Geological maps in town planning—A step towards sustainable development in Finland

Introduction

Land-use planning and building in Finland have always been subject to strict legislation and to supervision by the authorities: from the initiation of any building project, until the final result is at hand. The most recent revision of the present Building Act transfers decision-making and the responsibility for supervision from the state regional administration to the local authorities in towns and municipalities. A major aim has been that decisions on land use should be made nearer the people and with full access to information on the local circumstances.

Finland is a sparsely populated country, where some 5.2 million people have 338 000 square kilometers at their disposal. However, the population is irregularly distributed over the area: population densities are highest in the south and southwest. The majority of the population (60%) is concentrated in towns, which constitute the cores of the economic areas and provinces (Statistics Finland 1998). Almost one-quarter (23%) of the population lives dispersed in rural surroundings. Finland has but one urban centre which fulfills the European town criterion - a population figure in excess of 250 000. This is the capital, Helsinki. The economic area surrounding the capital actually has some 1,150,000 inhabitants. On the other hand, there are nine urban regions with populations of over 100,000. The structure of Finnish towns is dispersed, with abundant green zones, water and parks. On the outskirts of traditional square-grid towns, the suburbs are surrounded by green areas. The dispersed urban structure and the lack of dense building are partly due to the comparatively low price of land, and partly to the Finnish building tradition. To a Finn, the dream house is a one-family house on a lake shore with all services nearby. About half of the Finnish dwellings—2,390,000 in all—are one-family houses or terrace houses, whereas over one million homes are situated in blocks of flats. The Finns strive to fulfill their dream by building lake-shore holiday houses as near their winter residences as they can afford. According to statistics, there are now some 430,000 holiday homes in Finland.

Communication and transport throughout the country requires much infrastructure. Finland has 78,500 km of public roads, 5,900 km of railways, 7,800 km of coastal sea routes, 9 700 km of inland water routes and 27 airports.

In land-use planning, Finnish society responds to the needs of citizens and of busi-

ness and industry with due regard to sustainable development and the special requirements of the Nordic environment.

The Finnish land-use planning system

Land-use planning takes the form of plans which are both written and presented on maps. The land-use planning system under the present Building Act has five different types of plans: regional plan, master plan, town plan, building plan and shore plan (Ranta 1997). Of the present land-use plans, the regional and master plans are of a general nature, whereas the town building and shore plans are more detailed. The planning procedure is regulated through the Building Act and the Building Decree (Table 1). The new Land-Use and Building Act, which comes into force on 1 January 2000, contains the regional land-use plan and the local master plan, while the town plan, the building plan and the shore plan are amalgamated into a local detailed plan.

Under the Building Act, a municipal federation sees to the drafting of general plans for its area according to local development needs. The municipalities, on the other hand, are responsible for the drafting of detailed plans. The main aim of planning is

to "provide, for different types of buildings, and sufficient and suitable land areas, so as to create pleasant and functional living environments for people". Good land-use planning is one of the most important instruments in developing a municipality. A 1994 amendment to the Building Act stipulates that land-use planning has to contribute to sustainable development, which means that environmental, economic and social effects have to be taken sufficiently into account. The hierarchical plan system means that a land-use solution indicated in a general plan will be rendered more precise in the more detailed plans.

The regional plan

Actual regional plans date back some 30 years, but Finland has worked with regional planning for over 50 years. Regional land-use planning and regional planning mean that more extensive areas than one municipality are considered at the same time. The comprehensive planning done by the municipal federations consists of an overview of the regional resources and prerequisites for development. Regional and functional goals are set, and long-range frameworks established. In this respect, a regional plan does not focus on local short-sighted interests and development goals, but applies instead a broader perspective, thus providing guidelines for long-range activities and growth. The responsibility for this kind of work rests with the municipal federations or regional councils.

A regional plan comprises a general scheme for the use of a certain area for specific purposes, based on necessary research and survey. The Ministry of the Environment initiates such plans, supervises the work and ratifies the results. A regional plan should always be seen as indicative and general, in contrast to the detailed plans. A regional plan allows flexibility in local planning, as well as in building and excavation.

The master plan

The master plan indicates the main types of land use in the area it covers. These include housing, business and industry, services, farming and forestry, recreation, traffic, water supply and other public necessities. Master plans are compulsory for towns, whereas other municipalities may choose different types of plans. The main master plan covers to the whole area of the municipality, whereas secondary master plans may be drawn up for parts of it. The juridical

Table 1 *The present and future Finnish land use planning systems and the plan hierarchies.*

PRESENT LEGISLATION	LAND USE AND BUILDING ACT 1.1.2000
REGIONAL PLAN REGIONAL AUTHORITIES	REGIONAL LAND USE PLAN REGIONAL COUNCIL
MASTER PLAN LOCAL AUTHORITIES	LOCAL MASTER PLAN LOCAL AUTHORITIES
TOWN PLAN LOCAL AUTHORITIES	LOCAL DETAILED PLAN LOCAL AUTHORITIES
BUILDING PLAN LOCAL AUTHORITIES	
SHORE PLAN COMMISSIONED BY THE LANDOWNER	

effects of master plans may vary, depending on their ratification status. Master plans for towns usually indicate land use with the precise locations of blocks or corresponding areas. In rural areas, secondary master plans have been used to design settlements and urban centres. Master plans have also proved useful in the improvement of the surroundings of built-up areas. The plan description will generally explain the environmental, societal and other effects of the plan implementation.

The town plan and the building plan

Town plans are used for detailed regulation of land-use in towns and cities. They are quite specific, and may reserve sites for residential areas, parks, squares, and the like. They also indicate the boundaries of plots and the building rights, the heights of buildings and the total area of floors. The plan regulations may also refer to such issues as roof structures and greenery.

When town plans are drafted, the existing built-up environment and its rational use must be taken into account. The plan description shall also include the environmental, societal and other effects of the implementation of the plan.

The building plans refer to other than urban municipalities; they largely correspond to town plans, although the surroundings are different.

The shore plan

Shore plans, on the other hand, are drawn up at the initiative of the landowner. They mainly deal with holiday housing. In some cases, the local authorities may engage in drafting shore plans, which are approved locally and are ratified by the regional environment centres. Since the revision of the Nature Conservation Act, the development of shore areas without plans is no longer possible except in a few specific cases (Ranta 1997).

Building ordinances and building instructions

The local building ordinances supplement the Building Act and the Building Decree, providing general regulations to promote suitable and useful development, and facilitating plan implementation. The regulations may refer to, say, the minimum size of plots for building and the location of buildings. These regulations are always general and never refer to individual building sites, and they may not unduly restrict the rights of the landowner.

The building instructions again provide details pertaining to the actual construction work. They reflect the local view of what

issues should be taken into consideration when siting the buildings and adapting them to the surroundings. The building instructions are generally drawn up in cooperation with the local people and the landowners.

Economic issues

Land-use planning has a bearing on major economic interests. The relations between local land use and the local economy have to be well understood, so that the decisions made will lessen the stress on the local or urban economy, and minimise costs for those living in the area and for the builders (Ministry of the Environment 1997).

The qualitative elements which influence building include absence of soil degradation and the quality and protection of groundwater bodies, and these have to be taken into account in any calculations referring to plan economics. Building in an area with contaminated soil may require removal of the top soil layer. If the worst comes to the worst, the contaminated soil has to be treated at a hazardous waste plant. The purification of contaminated groundwater is also very costly. At present, so-called natural energy sources are becoming increasingly popular. A geological example is soil heating.

If the surface deposits on a building plot are unsuitable for construction, this may cause a 10% increase in building costs and a 20% increase in infrastructure costs, compared with ground which is more suitable for building. Mistakes in the structural foundation may cause a building to settle or the structures to break or crack.

Geological maps in land use planning

Large-scale geological maps

In addition to ordinary survey maps, land-use planning should be based on detailed data concerning soil quality, the various types of soil, the load-bearing capacity, and other factors influencing building. A detailed and accurate surface deposit map will help in directing building and other land uses to suitable areas and will also take natural resources and the general environment into account. This can create considerable savings in planning, research and building costs, and in land acquisition costs. Proper siting is a key to the sensible preservation and use of natural resources, and to environmental protection.

The geological map shows the types of soil to depths of one meter and, based on bore hole sampling, provides information on soft spots extending beyond the supporting layer. It also contains information on the quality of the moraine, so that any additional

borings required may be properly planned. Moreover, the geological map presents specific geomorphological features (such as shore deposits and dunes or moraine formations), which may have to be taken into account in land use planning.

The costs of geological mapping amount to a fraction of the value of a building plot. To investigate the soil at different scales is an advantageous method which helps in planning geotechnical and other, more expensive studies. Soil mapping makes for cost savings at different stages of land-use planning and plan implementation. Geological information has a particular value at the land acquisition stage, as it may influence price-setting and the possibilities for building on the site.

Ordinary geological maps

Experience has shown that an ordinary geological map is not, as such, directly suitable as a land use planning map. This is because the speed required in ordinary geological mapping and the size of the grids used make generalizations unavoidable. The minimum grid square size in geological maps is 20,000 m² and for particular formations, squares the size of 1,000 m² may sometimes be used. The maximum breadth of a narrow grid strip is 30 m on the terrain. Some of the figures are based on interpretation, and the description does not cover all thin and partially exposed soil layers. The ordinary geological map provides regional information on the thickness of the surface deposits, based on borehole samples taken along road and railway lines, and sounding data on major soil configurations. There is also detailed information on mires and sources, pertaining to the quality and thickness of turf and the flow of springs. The maps are generally accompanied by written descriptions of the properties of the soils in the area, and tables illustrating soil and groundwater qualities (Huttunen et al., 1993).

The ordinary geological maps are prepared to cater for the needs of various users. A study of what the users expect (basic soil mapping in Finland, 1977, Haavisto-Hyvärinen et al., 1989) reveals that interest in geological mapping is on the increase. The respondents to the query make it clear that the ordinary geological maps have great importance for regional land use planning, especially for the land use plans made by regional and local authorities. The Land Use Department of the Ministry of the Environment has published a study (Rautamäki 1989) which indicates that research, information and considerations relating to soil are the main basis for the future development of many areas. The soil is the working area, both in land-use planning and environmental planning. The study also emphasises the importance of bedrock. This is the backbone

of the terrain, and it is a non-renewable natural resource. In a built-up environment, exposed rock surfaces are considered valuable elements, symbolising permanence.

A well-researched geological ground is a firm basis for urban structures

Large-scale geological mapping makes it possible to define with sufficient accuracy suitable building ground, as opposed to soft spots. Nevertheless, softer ground may also be divided into types which are more and types which are less profitable for building. Geologically, it is possible to detect, beneath clay and silt layers of less than one meter, good ground for building. The borders of the soil formations are investigated by using boreholes. In the border zones between load-bearing friction soils and soft areas, there may be places where it would be risky to build, such as where sand and silt cover underlying clay layers.

Some of the moraine areas have physical properties which make them suitable for building—sand moraine for example—whereas others are fine-grained moraine and unsuitable. The water permeability of sand moraine and fine-grain moraine is quite different. The fine-grain moraines generally hold water quite well, and are in that respect comparable to clay soils, whereas sand moraines let water permeate through as sandlands do. With respect to thawing and sludge formation, clayey fine-grain moraines have disadvantages as compared to sand moraines.

The ordinary geological maps are well suited for use in large-scale land-use planning, such as for regional land-use plans and municipal master plans. They make it possible to direct finer mapping operations to presumptive suitable areas. The Geographical Information Systems (GIS) make it possible to use the ordinary geological maps as the basis of thematic maps for classification for building purposes, shore types, and soil permeability. More accurate information is nevertheless required in order to provide geological maps on the same scale as the land-use maps, and soil borings and soundings are required to study the soil layers and their physical properties.

The indicative size for minor areas on ordinary geological maps is two hectares. However, this accuracy and the mapping grounds are not sufficient for land use planning on the secondary master plan level. The need for more detailed, accurate soil mapping, suited to specific purposes, has increased. In the 1960s and 1970s, geological and geotechnical soil maps for building purposes were made on the scale 1:10,000 in Espoo, Helsinki and Vantaa in connection with geotechnical investigations (Lappalainen 1992). The instructions for soil mapping in connection with land-use planning (ALPO 1986) presents examples and

Table 2 The Finnish land-use planning system and the pertinent geological map types.

REGIONAL PLAN REGIONAL AUTHORITIES	GEOLOGICAL MAP 1:20 000 - 1:100 000
MASTER PLAN LOCAL AUTHORITIES	GEOLOGICAL MAP 1:20 000
TOWN PLAN LOCAL AUTHORITIES	THEMATIC GEOLOGICAL MAP 1:2 000 - 1:10 000
BUILDING PLAN LOCAL AUTHORITIES	THEMATIC GEOLOGICAL MAP 1:2 000 - 1:10 000
SHORE PLAN COMMISSIONED BY THE LANDOWNER	THEMATIC GEOLOGICAL MAP 1:2 000 - 1:10 000

instructions for geotechnical soil maps on the scales 1:10,000 and 1:2,000.

The advantages obtainable from large-scale geological mapping may be summarised as follows:

- In prospective land acquisition and in preliminary land reservations, the soil information on large-scale geological maps is necessary. This information gives the parties to a land acquisition transaction a tangible and reliable basis for assessing the possible uses of the land and its value for different purposes.
- With the aid of a detailed geological map, the geotechnical soil studies required at different stages of land-use planning may be effectively directed to the proper locations.
- The use of large-scale geological maps gives savings at the initial stages of land use planning, when the development of new conglomerations, town blocks and different networks is drafted.
- Geological data are also needed in the final stages of land-use planning for the determination of building plots.
- Land-use based on geological data also results in savings at the construction stage. For instance, the costs for laying the foundations of a small multi-storey residential building may be cut by almost a million Finnish marks. On clay and other soft soils, the required pillar support structures may cause additional costs amounting to 10% of the total, as compared with building on firmer ground.

Soil mapping on the basis of geological data is a rapid method which leaves no traces in the terrain. Most of the mapping is done by a mapper on foot, carrying his boring equipment. After the mapping, soundings and additional borings may be made at key points, if the need arises. A combination of geological mapping, sounding and boring

will give a reliable picture of soil conditions in the area, such as the different soils and their properties, and the stratification of the different layers.

Soil mapping does not require open lines or fixed points on the terrain. The localisation of soil configurations and their delimitation is made with the aid of an accurate survey map and magnified air photographs. A new method for locating fixed points on the terrain and marking the sounding lines is GPS, which is based on satellites, land stations and the receiving apparatus used by the mapper. The new equipment makes the accuracy about one meter.

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Dr. Keijo Nenonen

Geological Survey of Finland,
P.O. Box 96,
FIN-02150 ESPOO,
FINLAND
E-mail: Keijo.Nenonen@gsf.fi

Dr. Olli Ristaniemi

Regional Council of Southern Ostrobothnia,
P.O. Box 109,
FIN-60101 Seinäjoki,
FINLAND
E-mail: Olli.Ristaniemi@epiitto.reg.reg.elisa.fi

Mr. Pentti Kallio

Maapeka Ltd, Seinäjoki,
Hakokuja 2A,
FIN-60100 Seinäjoki,
FINLAND