1. Introduction

Geographic information infrastructure is a set of basic services needed for the efficient exploitation of geographic information in the society. In Finland, the Ministry of Agriculture and Forestry set-up the Consultative Committee for Shared use of Geographic Information (PYRY). PYRY is composed of suppliers of geographic information from the state administration. One task of PYRY has been to determine the state of the art and the future development objectives of the national geographic information infrastructure. As a vision on the future usage of geographic information in Finland, the committee defined that: “Geographic information will be available through networks to any users. The optimal usage of the geographic information in the society will be insured by a variety of available services.” (PYRY, 1996)

As an example of the situation where geographic information will be used the committee proposed a system, where “the harvester in logging updates the company’s forest information system on the hardwood pulpwood processed during the day. From the information system a message is automatically sent to the inventory for transport. The information systems of the transport companies analyse this message and send back bids for transporting the timber. The transportation manager back in the forest company confirms the suitable bid with the assistance of the information system”. (PYRY, 1996) This kind of system, although not fully automated, is nowadays in use in all of the three biggest forest industry companies in Finland.

The purpose of this paper is to describe the current situation in the availability of geographic information for the forest technology applications in Finland.

2. Geographic information

2.1. General

Geographic information has been defined in Finland as “a complete set of spatial, attribute and identifying information of an object of the reality, including information concerning the quality of the information,” and in Europe as “Information about objects or phenomena that are associated with a location relative to the surface of the Earth. A special case of spatial information.” (PYRY, 1996; AGI, 2001)

Burrough & McDonnell (1998) have gathered definitions on geographic information systems into three groups. The groups differ from each other the way they approach the system. Toolbox-based definitions focus on spatial data processing tools. Database definitions are based on data flow in the system and data organization needed to handle spatial data. Organisation-based definitions emphasizes the role of institutes and people handling spatial information. It is worth noticing that operational environment have changed rapidly in the last few decades and this is why also definitions of GIS have changed during that time.

Geographical data models formalize how space is descretized into parts for analysis and communication. They assume that the phenomena can be specified exactly in terms of their attributes and spatial position. The soil properties and landforms vary smoothly and continuously over the geographic space. Thereby the
model of the space must also describe the variation of continuously varying attributes. The raster data model is the most-used alternative describing continuous surfaces. In the grid cell representation the 2D geometric surface is divided into square cells whose size define the resolution of the model. (Burrough & McDonnel, 1998) In vector format, spatial location is defined by the single coordinate pair (in the case of point data) or with the ordered coordinate pairs (in case of line and polygon data). Attribute data is related to the coordinates.

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**Figure 1.** Geographic datasets describe different phenomena. These information can be combined, analysed, and visualised using the tools provided by GISs. Usually the objects are modelled as points, lines or areas or represented as grids. Often there are various attributes related to these objects. (modified from PYRY, 1996)

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### 2.2. Available geographic information datasets in Finland

#### 2.2.1 Data providers

The most important geographic datasets for forest technology GIS applications in Finland are produced by National Land Survey of Finland (NLS) and Geological Survey of Finland (GSF). Other important datasets are provided by Finnish Meteorological Institute (FMI) and Finnish Environment Institute (FEI).
National Land Survey of Finland produces and provides information on and services in real estate, topography and the environment. It is responsible for Finland’s cadastral system and general mapping assignments and it promotes the shared use of geographic information (NLS, 2000 a).

The Geological Survey of Finland provides basic geological information about the Earth’s surface using geological, geophysical and geochemical methods. It also provides consultancy services in searching for exploitable resources in both bedrock and surficial deposits, including peat reserves (GSF, 2000 a). The Finnish Environment Institute produces information on the state of the environment and its development, as well as factors affecting it. (FEI, 2000) The Finnish Meteorological Institute produces basic climatrical data for various kind of research.

2.2.2 Useful data for a GIS-based routeing model

The following datasets has been considered to be useful for a GIS-based in-forest routeing model:
- elevation model in raster format or contours in vector format, (data provider NLS)
- streams and lakes, (data provider NLS)
- road network, (data provider NLS)
- cadastral boundaries, (data provider NLS)
- special terrain data (peatlands, rocks etc.), (data provider NLS)
- map of quaternary deposits / soil type map, (data provider GSF)
- climatological datasets (data provider FMI)
- land use and vegetation cover (data provider NLS)
- basic map as a background view for an operator (data provider NLS)

Digital elevation model (DEM) could be used for determining the water movement in the site. It is also usable when e.g. calculating the grade resistance on slopes. Nation-wide elevation model (DEM25) describes the height above sea level and it is calculated from the contour lines and coastline elements of the basic map by triangulation network interpolation into a grid model where the grid cell size is 25 x 25 m. The elevation model is supplied in a Finnish uniform coordinate system and altitude (dm) is described in N60 coordinate system. Inaccuracy on location of the model is 2-10 m. (NLS, 2000 b)

NLS has started to produce the new elevation model with the resolution of 10 meters but the dataset is not yet a nation-wide (Toivanen, 2000). This model is considered to be better than DEM25 for modelling hydrology in trafficability analysis. Thus if this resolution is required before the commercial dataset is ready, the model has to be produced with the GIS software tools based on the contours, lake shorelines and height points (in vector format). NLS is a provider for these datasets and the datasets are nation-wide.

Information about streams and lakes as well as artificial drains is available and can be used to determine a so called hydrologically correct elevation model. In this calculation, water is directed to the streams and drains and the cells which act like water sinks in DEM are corrected to the level which allows the water movement through those cells. This calculation scheme may be useful in some cases. It will, however, remove also the real topographic depressions and thus reduce the information content and usability of the DEM in trafficability analysis. The problems are also related to the artificial drain network as it affects too much to the new elevation model. Stream and lake dataset (in vector format) is also usable when determining the buffer zones (e.g. restricted areas near the waterways and riparian zones) in trafficability analysis.
**National Road Database of Finland** covers whole country and contains data on both the public and private roads. It is the most accurate dataset of roads with the locational accuracy of three meters. The road database includes e.g. road classification, road and section numbering, data on road surface material, stage of construction and height restrictions. The road dataset is nowadays used e.g. in timber procurement logistics. (NLS, 2001 a)

**Dataset of cadastral boundaries**, together with GPS, can be used directly in the real-time routeing model as a part of its alarming system. This kind of system is quite helpful in Finland as the average size of a single land ownership unit (holding) is quite small and in some cases boundaries aren’t clearly seen in the forest because of the vegetation. This boundary dataset is nowadays available nation-wide. (NLS, 2001 b)

**Special terrain data** is available as a single dataset (Maasto/1) (Toivanen, 2000). This dataset includes information about e.g. peatlands, other peat-covered areas, bedrock outcrops and groundwater springs, all of which can be directly used in trafficability analysis. The dataset is in vector format, which allows e.g. easy scaling when the dataset is visualised.

**The soil type** is used as a surrogate factor for determining the hydrological properties of the site. In addition, it can be used directly in trafficability analysis when determining e.g. bearing capacity of the terrain. In Finland, map of quaternary deposits (in scale 1: 20 000) contains deposit borders as polygons, small bedrock outcrops, dunes, glacial marginal formations and ancient shore lines. It includes also some point data about boreholes, wells and soil samples and hydrological information about groundwater and springs. The completeness of the map series is not a nationwide and in digital format it is available mainly in Southern Finland. (GSF, 2000 b) A nation-wide soil type map, in raster format and with a quite rough soil type classification, is available with the resolution of 200 meters. (Vallimies, 2001)

Database of Finnish quaternary mapping includes information of the digs, boreholes and the sample points which were collected for producing of the map of quaternary deposits. One sample point is described by 14 attributes including e.g. subsoil material, peatland type, thickness of peat deposit, groundwater level, and clay content on three layers (0-40, 40-90, and 90-150 cm) from the ground level. (Paikkatietohakemisto, 2000 a)

**Basic climatical datasets** include monthly normal values e.g. evapotranspiration in all main land types and detailed maps of water balance components for the period 1961-1990. The observation network of the Finnish Meteorological Institute consists of about 400 stations. Data from measurement sites is available as a single point observations or in lattice where distance between points is 10 x 10 km. Depending on the dataset, one sample point is described by 4-13 attributes including e.g. monthly precipitation, mean temperature and thickness of snow cover. (Paikkatietohakemisto, 2000 b) By using FEIs internet service Ilmanet, it is also possible to get weather information for a certain time period (e.g. sum of precipitation for past few days). (FMI, 2001)

**Dataset of land cover and forest classification** is based on national forest inventory data, topographic map and satellite images. The dataset is nationwide and the resolution of the data is 25 x 25 meters. Finland is the first country in Europe to produce this kind of extensive and accurate digital ground inventory. The relative occurrence of tree species and the density of the growing stock can be distinguished in the dataset. The dataset is updated every four years. (NLS, 2001 c) The new version of the dataset (SLICES) includes
also information from other sources. (SLICES, 2001) The basic dataset is applicable for the water budget calculations together with climatival data and DEM. Water budget could be used to describe the relative differences in site wetness and thus in site sensitivity.
References:


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