map showing the distribution of the broadband network in 2013 (in blue) and the planned projects to extend the network (in red). Source: Storumans kommun 2015.*

are used in support of land use foresight analyses, which are described in detail in the next chapter. The figures are part of the 2014 Tärnaby Masterplan, which established the need for the development of housing, lodging and services to support the growth of recreational tourism (including a proposed expansion of the local ski area), as well as promoting the area as an attractive place to live long term. The latter is important, in conjunction with the potential for mining development at Nickel Mountain in Ronnbäcken, which is just 20 km away. Promoting the area as an attractive place to live could support local population growth, which is seen as preferable to seasonal or fly-in–fly-out labour patterns.

The maps in the plan were produced by the consultancy ÅF and show two different options for land development to achieve a scenario of maximum growth. One vision presents "concentrated development" around the existing village (Figure 7) while the second (Figure 8) shows "dispersed development" around access points for the local ski lifts. Along with the Masterplan, these maps have been used to communicate spatial visions of development in discussions with local stakeholders in

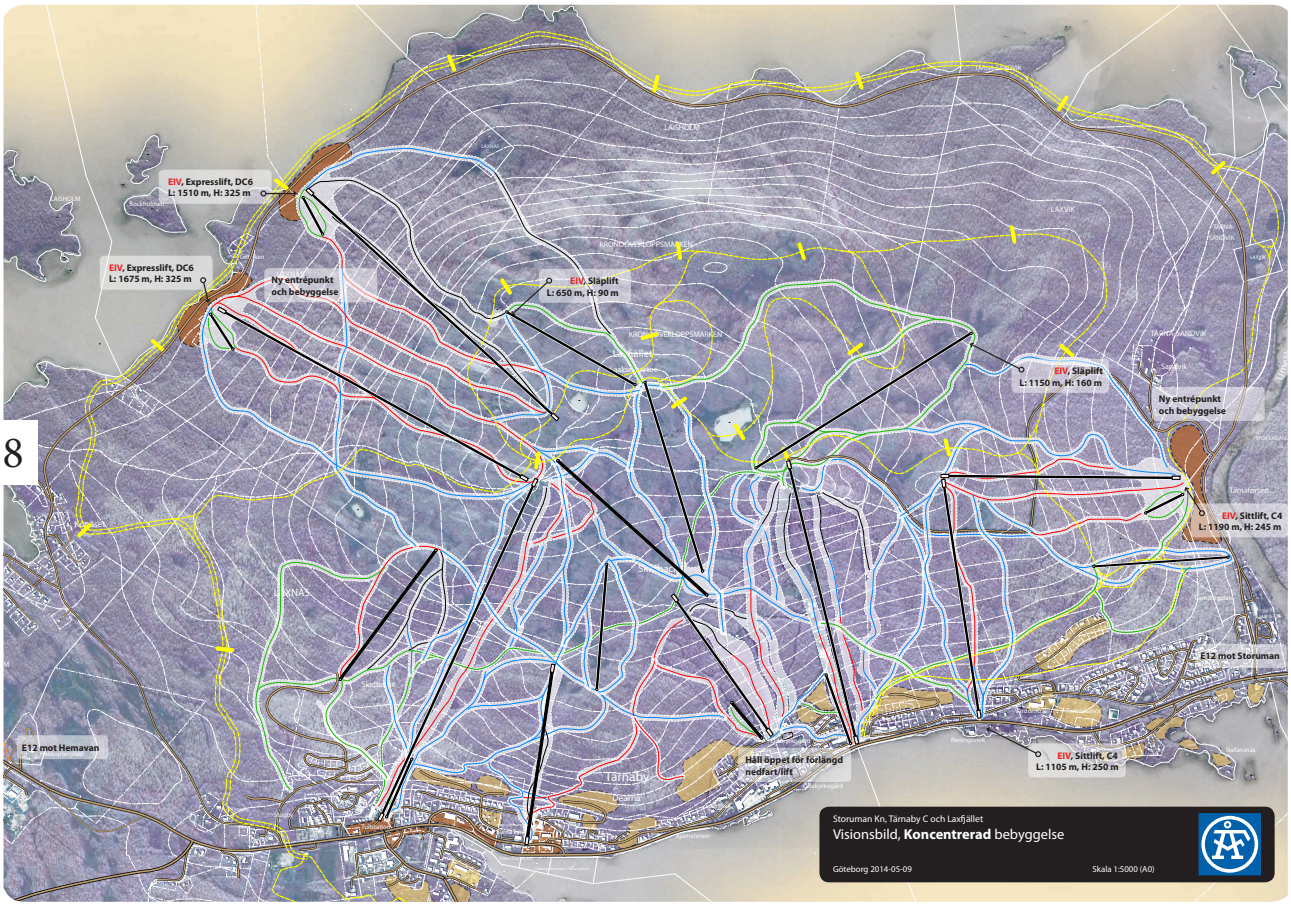

Figure 7: *Map showing a vision for the concentrated future development of Tärnaby as both a destination for recreational tourists and a home for new full-time residents. Note the brown shading denoting potential development areas, which are concentrated around the existing village. Source: Storumans kommun, 2014)*

Tärnaby. This is an ongoing process, with the next steps being to harmonize the Masterplan with the existing comprehensive plan for Tärnaby, then to produce binding detailed plans for the specific areas chosen for further development. In addition, the municipality intends to present these maps on the municipal website for public viewing – a further example of outreach using GISs.

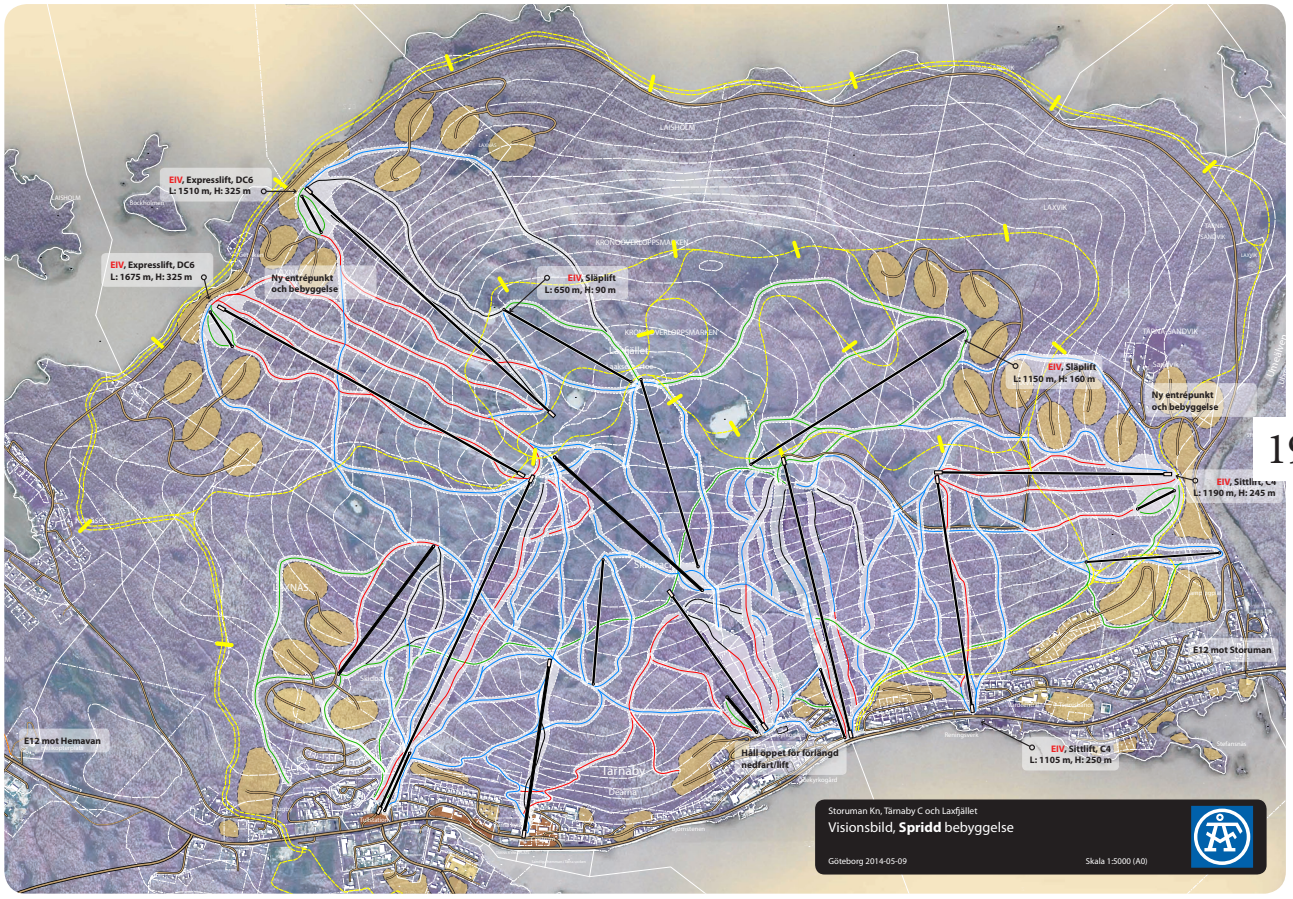

Figure 8: *Map showing a vision for the dispersed future development of Tärnaby as both a destination for recreational tourists and a home for new full-time residents. Note the brown shading denoting potential development areas, which are spread around the low-lying areas surrounding the ski resort. While this would provide much more ski-in–ski-out potential, it would also imply more land consumption and infrastructure development. Source: Storumans kommun, 2014)*

Local competency development

Table 3: Responses to local competency questions for Storuman, Sweden

Question	Response
What GIS tools, programmes and applications do you use in house?	MapInfo, Solen (Cartesia), Topocad (including the Plan module).
To what extent do you outsource any of your land use planning and GIS work to consultancies?	Until recently, everything was outsourced, but now we are trying to do everything ourselves.
Do you foresee a need to develop your internal competencies related to GISs and communication using maps?	We are working intensively on this.
Do you host maps in digital format on your website relating to your land use plan(s)?	Not currently, but it is our intention to do so.

Sodankylä, Finland

Overview of key land use plans

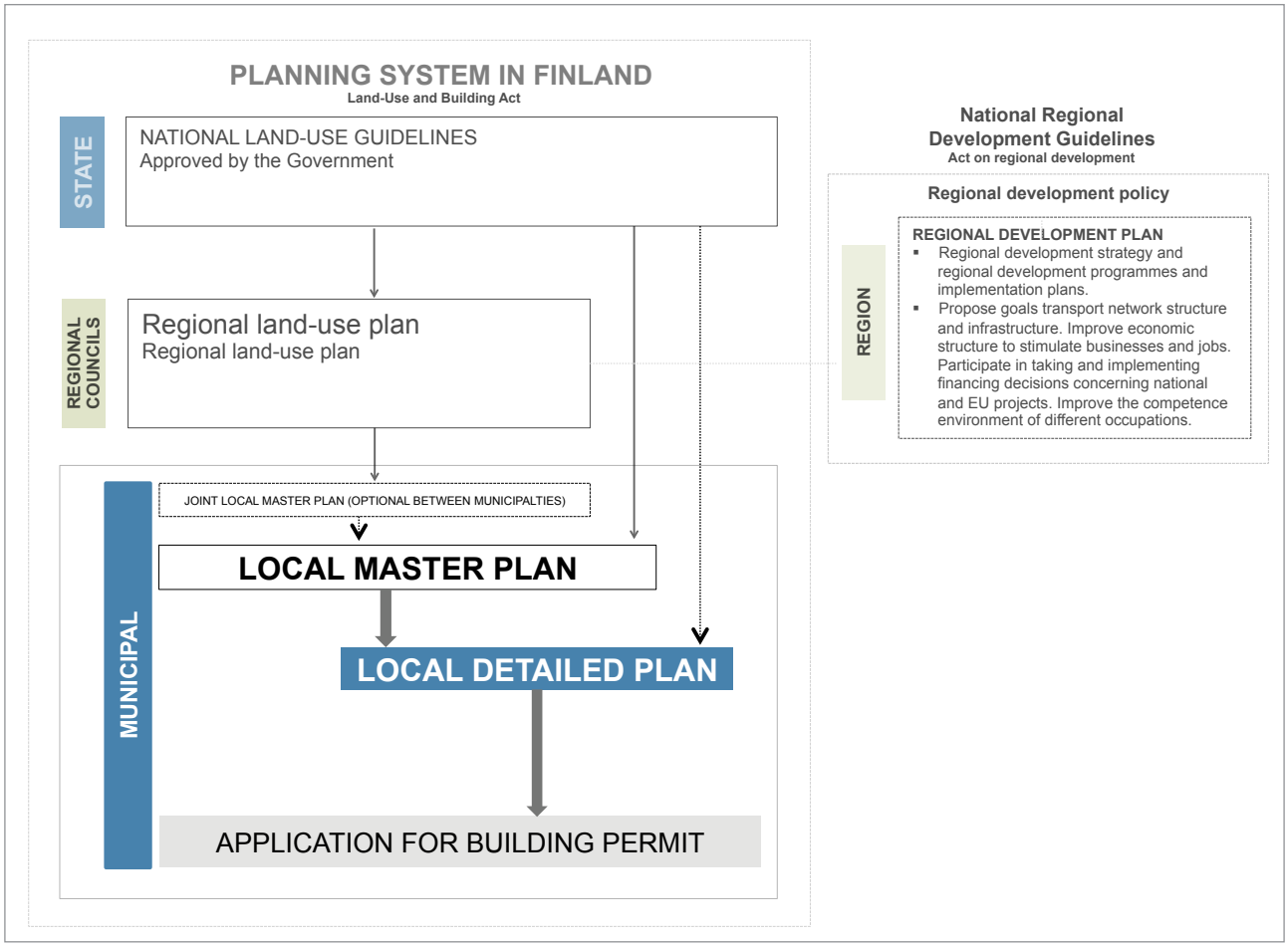

Figure 9: *Overview of spatial planning in Finland.*

Unlike most countries in the Northern Periphery region, Finnish national and regional bodies have a relatively strong role in local land use planning. As shown in Figure 9, binding national land use guidelines are included in the Land Use and Building Act prepared by the Ministry for Environment. From this foundation, binding regional land use plans are created by regional councils (comprising representatives of all municipalities in the region), and these in turn guide local master plans or optional joint local master plans shared between municipalities. Detailed local plans are then created where needed, and these instruct development processes.

In the mining context especially, regional-level land use planning has a crucial role in determining the strategic choices of the municipality as well as the wider region, and so it is important for Sodankylä municipality to both follow and contribute to the regional land use planning process (owned by the Regional Council of Lapland).

The municipality of Sodankylä has a non-binding land use policy strategy for the period 2015–2020. It is the first land use policy strategy ever completed in Sodankylä and provides general goals and guidance. In the future, such strategies may be more detailed and therefore provide more direct guidance on land use planning processes.

The strategy outlines the following five main principles for the coming years.

1. The unification of community infrastructure in the town centre:
   a. The land use plan for the town centre is ready.
   b. The ongoing planning process includes detailed land use planning for a new health centre and a location for an energy station.

2. Developing and maintaining the vitality of rural areas and hamlets:

a. In 2017, Sodankylä will begin a land use planning process around Lake Unari, located in the southwest part of Sodankylä, intended to include both residential and tourist accommodation.

3. The comprehensive improvement of tourist resorts:
   a. The main tourist resort, Luosto, has a land use plan in place, but there is a need for land use planning in other resort areas, especially in response to development plans initiated by entrepreneurs/companies.

4. Promoting large investment projects:
   a. The area zoned for future industry will be expanded.
   b. Mining areas are planned/reserved as part of the regional-level land use planning process.
   c. For wind power, planning is done at a regional level, but the municipality has the "exclusive right" to make decisions contrary to, or in addition to, the regional-level land use plan (according to recent court cases in Finland).

5. The advancement of logistical connections and access:
   a. Significant logistical connections have been described in regional-level land use planning, in which Sodankylä municipality is actively participating (Sodankylän kunta, 2015).

In accordance with Finnish law, Sodankylä municipality is reporting annually (on its website) about active and forthcoming land use planning processes.

GIS tools and data used in Sodankylä

Examples of GIS use mentioned in the above documents generally fit into one of the two following categories.

1. They present the current state of land use, including detailed planning areas, permits for operation, land ownership or national government interests. For example, Figure 10 shows a map recently produced by the Finnish Network for Sustainable Mining that details current land use, including exploration and mining, reindeer herding, special reindeer herding, NATURA2000 areas, nature conservation areas, national parks, Sami Indigenous regions, protected landscapes, etc.

2. They present area(s) scheduled to undergo some form of development. For example, Figure 11 presents the InfoGIS service of Sodankylä municipality. Users can see detailed land use plans by clicking an area of interest (red lines mark the areas for which there are detailed land use plans in Sodankylä town centre) and the green lines show the broadband network.

Spatial data has been, and is being, created mainly in AutoCAD and then rendered in a more readable form using MapInfo. Sodankylä, like other municipalities in Finland, also utilizes spatial data produced by other state organizations, for instance the Centre for Economic Development, Transport and the Environment and the Regional Council of Lapland.

In Sodankylä, spatial data has been used mostly in

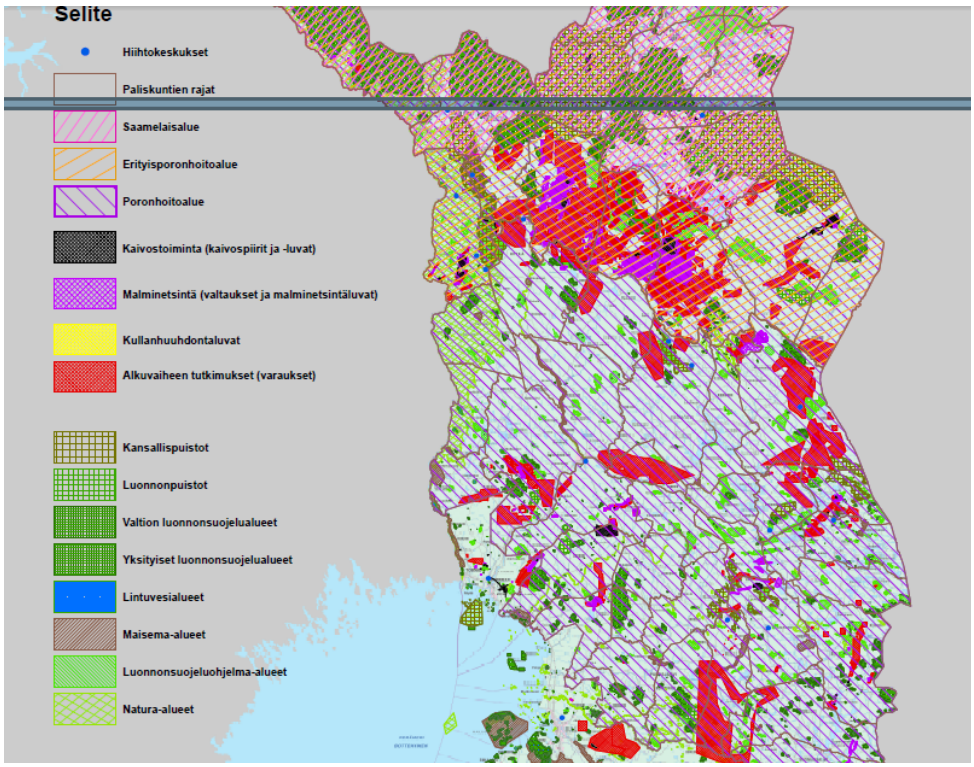

Figure 10: *Current land use, including exploration and mining, reindeer herding, special reindeer herding, NATURA2000 areas, nature conservation areas, national parks, Sami Indigenous regions, protectable landscapes, etc. Source: http://www.kaivosvastuu.fi/teemakartta/.*

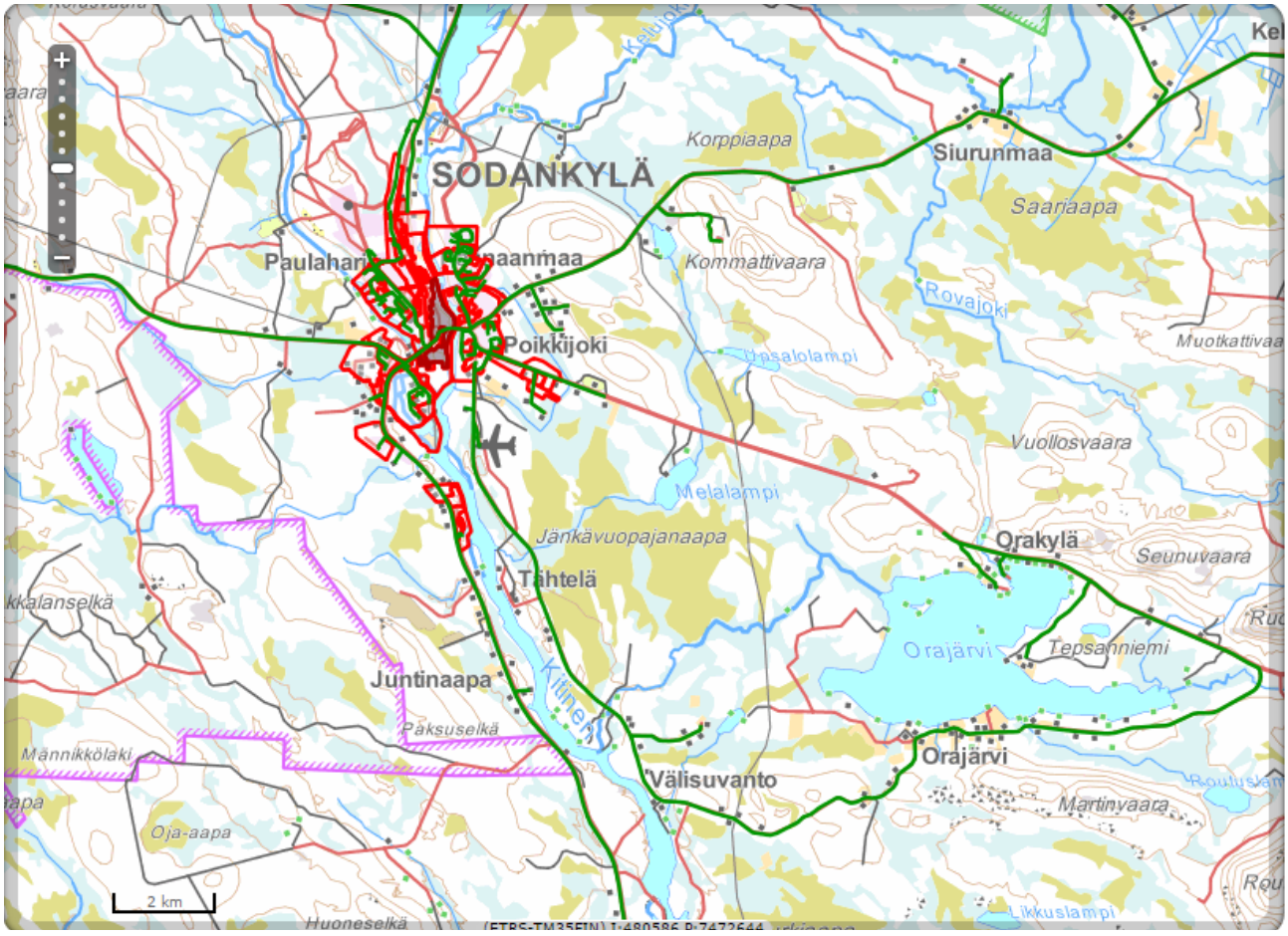

Figure 11: *The InfoGIS service of the Sodankylä municipality. Source: infogis.infokartta.fi/infogis-sodankyla/.*

planning and zoning, the supervision of building activity and services, route mapping (e.g. for snowmobile and cross-country skiing tracks) and permit-granting processes. One example of mapping to facilitate planning is in the health sector. An age structure map of all the hamlets in Sodankylä was created using a GIS to better understand patterns in the need for health services and related infrastructure.

In addition to more traditional mapping and spatial data uses, Sodankylä is currently working to develop new ways in which the public, including local residents, stakeholder groups and tourists, as well as planners, can utilize spatial information. This is part of a broader municipal planning and communications objective to make as much diverse spatial data as possible open and accessible to all. For example, there is an online InfoGIS map service where spatial data such as transport routes, area plans, cross-country ski tracks and snowmobile routes can be viewed and explored.

In the future, Sodankylä sees two main opportunities for further developing its use of GISs in planning and communication. The first is additional development of the InfoGIS platform to provide information on leisure and tourism. For example, the current data coverage of InfoGIS could be expanded to include hiking trails, campsites, wilderness huts, scenic points, ski tracks, snowmobile routes and service locations such as shops and petrol stations. There could also be information on civic services like swimming pools and recycling stations. The expanded system would serve the tourism sector and support its further development. Another idea for expanding the InfoGIS service that could benefit both tourists and locals is a map of the most common 3–4 canoe routes in the municipality and information about them, including nearby destinations (e.g. bird watching towers). Another necessary improvement is to extend the current platform, which does not yet have a fully responsive design, to work well on all types of mobile device.

While the previous examples show the effective use of GISs in their communicative role, Sodankylä also uses them as an innovative land use foresight tool, di-

rectly contributing to participatory planning processes. Sodankylä municipality has procured a licence for a participatory planning tool called Harava, produced by the Finnish company Dimenteq, and has used it to plan the locations of a new health centre and new shopping area. As shown in Figure 12, Harava is an online map-based survey tool allowing local residents to provide their opinions about different areas of a city, or to evaluate different planning alternatives. Harava has not yet been used in Sodankylä (by the municipality), but it's recognized as a good tool for forthcoming land use planning processes.

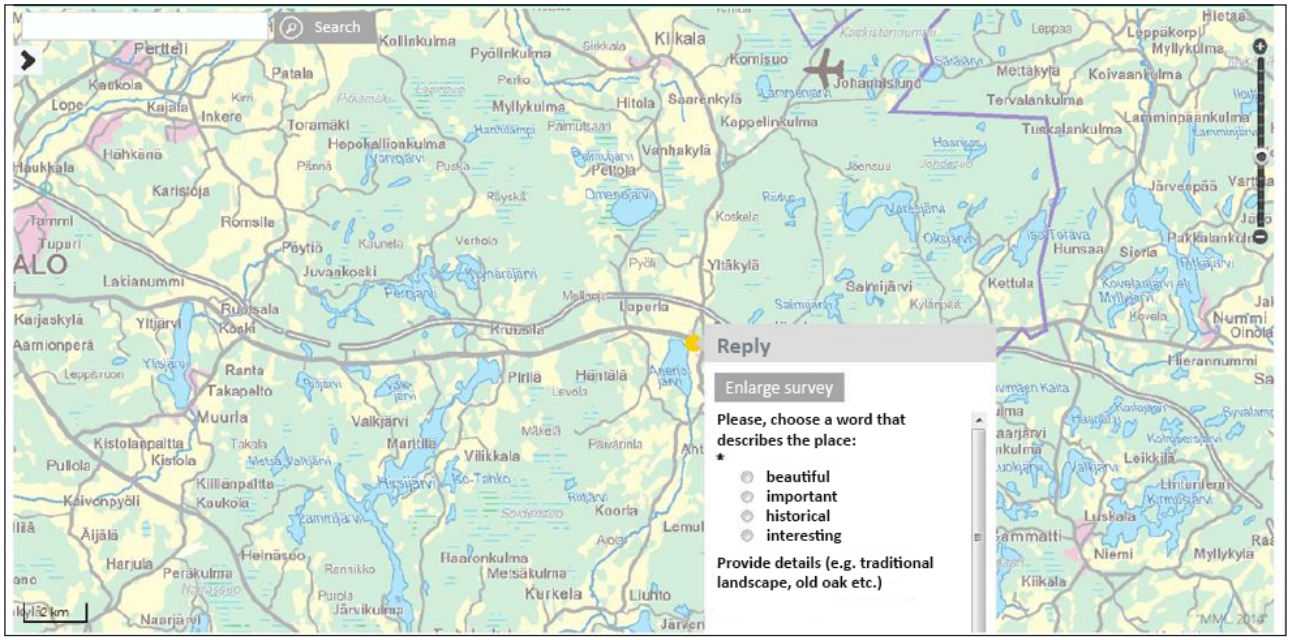

Figure 12: *Example of the online map-based survey tool Harava.*
Source: https://www.eharava.fi/en/references/userstories/salo/default.aspx.

Local competencies

Table 4: Responses to local competency questions for Sodankylä, Finland

Question	Response
What GIS tools, programmes and applications do you use in house?	AutoCAD, MapInfo.
To what extent do you outsource any of your land use planning and GIS work to consultancies?	When we need impact analyses and studies, or have demanding land use planning work to do, we procure consultants. Approximately 50% of our work on land use planning is outsourced. It's estimated that more work is done in house by the Sodankylä municipality itself than in some other small municipalities.
Do you foresee a need to develop your internal competencies related to GISs and communication using maps?	Currently the competency is at a reasonable level, but the technology and its applications are rapidly developing, so there is always a need for capacity building.
Do you host maps in digital format on your website relating to your land use plan(s)?	Yes.

Kualleq, South Greenland

Overview of key land use plans

As mentioned previously, land ownership in Greenland is quite different from other countries in that all land is common property. Consequently, land management and land use planning cannot be wholly transferred to companies, individuals or administrative entities. Instead, they are managed by "society" as a whole. Different government entities divide the work and undertake it on behalf of the government, but ultimately any overarching decisions need to be endorsed by the parliament. This means that while municipalities are expected to develop local plans for land use within their area, the land remains common property and decisions should be confirmed by the national authority. This may cause conflicts, because the municipalities' interests may deviate from national interests.

Regarding mining activities specifically, permission for resource extraction or appraisal, or an exploitation licence for oil and petroleum, must be sought through the national Mining Authority (within the Mining Department of the Ministry of Industry, Labour and Trade). As any new business must comply with all Mineral Resources Act requirements, the process starts with an application to the Licensing Division of Mineral Resources.

Responsibility for planning was one of the first areas that was delegated to Greenland after Home Rule was established in 1979. There is a great desire among Greenlanders to ensure that the country's land use is based on a pro-social perspective that emphasizes the interests of Greenlanders, using the opportunities provided through Home Rule. Physical land use planning has key importance in enabling the country to decide where different social services should be placed, to enable the development of coherent geographical structures.

Recent municipal reform providing increased flexibility in planning was expected to facilitate more active use of spatial planning by municipalities as a tool for business development, environmental strategies, education strategies, transport structure, etc., to create sustainable municipalities. In January 2009, the previous 18 municipalities in Greenland were merged into four. These larger municipalities became solely responsible for their own planning strategies and local plans. Similarly, from 2011, they have had delegated responsibility for planning and land use development within rural areas, which was a task of the central government under the old municipality structure. The municipalities are therefore expected to become even more important actors in relation to planning.

GIS tools and data used in Kujalleq

A major problem associated with the municipal reform described above has been that the municipalities were not allocated funding to support their new responsibility for activities such as spatial data management and the development of GIS competencies. Instead, more funding was allocated to the development of the national NunaGIS system, and updating information relevant for national planning.

In order to compensate for this disparity, NunaGIS was designed to give users the option to download data from the national system. Unfortunately, the MapInfo format was chosen, which did not allow the municipalities to use the data for spatial analyses (although, on the positive side, it enabled some level of map presentation). Recently, Asiaq announced that an updated version of NunaGIS may allow users to export data in ArcGIS compatible formats. The municipalities could then access centralized data for use in local analyses. Kujalleq municipality is also considering QGIS as an alternative planning tool.

Local competencies

Table 5: Responses to local competency questions for Kujalleq, Greenland

Question	Response
What GIS tools, programmes and applications do you use in house?	NunaGIS is used as the repository of national and regional data. Data is not updateable locally, only through national agencies. MapInfo is used as a tool for showing the registered data. When thematic maps related to the municipality are needed, analogue maps are often used.
To what extent do you outsource any of your land use planning and GIS work to consultancies?	Due to cooperation with a number of companies and institutions with the capacity to generate digital maps, some analyses are taking place based on this information. But most such work uses analogue maps. The registration of cadastral and land use maps in relation to sheep farming is taken care of by a local land survey company.
Do you foresee a need to develop your internal competencies related to GISs and communication using maps?	The information from Asiaq about the potential of exporting NunaGIS data to Arc formats has opened a discussion in the municipality about the future use of ArcGIS as an analytical tool. What may be more important, however, is the potential of using QGIS for local analyses, primarily because the ArcGIS series of tools may be too expensive for a municipality like Kujalleq. If Asiaq provides access to ArcGIS at a reasonable price and other municipalities adopt that solution, it may become a joint administrative tool in Greenland. Decisions about the development of internal competencies will of course depend on any central decisions about software.
Do you host maps in digital format on your website relating to your land use plan(s)?	No, except to the extent that data has been included in the national plans available through NunaGIS.

Brønnøy, Norway

In Norway, regional authorities (fylkeskommuner) are responsible for developing non-binding regional planning strategies, which should be in line with national guidelines and frameworks (Norwegian Ministry of the Environment, 2011). Therefore, the municipal plan is the main document governing land use and development within a municipality (see Figure 13). The municipal plan should comprise a strategic plan and a land use plan. The land use plan directly guides local plans and is legally binding. A key issue with newly introduced strategic plans at the municipal and regional level is that they must be updated regularly – at each new mandate period. The strategic plan should address long-term environmental and development challenges, and should be balanced between major urban areas and other regions, ensuring good living conditions in medium-sized cities that can reduce the pressure on the large urban areas (Norwegian Ministry of Local Government and Regional Development, 2013).

Overview of key land use plans

Brønnøy municipality has passed several strategic plans in recent years: the Municipal Master Plan for Brønnøy, which includes a social component; the Municipal Financial Plan; and the Municipal Planning Strategy of 2012, which is currently being implemented. The Municipal Planning Strategy must be in accord with legislation and national and regional guidelines. Brønnøy municipality has 39 different planning documents, of which three relate to the higher, strategic level, including the social component of the Municipal Master Plan 2013–2024 and the land use component of the Municipal Master Plan 1998–2010. The remainder are technical or thematic plans, e.g. the Strategic Business Plan 2012–2014, the Energy and Climate Plan 2011–2015, agriculture plans or plans for general and preventive health services. In addition, there are approximately 70 zoning plans. Currently, work is continuing on the land use component of the Municipal Master Plan and the Strategic Business Plan. Some current plans are under revision, e.g. the Cultural Heritage Plan and various zoning plans.

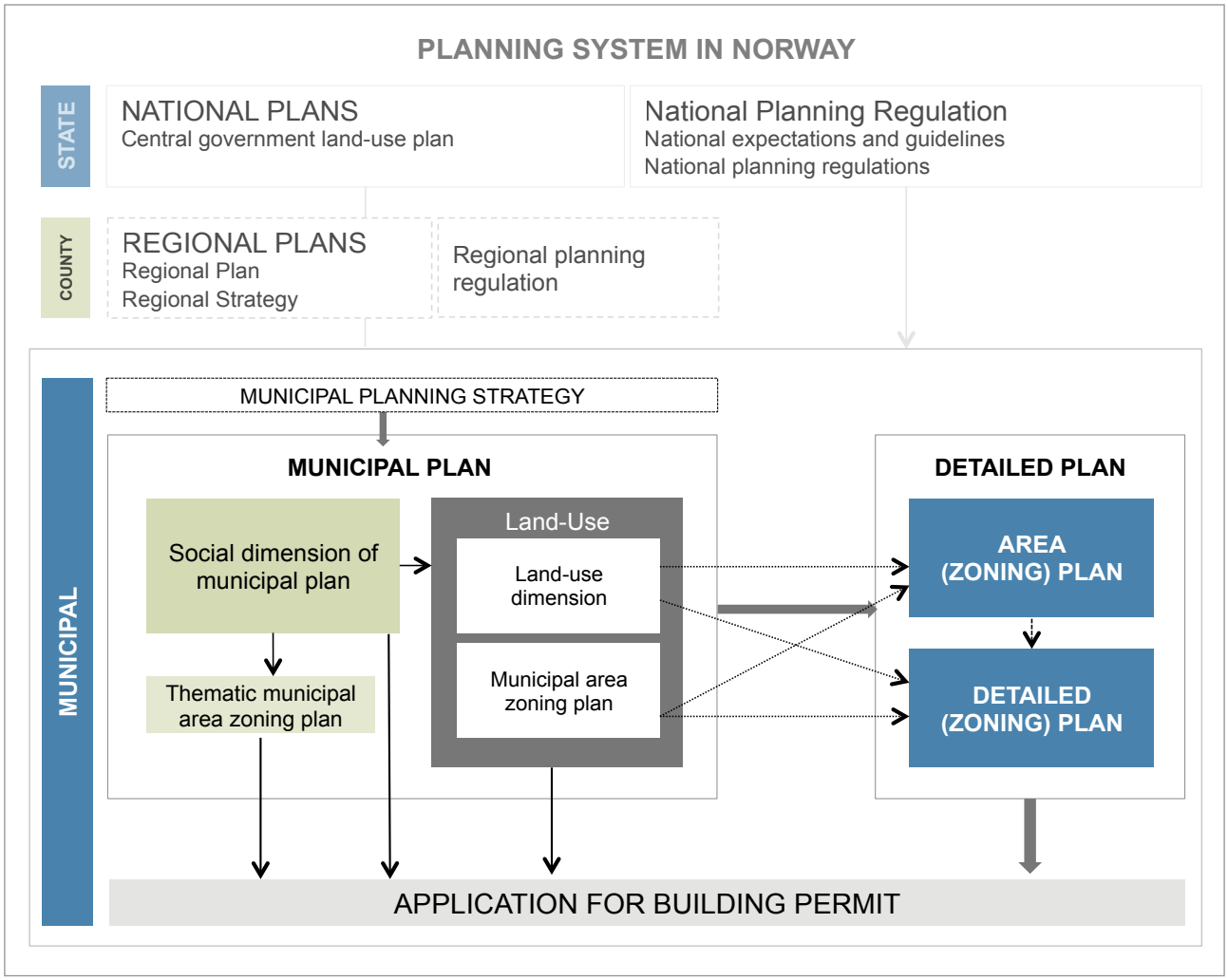

Figure 13: *Overview of the spatial planning system in Norway, with a focus on the local level.*

Development of the social component of the Municipal Master Plan in Brønnøy is the primary activity supporting the municipality's strategic management. It focuses on:

- the population and their living conditions;
- laying the foundation for a sound industrial sector;
- strengthening healthy local communities;
- further developing a functional and active regional centre; and
- strengthening the municipality's abilities and vigour.

The plan describes important features of the municipality (connected to people and settlement, social and health conditions, day care centres, schools and child welfare, culture, sports and outdoor life, industry, transport and infrastructure, nature, cultural life, landscapes, the environment, the climate, social security and the municipal economy) and the major objectives and strategies for four priority areas (health, quality of life and the childhood environment; wealth creation and development; town, district and regional centre development; and Brønnøy municipality as an organization and service provider).

GIS tools and data used in Brønnøy

Municipal planning is done with analogue maps that are digitized in AutoCAD (See Figure 14). Processes for transferring maps into GIS format were initiated, but the work has not yet been completed. This affects daily planning work on rollovers and revisions of new area plans. According to the plan and building act §2-2 (Plan- og bygningsloven), the municipalities must have an electronic plan register providing information on current land use plans. Therefore, it is a priority for the municipality to resolve the challenge of converting its maps to GIS format.

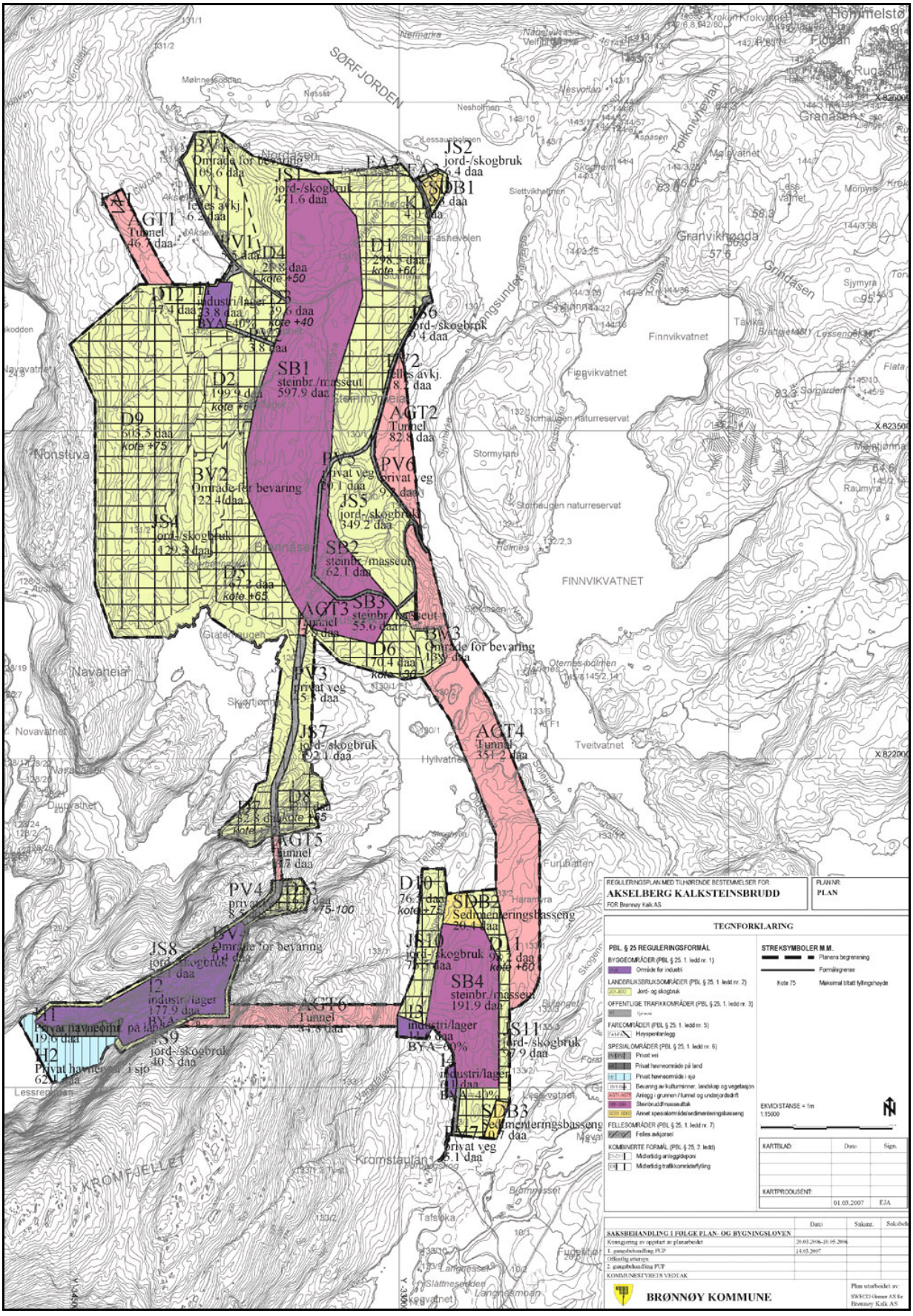

Figure 14: *Example of a local land use plan for Akselsberg, showing the area used for Brønnøy kalk mining activity (e.g. open mining areas are coloured purple). Source: Brønnøy kommune, 2007.*

Local competencies

Table 6: Responses to local competency questions for brønnøy, norway

Question	Response
What GIS tools, programmes and applications do you use in house?	AUTOCAD,GIS/Line and, to a limited extent, ArcGIS.
To what extent do you outsource any of your land use planning and GIS work to consultancies?	Most GIS work is outsourced.
Do you foresee a need to develop your internal competencies related to GISs and communication using maps?	Yes. There are three people in the administration working with GIS: one area planer and two working on mapping. Further staff could benefit from technical and general competency development.
Do you host maps in digital format on your website relating to your land use plan(s)?	Maps are available at http://www.bronnoy.kommune.no/>planinnsyn and http://tema.webatlas.no/bronnoy/Plan-innsyn (described under baseline 2.4). Brønnøy municipality has described the challenges it faces in digitizing maps.

Alstahaug, Norway

Overview of key land use plans

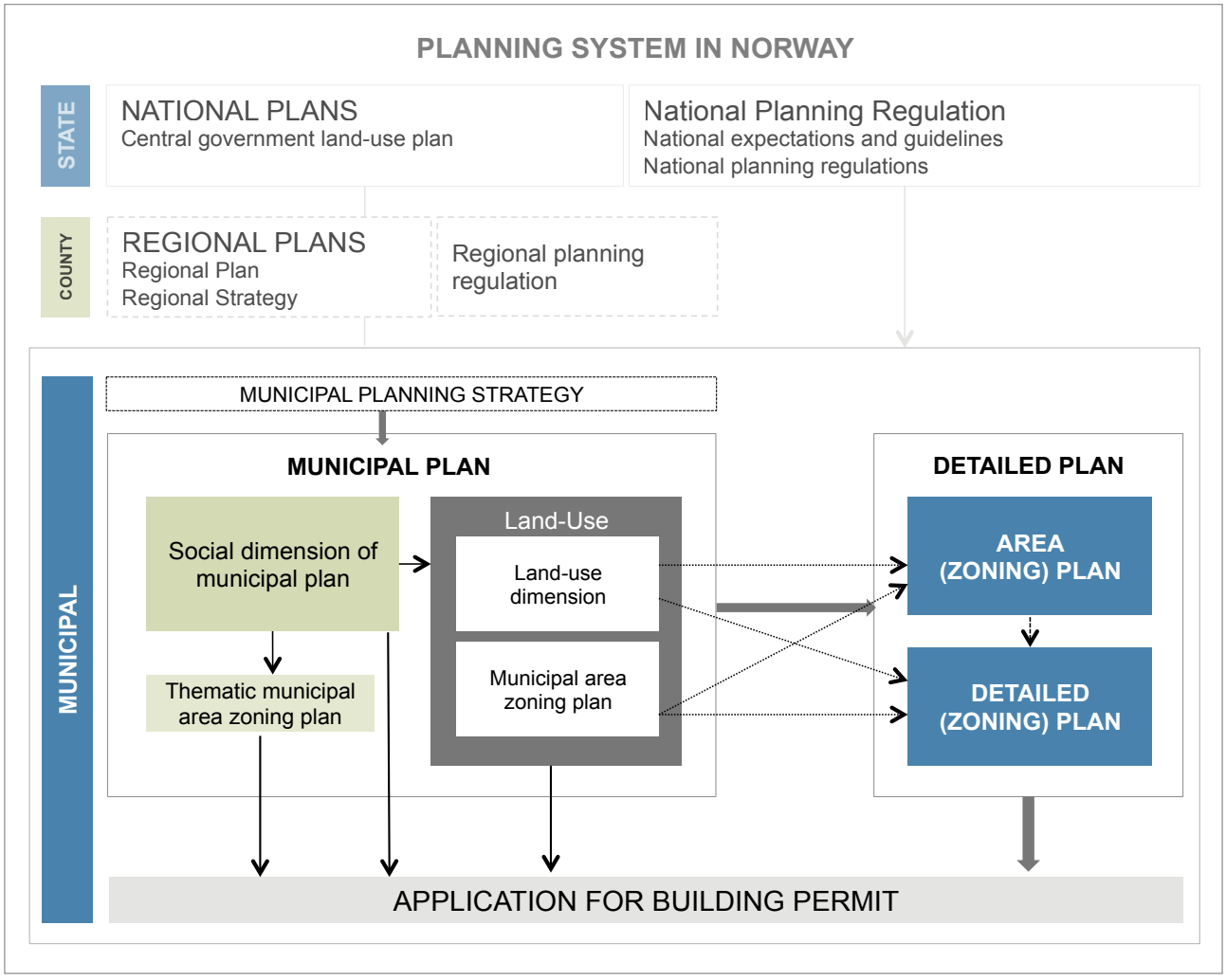

Figure 15: *Overview of the spatial planning system in Norway, with a focus on the local level.*

Regional authorities (fylkeskommuner) are responsible for developing non-binding regional planning strategies, as described for Brønnøy previously. The same protocols apply in Alstahaug.

GIS tools and data used in Alstahaug

A digital online mapping platform to support public participation in planning processes has been implemented in Alstahaug. Children's Paths (Barnetråkk) is an interactive, map-based website where children can register their use of urban areas in the municipality (see Figure 16). This information gives municipal planners and decision makers important insights into how children use and move through the municipality, and can be used to help develop transport infrastructure, recreation areas, security measures, etc.

Sandneselva is another project encouraging community participation. Here, the Alstahaug municipality uses its Facebook page to involve and inspire residents to use their local nature parks. There are, for instance, locations for geocaching and "mail-boxes" for the registration of visits in the area, with chances to win prizes.

Alstahaug municipality also provides links on its website to information about outdoor activities (hiking, canoeing, cross-country skiing, hunting, fishing, kayaking, etc.; http://www.alstahaug.kommune.no/kultur-og-fritid.197767.no.html). Further development of GIS and mapping activities in connection with these services, and land use planning in general, is an area of great interest for the municipality.

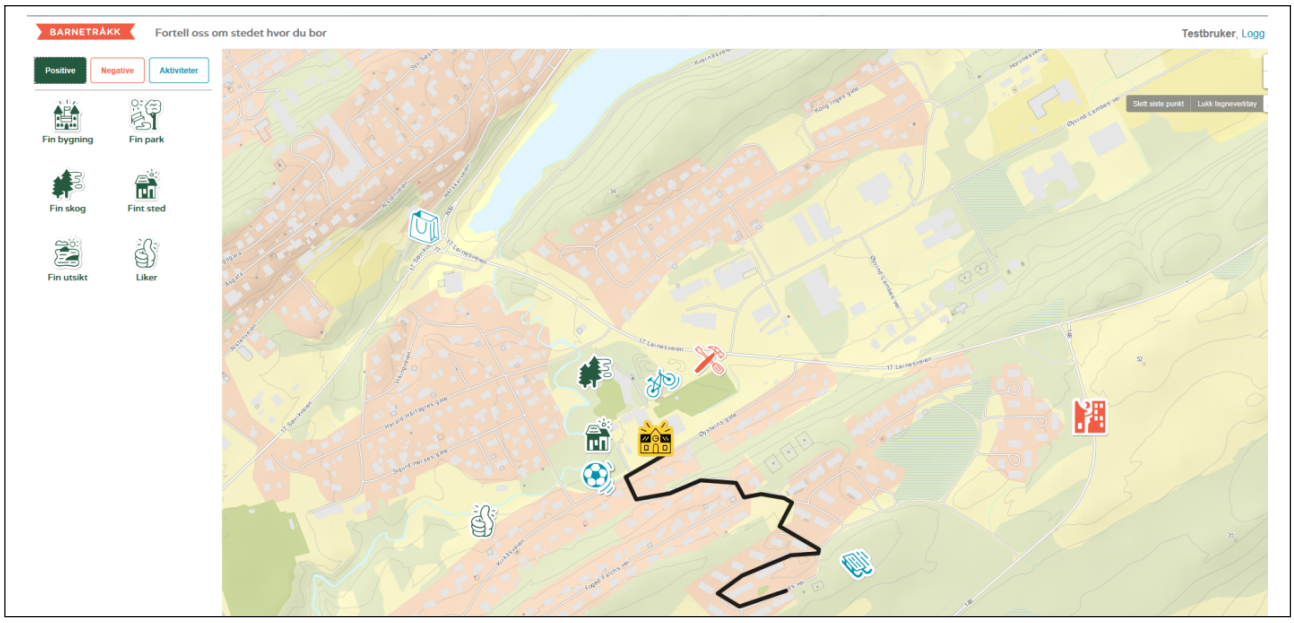

Figure 16: *Screenshot of the Barnetråkk platform for citizen participation in planning.*

Source: http://www.reginaproject.eu/s/Alstahaug-municipality-presentation.pdf

Local competencies

Table 7: Responses to local competency questions for Alstahaug, Norway

Question	Response
What GIS tools, programmes and applications do you use in house?	AutoCAD, GIS/Line.
To what extent do you outsource any of your land use planning and GIS work to consultancies?	N.A.
Do you foresee a need to develop your internal competencies related to GISs and communication using maps?	Yes, we want to continuously improve our skills.
Do you host maps in digital format on your website relating to your land use plan(s)?	Yes, but only on a basic level. We have used Barnetråkk as a digital platform for citizen engagement (with children), but would like to further extend this type of tool.

3. Foresight as a land use planning process

LAND USE FORESIGHT is a process for investigating, and providing information about, the future of land use in any given context. In the context of the REGINA project, it is a subset of local land use planning that focuses on anticipating the future impacts of possible land use decisions. It comprises a range of analytical tools and approaches that identify the impacts of future land use on the local society, economy and environment. Some of these tools were introduced in the previous section; others are included the discussion below. Another crucial consideration is the role of land use foresight as a process involving stakeholders, to create dialogue and gather opinions, in order to produce a plan that has the best chance of success in its local milieu.

Impact assessments

A form of foresight analysis commonly applied within the land use planning process is impact assessments. Zoning and development plans, which may have a major impact on the environment and community, must be assessed for their environmental and social impact. These assessments are often done in conjunction with risk and vulnerability analyses for the planning area. The assessment process should explain the assessed alternatives and be relevant to the decision that will be taken. This process is a formal and legitimate foresight study in that it assesses the potential impacts of a development project. Examples of potential environmental and social impacts are: damage to cultural heritage or the cultural environment; restricting Sami husbandry through the disruption of value-adding reindeer herding territory; increased air pollution, noise or smell; substantial pollution of water, the ground or sediment; a substantial increase in the emission of greenhouse gases; and substantial consequences for the population's access to outdoor areas, buildings or services. In addition, impact assessments should describe and assess factors such as biodiversity, outdoor activity, the landscape, children and young people's upbringing and public health.

While impact assessments have the potential to identify possible environmental or social impacts, their inherent weaknesses include:

- potential bias, in that they are generally conducted by the industrial actor that hopes to invest in a development;
- they are only conducted prior to the development of projects, so unforeseen social or environmental impacts (realized only during or after a project) cannot be evaluated; and
- they are not followed up with the monitoring needed to manage potential social or environmental conflicts. This is particularly important given that many large-scale natural resource projects have time horizons measured not in years but in decades.

Land use modelling

Section 1 mentioned the development of GIS-based integrated land use and transport models that can be applied to help forecast residential, business and transport development and their impacts on society, the economy and the environment (see for instance Nordregio, 2014). These GIS-based models use mathematical representations of the real world to forecast and evaluate the complex interactions between different elements of a land use system (Berglund, 2014). Typically, three elements are considered: the location of people in residential areas, the location of people where they work and the transport modes and networks used to move between home and work. The outputs of such a model could include, for instance, the predicted optimal distribution of new housing and work locations based on the existing urban form and planning development objectives (e.g. compact development, reuse of existing built-up areas, continuation of existing building development trends, increased urban sprawl, etc.). Other outputs could indicate the social, economic and environmental impact of future development.

Integrated land-use–transport models can be cat-

egorized by the underlying functional mechanism that rules the behaviour of the model, and by the model's theoretical foundation, as follows.

▶ Spatial input–output (I/O) models address spatial patterns in the locations of economic activities and the movement of goods and people between zones. They account for producers and consumers of goods and services and their interactions. They are mainly econometric models, developed by identifying the relevant actors, conceptualizing the drivers of their economic decision-making processes, hypothesizing variables that reflect those drivers and developing statistical approaches to test the hypotheses.

▶ Agent-based models (ABMs) are activity-based models with the individual (a person, household, firm or any other agent in the urban system) as the unit of analysis. An ABM consists of multiple interacting agents within a simulated environment. Rules are defined for the agents' actions, and these rules affect their behaviours and relationships. ABMs allow the exploration and simulation of the behaviour of an urban system at a fine level of detail. Activity patterns are modelled from the bottom up.

▶ Multi-agent simulation (MAS): ABMs can be extended to MASs, which not only contain an ABM representing disaggregated decision making, but also include cellular automata (CA) models (see the following section). The CA component models land use changes, while the agents represent human behaviours in the simulated environment. Thus, such models can simulate the complicated interactions both among agents, and between agents and the environment.

▶ Rule-based/spatial allocation models are simpler, faster, more visually accessible desktop tools. These tools are based on lightweight, less data-intensive and/or less theory-rich approaches (e.g. rule-based/GIS-based tools) compared with those above, and they aim to support rapid scenario analysis, visualization and community engagement using state-of-the-art interactive graphics, sometimes embedded in a web-based interface. Rule-based models are useful for planning agencies for long-range scenario testing, because they are easy to apply. They are often based on economic theories and market rules, but are not comprehensive enough to model complex economic and market processes. Simulations are generally based on specific policy alternatives. Spatial allocation models have typically been developed by geographers or planners who identify neighbourhood conditions that tend to be correlated with certain types of land conversion, especially residential and commercial development. A predicted amount of residential or commercial growth is allocated to specific locations (e.g. grid cells) to simulate future land use.

▶ Cellular automata (CA) models operate over a grid of cells. They consist of a matrix of regular cells spanning the urban area, each with a designated status (e.g. a land use status). The model defines the neighbourhood of intercellular influence (i.e. for any given cell, how many layers of neighbouring cells are affected by its status) and a set of transition rules that are applied to individual cells based on the statuses of the cells in their neighbourhood of influence. Some CA models also have an associated time aspect. CA models are basically deterministic and rule-based, as the transition rules are formulated as formal logical statements. CA models have been widely applied in geography and related fields because of four key advantages: spatiality and affinity with GISs, dynamism, micro-simulation and a bottom-up approach. Most often, they are not based on economic theories but rather rely heavily on historical trends. There are many potential applications. CA models can be used as part of a MAS model; in this context, a cell is considered an agent.

Foresight processes using integrated land-use–transport models are often seen as particularly useful because they can model complex interactions within the urban system, thereby increasing our understanding of cause and effect in these systems. In turn, they can be used to test different development options, to gain insight into potential impacts. In addition, the outputs of these models are especially important for facilitating participatory planning processes for collaborative decision-making (Batty, 2012). They become tools for stimulating thinking and facilitating discussion, rather than outputting definitive decisions to replace participatory planning (Berglund, 2014). This highlights their role as a component of a broader planning decision support system.

In the context of the REGINA project, two underlying challenges to the use of integrated land-use–transport models are notable. The first is the challenge of size. In small, rural and remote municipalities, which often lack well-developed GIS competencies, as described in the previous section, there may be insufficient underlying knowledge and spatial data to run such models. The second is the challenge of growth. Integrated land-use–transport models are often applied in larger urban areas that are trying to manage significant levels of population and workforce growth. These long-term and structural growth patterns are not characteristic of the

small- and medium-sized towns of the Nordic Arctic and Scotland. These challenges bring into question the usefulness of integrated modelling approaches outside large urban centres.

Digital platforms for stakeholder engagement

Digital stakeholder engagement platforms include any computer or online tool that allows stakeholders (including the public) to participate in planning-related processes. These technologies provide ways of ensuring that the views of public and private actors are considered when managing public infrastructure and services, as well as in the development of local land use plans and strategies. Participatory planning goals can thus be achieved during local development processes, while also responding to the basic principles of sustainable local development.

Different types of digital platforms exist in practice. For example, online surveys and questionnaires, distributed to stakeholders via email, a web link or other forms of outreach, exemplify a basic form of digital platform. The REGINA report, "Tools for Monitoring Social Impacts," details the use of questionnaires and surveys as tools that can provide foresight on the potential impacts of development projects.

Another more interactive and digitally innovative approach is the development of web-based GIS platforms that can be used to gauge stakeholders' reactions to current land use situations, as well as comprehensive plans, prospective land use master plans or even detailed development plans. As such, these digital platforms act as a form of foresight tool that can not only engage with local stakeholders but also provide foresight on the potential social and economic impacts of development plans. The capability of these platforms to analyse data (both visually and statistically) makes them particularly attractive for planners. They also offer the opportunity for planners to engage with local stakeholders earlier in the planning process, and to articulate more clearly how public input can contribute to the development of plans. This contrasts with the existing protocol of "public consultation periods" in which the public can comment on a pre-drafted plan, but after which there is no clear mechanism for applying or following up on public consultation within the planning process.

In Section 2, the reviews of GIS and spatial data use in municipalities identified two cases where GIS-based digital platforms have been developed or applied by local partner municipalities. The Finnish platform Harava has been introduced in Sodankylä, and the Norwegian platform Barnetråkk has been applied in Alstahaug. Both municipalities see opportunities for further use of such tools, as do other local partners (as reported during a project seminar in August 2016). Ad-

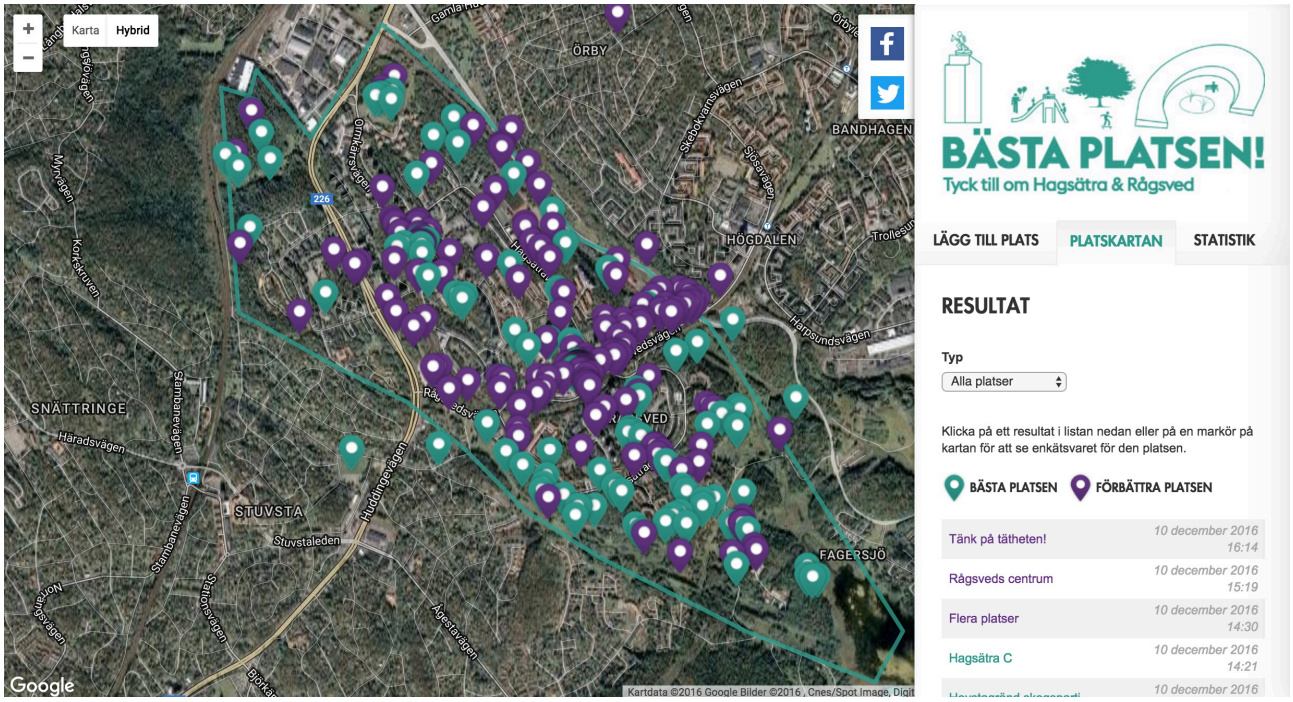

Figure 17: *Screenshot of the participatory GIS platform developed by SpaceScape and Project for Public Spaces.* *Source: http://dialog.spacescape.se/hagsatraragsved/*

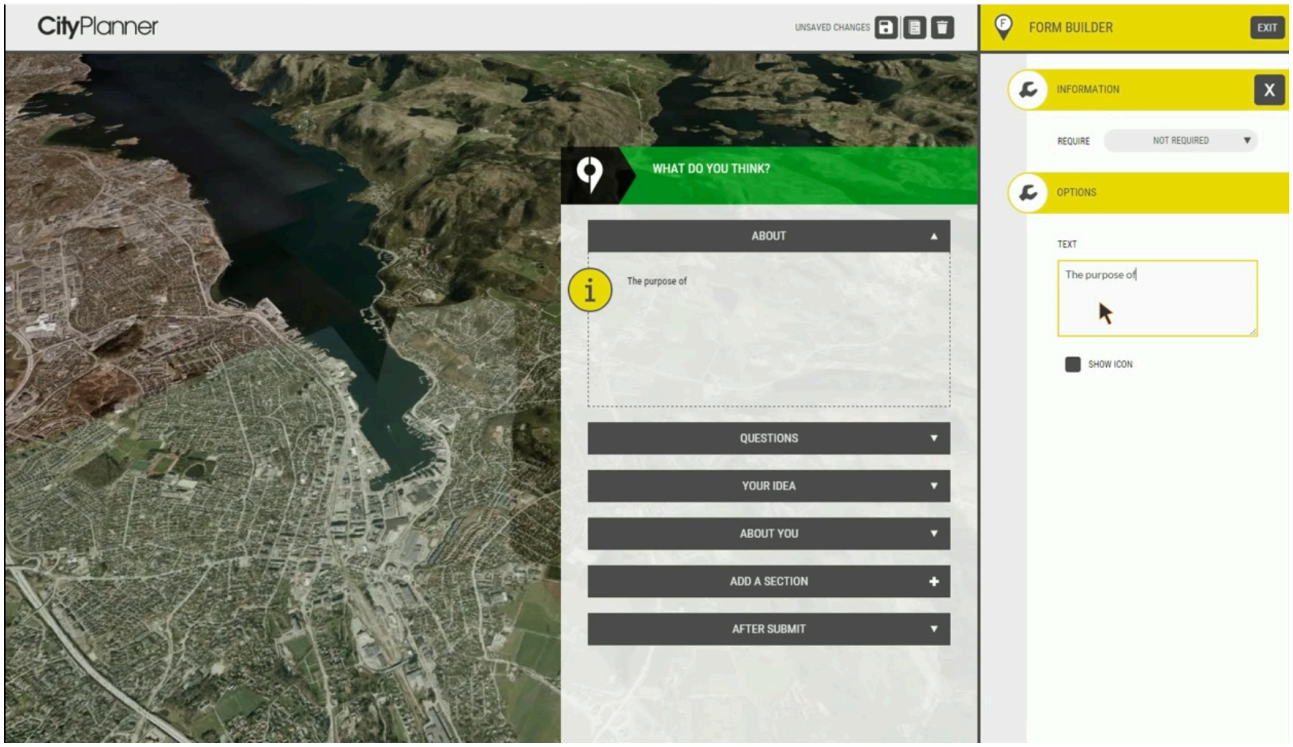

Figure 18: *Screenshot of the participatory GIS platform CityPlanner developed by Agency9.*

Source: https://cityplanneronline.com/site/index.php/crowd-sourced-urban-planning/

ditional existing platforms for participatory GIS exist, including the Bästa Planen (The Best Place) tool developed by the Swedish consultancy Spacescape, together with an American non-profit organisation called Project for Public Spaces (PPS), as well as the CityPlanner tool developed by the Swedish consultancy Agency9.

In practice, Bästa Planen is implemented as a consultancy project by Spacescape, which includes set-up of the platform, deployments support and analysis of the results. Figure 17 provides a screen-shot of a recent implementation in Stockholm Sweden, showing the use of a simple google base map and a delineated study area, with geo-located responses in two different colours: green for existing high quality locations and purple for existing areas that can be improved. Note that development can be easily overlaid on top of the base map so that respondents can provide comments about both the current situation of land use as well as ideas and designs for future development. When marking a location, respondents are asked a few predefined questions about the location, as well as being able to provide their own comments. Respondents are also asked some simple personal questions to obtain demographic information of their responses. In addition to its overall simplicity, a good feature of Bästa Planen is the statistics portal which provides the ability to analyze the results in real time, both by planners and the respondents themselves.

Figure 18 provides a screen-shot of the set-up process of Agency9's tool, which is part of their CityPlanner tool called "crowdsourced urban planning". Like the other tools, it also provides the ability to involve stakeholder and citizens in the early stages of planning processes, gather their ideas and knowledge, and harness that knowledge as information that can expedite projects. The CityPlanner tool also offers the ability to develop a future visualisation of a project in 3D, and use that planning vision as a basis for gathering input from respondents.

The main difference between Bästa Planen and the CityPlanner tool is in terms of how it is implemented in in a specific location. The user of CityPlanner is responsible for most of the customisation of the tool and its content to the local project, as well as managing the responses and analysing the output, while Bästa Planen is implemented more as a consultancy project by Spacescape. Therefore, the CityPlanner tool appears to be a more comprehensive platform, which is less expensive than Bästa Planen in terms of upfront costs, but this comes at the expense of time to learn, set-up, deploy and analyse the results.

Certain challenges in the use of web-based digital

platforms can be foreseen, however. For example, these platforms require parallel outreach activities to notify potential contributors about the existence of the platform, which in turn can create a challenge for ensuring a balance between different response groups. Other challenges include ensuring the reliability of the system, and providing the ability to generalize the results (to preserve the anonymity of responses) while maintaining the relevance of individual responses. Another challenge is that radical and dramatic responses may be over-represented compared with neutral and positive responses. These potential drawback need to be considered when using such tools, with potential solutions being incorporated on a project-by-project basis.

4. Practical guidelines for implementing land use foresight processes

GUIDELINES FOR IMPLEMENTING land use foresight processes are presented below as a conclusion to the previous sections, which have provided an overview of spatial data and GIS (Section 1), municipal land use planning and GIS use profiles in local partner areas (Section 2) and an introduction to land use foresight as a planning process (Section 3). The guidelines we offer must reflect the manner in which potential foresight methods are being applied within existing local planning structures, while also taking into account the GIS in use, existing plans and existing stakeholder networks. Considering the outlook for northern, sparsely populated municipalities, we have identified four key trends and findings concerning planning, GIS use and the use of foresight techniques, as follows.

First, more comparable and consistent data is being developed through initiatives such as INSPIRE. This helps to ensure that data developed from the bottom up (i.e. by municipal, regional and national authorities) is more consistent, thus improving data quality for local use. This process is also leading to the development of third-party planning tools such as models and web-based data portals, which in turn improve the availability of planning tools and overall data accessibility for local users.

Second, the availability of open spatial data will continue to increase. This will not only allow local authorities to do more evidence-based land use planning, but will also accelerate the development of innovative analytical approaches using GIS. A similar process is taking place in terms of the GIS tools themselves. Five to seven years ago, ArcGIS and its associated licenses often represented a financial burden for all types of users. The recent emergence of free, open-source GIS solutions, particularly the community-developed open QGIS software, has made GIS applications significantly more accessible. In turn, this has promoted the development of innovative spatial analysis methods related to land use planning, as well as providing a new entry point for local authorities to further develop their in-house GIS skills..

Third, the crowd-sourcing of data, such as through web-based mapping and information platforms, is increasingly a means for planners to acquire information from stakeholders. This helps to ensure that land use plans acknowledge and reflect local social, economic and environmental considerations as perceived by local stakeholder groups, including the public.

Fourth, the overviews of municipal land use planning practices shed light on the current use of GIS in northern, sparsely populated communities. The responses clearly indicated that while formal planning documents such as master plans and comprehensive plans are produced in much the same way here as in larger municipalities, the use of new and innovative GIS platforms and tools lags behind, especially in light of the growing availability of data. For example, when asked about GIS tools, programmes and applications that local partners use in-house, the responses emphasized rather outdated GIS solutions such as the AutoCAD digitization of analogue maps, or the use of long-standing GIS products such as MapInfo or custom-built national platforms such as NunaGIS and GIS/Line. Furthermore, each of the local partners wished to develop their in-house GIS competency, as well as seeking to apply new technologies. At the same time, however, they noted significant challenges in terms of funding investment in GIS tools, the cost of consulting and training for new applications, and not least, a shortfall in terms of the time investment required for gaining these new skills.

In response to these challenges, REGINA provides an opportunity for partners not only to share knowledge and experiences, but also to work collectively to develop and implement new planning tools that can contribute to land use foresight processes, particularly

in measuring and monitoring the social impacts, such as population growth, of large development projects – both land use development for industrial projects specifically, and indirect land use development arising from new industrial projects. Indeed, a key aim of the REGINA project, in relation to social impacts and effective land use management and planning, is that local authorities should view environmental and social impact assessments as a point of departure for further planning and outreach in the local community, rather than as an end goal of planning risk management. In particular, it is desirable to implement tools and analyses that more effectively evaluate the societal impacts of large-scale industrial projects during their development and operation, rather than only prior to construction. Furthermore, ongoing monitoring of these societal impacts will ensure that local positive impacts are sustained and negative impacts continue to be resolved systematically.

In order to help partners to monitor the social impacts of large-scale projects, REGINA has prepared the working paper "*Tools for Monitoring Social Impacts*." This provides several recommendations, including a comprehensive survey template, which can also be applied in the context of land use foresight processes. This is available from the Resource Centre on the REGINA website (http://www.reginaproject.eu/resourcecentre/). This working paper forms one of the two main components of the SIMP (Social Impact Management Plan) Toolbox.

The second component of the SIMP Toolbox will be guidelines on the use of innovative digital platforms for citizen engagement; namely, web-based GIS platforms that can be used to gain stakeholders' reactions to comprehensive plans, prospective land use master plans or even detailed development plans. Based on the experiences of specific local partners, the key value-added of such platforms includes their ability to:

- be efficiently distributed to a wide number of stakeholders as potential contributors;
- record and analyse stakeholder contributions, synthesize the findings and communicate these back to planners and stakeholders in an effective way; and
- create a structure for incorporating stakeholder input into planning processes at an early stage, so that the input is used to shape plans rather than merely to approve or contest them. This positively reinforces the importance of stakeholder input to the stakeholders themselves.

The Finnish platform Harava and the Norwegian tool Barnetråkk have been introduced and described in Section 2 while Bästa Planen and the CityPlanner tool were introduced in Section 3. It is a recommendation of the REGINA project to employ such innovative approaches to support land use foresight processes, through community outreach and stakeholder participation at early stages of the planning process. Our work in the coming year will be to provide more concrete instructions on the use of these platforms, through a pilot implementation of an existing platform in at least one of the local partner areas.

In addition to the components of the SIMP Toolbox, local communities facing significant population and economic growth stemming from large-scale natural resource development should consider the use of integrated land-use–transport models. While it was judged (in Section 3) that these foresight models are generally more readily applicable in larger municipalities or urban areas, specific local population growth pressures can provide opportunities for their use in smaller communities as well. Like digital platforms for stakeholder engagement, these models can be deployed at an early stage of the land use planning process to inspire stakeholder deliberation about land use planning alternatives. These models are typically implemented by consultancies, which can help overcome the burdens associated with internal competency development – albeit with an associated cost.

Lastly, and considering GIS competency development in general, it is clear that while new and more advanced land use planning tools are needed by local authorities, there are significant time and cost burdens that limit their adoption. The Kujalleq municipality noted that they are beginning to use the free, open-source QGIS platform for local GIS work. The lack of an upfront cost, coupled with the high quality of QGIS as a GIS platform, makes this a prudent choice. Not only is QGIS well integrated with a host of third-party extensions and plugins that support land use planning, but also the opportunity for in-house development of GIS competencies using QGIS can, in turn, advance a municipality's internal awareness of other emerging opportunities for improved land use foresight.

References

Batty, M. (2012) *Urban Models for Transportation and Urban Planning*. Eunora Consortium.

Berglund, L. (2014) *Review of Land-Use Models: Summary and Documentation*. WSP Sverige. Online: http://www.nordregio.se/Metameny/About-Nordregio/Nordic-working-groups/Nordic-working-group-for-green-growth--sustainable-urban-regions/Review-of-Land-Use-Models/ [Accessed: 2016-10-21].

Brønnøy kommune (2007) *Brønnøy Kalk AS, Forslag til reguleringsplan.* Brønnøy kommune Plan og utviklings avdelingen: Brønnøy.

CityPlanner Online (2017) *CityPlanner – Crowdsourced Urban Planning*. Online: https://cityplanneronline.com/site/index.php/crowdsourced-urban-planning/ [Accessed: 2017-01-02].

Eharava (2016) *Survery on Suomusjärvi.* Online: https://www.eharava.fi/en/references/userstories/salo/default.aspx. [Accessed: 2016-11-05].

European Environment Agency (EEA) (2016) *European Environmental Agency Homepage: Land Use*. Online: http://www.eea.europa.eu/themes/landuse#tab-datamaps [Accessed: 2016-06-14].

European Commission (2016) *European Commission Website: About INSPIRE Directive*. Online: http://inspire.ec.europa.eu/index.cfm [Accessed: 2016-2-18].

InfoGIS (2016) *InfoGIS Mapping Page for Sodankylä.* Online: infogis.infokartta.fi/infogis-sodankyla/. [Accessed: 2016-11-05].

Kaivosvastuu (2016) *Thematic Mapping Page*. Online: http://www.kaivosvastuu.fi/teemakartta/ [Accessed: 2016-11-05].

Nordregio (2014) *Integrated Models: Planning Urban Sustainability.* Nordregio Policy Brief 2014:1. Nordregio: Stockholm.

NunaGIS (2016) *NunaGIS Maps, Kommune Kujalleq Page*. Onine: http://kujalleq.nunagis.gl/ [Acessed: 2016-10-28].

Paikkatietoikkuna (2016) *Maanmittauslaitos.* Online: http://www.paikkatietoikkuna.fi/web/fi [Accessed: 2016-02-17].

REGINA (2017) *REGINA project website: news page – Partner meeting in Sandnessjøen*. Online: http://www.reginaproject.eu/s/Alstahaug-municipality-presentation.pdf [Accessed: 2017-01-02].

Sodankylän kunta (2015) *Maankäyttöpoliittinen ohjelma 2015-2020*. Finnish Consulting Group Oy, pp. 1–20.

Spacescape (2017) *Bästa Platsen – tryck till on Hagsätra & Rågsved.* Online: http://dialog.spacescape.se/hagsatra-ragsved/ [Accessed: 2017-01-02].

Storumans kommune (2015) *Bredbands-strategi för Storumans kommun – 2015–2020*. Storumans kommun: Storuman.

Storumans kommune (2014) *Masterplan för Tärnaby – Vision och utveklingsetapper*. Storumans kommun: Destination Hemavan-Tärnaby: Storuman.

Storumans kommune (2010) *Översiktsplan för Storumans kommun*. Storumans kommun: Storuman.

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