GIS and Water Supply

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Abstract

The GIS and Water Supply project deals with the usability and quality of GIS data and techniques related to water services. The main objective of the project is to find out the way detailed information on water services could be produced by joining GIS data and registers. There is no reliable and nationally comprehensive GIS data available on the water supply and sewer systems of real properties in Finland. The method for acquiring information on the water supply network connections of buildings in the densely built-up areas has been developed and tested. Acquiring information on the water supply and wastewater treatment systems of the rural areas is more complicated. The situation is completely unmapped at the moment and the data collection is difficult and time-consuming. Solutions for this problem have also been considered in this project.

1. Background and objectives of the GIS and Water Supply project

The GIS and Water Supply project is coordinated by the Finnish Environment Institute. The project deals with the usability and quality of GIS data and techniques related to water services, both water supply and sewerage. The project has a practical approach and is based on empirical research that has been carried out in cooperation with specialists and the representatives of the pilot areas. Pilot areas are made up from different types of municipalities in Finland. The project has concentrated on the problems of the densely built-up areas as well as rural areas.

The principles of sustainable development demand that the water services of the densely built-up areas should be properly organised. According to the Finnish legislation, the water services should be developed so that it meets the needs of the spatial structure of the communities (Water Services Act, 5§). At the moment there is no reliable and nationally comprehensive information available on the water supply and sewer network connections of real properties in the densely built-up areas in Finland. Therefore the monitoring of the present situation is very difficult. One of the main

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objectives of the project is to find a method for producing information in order to develop water services and land use planning by using GIS data and different existing registers.

In addition, the water supply and sewer systems of the rural and sparsely populated areas should be well organised. The problem is especially acute in the rural-urban fringe areas where new settlement is developing more quickly than the infrastructure. The fragile shore areas are also problematic, as the number of summer cottages is increasing rapidly. At the same time the equipment of the cottages is improving and the number of cottages suitable for permanent residence is expected to double by the year 2010 (Mäntylä 1999, 174-175). The water supply and sewer systems of the buildings outside the densely built-up areas are completely unmapped, which makes reliable monitoring of the development impossible. The information is also needed when planning improvements for the water services of the buildings.

2. GIS data concerning the water services

Detailed and up-to-date GIS data facilitates both land use planning and the planning of new water and sewerage networks, as GIS makes it possible to visualise the data on maps and to analyse the spatial relationships of different objects. For example, the planning of new residential areas is more rational when the information on the location of the existing infrastructure is available (Fig. 1). Planning water supply and a settlement simultaneously is good not only for environmental but also for economic reasons. If the settlement is allowed to disperse, infrastructure construction – including water services networks - will become very expensive for the municipalities, especially in the areas where building is increasing intensively (Kopra 1992, 45). On the other hand, there are rural areas where there is overcapacity of the infrastructure due to the declining population, which causes economic loss. It has been stated that arranging the water services is one of the largest expenses when calculating the cost of the infrastructure (Kopra/Meronen 1999, 4).

In environmental research GIS data is useful when mapping the locations of the non-sanitated, fragile environments. The environmental load of the real properties in the shore areas can be assessed if information on the water supply and sanitation equipment of the houses and the number of inhabitants is available. Also, the ground water areas with dense settlement without proper sanitation can be pointed out and the risks can be estimated. It is possible to calculate the average daily water consumption per inhabitant in a house or a small settlement. That kind of information makes it easier for planners to estimate the water conducting capacity of old pipes when water is connected to new areas from the old areas. The information is also needed when updating the annual statistics and completing EU questionnaires controlling the implementation of the directives.
Fig. 1: In this illustrative area there are buildings without a municipal water supply. The size of the circles denotes the number of inhabitants in each building. The age structure may also be an important factor when planning new pipelines. Map sources: National Land Survey of Finland, licence 7/MYY/02, Population Register Centre

Important GIS data concerning the water supply and sewerage are, of course, the networks of pipelines, which normally contain information on the capacity, age and material of the network. Another GIS data containing information on the water supply is the Finnish Building Register. The Building Register is a part of the Population Information System maintained by the Finnish Population Information Centre. The information on buildings, their addresses, use, area, connections to different networks as well as the number of inhabitants living in each building etc. are maintained in this register. Also the xy-coordinates of the central points of the buildings have been registered, which makes it possible to use the register as GIS data.

The problem is that the attribute information is not currently valid. The Building Register is updated every time someone applies for a new building permit or a permit for renovation of an old building (Kemppainen 1998, 26). Some of the alterations do not require a permit. One of these is connecting a building to the water supply network. The Building Register contains a considerable amount of incorrect information because the updating has not been properly organised. The reliability study of the Building Register was made by Statistics Finland (1990, 94) and the study stated that information on connections of buildings to the sewerage network in particular, was
quite unreliable. The reliability tests made in this project confirmed the statement and also found the information on water supply network connections rather unreliable.

3. Improving the quality of the Building Register’s water supply information

A method for making the Building Register’s water supply connection information more accurate has been developed in the GIS and Water Supply project. The water supply plants have reliable information on their customers in the Customer Registers, which are used for invoicing the customers. It is possible to join the information of Customer Registers to the Building Register if there is at least one common field in both registers. A common field can be the unique id-number that has been given to each building or it can also be the street address (Fig. 2).

![Fig. 2: Joining registers is based on at least one common field in the tables.](image)

<table>
<thead>
<tr>
<th>Building’s ID</th>
<th>Address</th>
<th>Use of the building</th>
<th>Inhabitants</th>
<th>Address</th>
<th>ID</th>
<th>Water</th>
<th>Waste water</th>
</tr>
</thead>
<tbody>
<tr>
<td>257488002038002</td>
<td>Street Address 1</td>
<td>residential</td>
<td>8</td>
<td>Street Address 2</td>
<td>1072</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>25701000050007001</td>
<td>Street Address 2</td>
<td>office</td>
<td>3</td>
<td>Street Address 1</td>
<td>0925</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>25701000050007005</td>
<td>Street Address 3</td>
<td>residential</td>
<td>15</td>
<td>Street Address 4</td>
<td>2541</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>2574120007025001</td>
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<td>trade</td>
<td>4</td>
<td>Street Address  1</td>
<td>0098</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>

BUILDING REGISTER

CUSTOMER REGISTER

The method for joining registers has been tested in the pilot areas of this project, and it seems that by joining the registers automatically with SQL requests approximately 80% of the information in the Building Register will be updated. With a more detailed inspection the percentage can be as high as 90 and the remaining 10% are mostly public buildings. When using the street address as a common field, some errors or mismatching will occur, e.g. due to spelling mistakes. Despite the occasional errors the end results were considered useful by the representatives of the pilot areas.

4. How to obtain water supply information from the rural areas?

The Customer Registers of the water works can only be used to obtain information on buildings that are connected to water supply networks. One of the aims of this project is to find ways to collect data and keep up a data system concerning the water
supply in rural areas as easily and reliably as possible. About 19% of the 5.2 million inhabitants of Finland live outside the public water services. The total phosphorus load to lakes, rivers and coastal waters caused by this minority (415 t/y) is 1.5 times higher than the load caused by the rest of the population (270 t/y) (Ministry of the Environment 2001, 10).

It is not possible to collect the data by simply asking the inhabitants questions by using an inquiry. An average inhabitant does not have enough knowledge of his or her own water supply and sewer systems nor of the terminology related to them to be able to answer the questions. The only way to be sure about the reliability of the data is that it is collected by an expert visiting every house. Thus, the data collecting means an enormous amount of work especially in Finland, where the settlements are quite sparsely situated. The present intention is to discover ways and means which would make the work easier and less prone to errors.

As an example, a map of one of the pilot areas was drawn showing the wastewater treatment systems of the houses. The results of the mapping were used to calculate the biological oxygen demand and phosphorus load of the wastewater caused by each house (Fig. 3.). The calculations were based on the water equipment, the wastewater treatment system and on the facts about the efficiency of different types of wastewater treatment systems. The efficiency of the most common wastewater treatment systems for individual households in Finland has been studied and tested by the Finnish Environment Institute (Kujala-Räty/Santala 2001).

Fig. 3: If the BOD load of buildings exceeds 5 g/ inhabitant/day, the waste water treatment should be improved. In the coastal zone the requirements may be stricter.
The information was transferred to GIS data. When the houses were located on the map it was easy to identify which of them were within a certain distance to the nearest water system. Thereafter it was relatively simple to make a proposal to each house regarding how the wastewater treatment should be organised in order to meet the requirements set by the legislation and the environment.

Bibliography

Water Services Act 119/2001