

# posiño

ICC 2015 Special Issue



## MAKING MAPS WITH OSKARI

# One Map Finland

One Map Singapore provided an example of integrating data and services from various governmental agencies already in 2010. In the beginning there were 16 contributing agencies and five services, and the amount is now doubled. Other success stories include the Netherlands where the Dutch National SDI (PDOK service) contains 81 datasets with 1.1 billion hits in 2014.

The National Land Survey of Finland (NLS) has set the goal to create One Map Finland by 2030. Important aims are applying cost-effectiveness and that the information content of the data must start with user needs. One Map Finland means integration of governmental and local spatial information using standards, open access to data services and easy-to-use interfaces. In fact, the goal is to only need three mouse clicks to start One Map Finland.

Finland has been one of the leading countries in the opening of its governmental data. The NLS opened topographic data as early as 2012. At the beginning of 2015, the Finnish Geodetic Institute was merged with the NLS giving us a great opportunity to utilise top research for the development of national spatial services.

In the European Union, the INSPIRE directive provides an important basis for the development of eGovernment services. The NLS together with the Ministry of Agriculture and Forestry are coordinating the implementation of INSPIRE in Finland.

We have already delivered a national geoportal ([www.paikkatietoikkuna.fi/web/en](http://www.paikkatietoikkuna.fi/web/en)) and further implementation is on its way. However, use of the infrastructure does not happen by itself. Therefore, we have invested in helping other governmental agencies and application developers to start using spatial information by offering the open source platform Oskari ([www.oskari.org](http://www.oskari.org)). Oskari provides an open source alternative for the utilisation of national spatial services.

The vision of One Map Finland needs co-operation with all partners. International co-operation is more and more important. The NLS together with other European mapping and cadastral authorities are working to implement a European Location Framework for providing access to authoritative data services ([www.elfproject.eu](http://www.elfproject.eu)). It is the first step towards One Map Europe.

ARVO KOKKONEN  
DIRECTOR GENERAL  
NATIONAL LAND SURVEY OF FINLAND



PHOTO: PIRKKO YLISELÄ / NLS



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POSITIO ICC 2015 SPECIAL ISSUE – CARTOGRAPHY AND GEOINFORMATICS IN FINLAND

THIS ENGLISH EDITION OF THE POSITIO-MAGAZINE REPORTS SOME OF THE PROGRESS MADE IN FINLAND IN THE GEOINFORMATION FIELD.  
IT'S ALSO FINNISH NATIONAL REPORT TO THE INTERNATIONAL CARTOGRAPHIC CONFERENCE.

EDITORS: KIRSI MÄKINEN, KIRSI.MAKINEN@NLS.FI, PAULA AHONEN-RAINIO, PAULA.AHONEN-RAINIO@AALTO.FI

EDITORIAL ASSISTANT KATRI ISOTALO, KATRI.ISOTALO@VIESTINTAISOTALO.FI, LAYOUT PEKKA JUSSILA, COVER PHOTO: RIKU NIKKILÄ, BACK COVER PHOTO:  
TOMI MUUKKONEN.

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C/O ANNAMAIJA KRANNILA, NATIONAL LAND SURVEY OF FINLAND, SIHTEERI@KARTOGRA.FI

# Hitting the limits of high-performance computing platforms

- With the increased size of data, our analysis and spatial modelling tasks have become more complex. A perfect case for advanced geocomputation.

**A**nyone operating with geospatial analysis has found themselves in a situation where a GIS application is unable to open the data due to memory limitations, or performing spatial analysis tasks takes far too long, or the application halts completely without explaining the real reason for the stop. In these cases, advanced geocomputation becomes of real value.

Geocomputation has been seen as a new paradigm for approaching spatial analysis. A characteristic of geocomputation is the use of large datasets and computationally intensive data processing. By ‘advanced geocomputation’ we mean the running of highly optimized code for spatial analysis that makes use of aggregated computing resources, such as multi-node clusters, accelerators like general-purpose graphics processing units (GPUs), and multicore processors. These computing resources may be available in high-performance computing (HPC) supercomputer clusters, but also in the hardware-accelerated workstations commonly used for running GIS applications.

## Too much data

The need for advanced geocomputation stems from factors related to data in terms of size and actuality, analysis and modelling, and the eligible level of interaction in user interfaces.

Development of sensor technology has led us to a situation where the amount of collected data extends far beyond the physical memory limits of any computing resource. Increased spatial coverage together with improved spatial and temporal resolution inevitably lead to a situation where the data will not fit in the memory of your device.

Simultaneously with the increased size of data, our analysis and spatial modelling tasks have become more complex. For example, we need to perform repeated computations due to input data based on real-time environmental sensors and the use of Monte Carlo method with 100–1,000 simulation runs that enables uncertainty awareness of the analysis. We also want to make large pre-renderings of extensive geospatial data for cached

Web map services and advanced animated geovisualisation. On top of that, we expect our applications to support a high level of user interaction. Luckily, we seldom need all these requirements simultaneously; rather, factors vary from case to case and also their impact on the consumption of computing resources varies.

At the Finnish Geospatial Research Institute and Åbo Akademi University, we have worked on several research projects to develop solutions for advanced geocomputation. Recently, our special interest has been on quick-response geocomputation, which enables batch processing, as well as interactive use through graphical user interfaces. Examples of these are presented in the following two cases, giving different perspectives for advanced geocomputation.

## Uncertainty-aware drainage basin analysis based on GPUs

In uncertainty-aware geospatial analysis we compute not only the solution to a given problem, but also estimates of the uncertainty of the solution.

Although the foundation for uncertainty-aware geospatial analysis is rather well established, it has received relatively little practical usage. One of the reasons for this situation is the fact that uncertainty analysis is computationally very demanding. The implementations depend on Monte Carlo simulation in which the underlying analysis is typically repeated hundreds of times. It is evident that to carry out uncertainty-aware geospatial analysis with large datasets covering geographically extensive areas stretches computation facilities to their limits. We have designed and implemented an uncertainty-aware drainage basin delineation program that utilizes multiple GPUs to speed up calculations and to permit to efficient processing of large digital elevation models (DEMs).

Incorporating multiple GPUs and using them in parallel is implemented by dividing the DEM into rectangular partitions. In this way, large sections of the partitions can be processed independently of other partitions, and only the values at the local bounda-

ries must be communicated between the neighbouring partitions (Figure 1a). The complexity of this communication depends on the task at hand. While parallelization of, for example, D8-based flow direction calculation for non-flat areas is trivial, filling pits preventing outflow from the DEM may require several iterations to be completed appropriately.

## Country-wide solution using HPC cluster

For benchmarking the HPC solution, we used the country-wide DEM10 (10 m grid) of the whole of Finland from the National Land Survey of Finland (NLS), which fits inside a bounding box of  $55,000 \times 114,000$  elevation points (Figure 1b).

In the first experiment, we used ten NVIDIA K40 GPUs in the HPC cluster operated by CSC – IT Center for Science Ltd. By this arrangement, each data partition with overheads filled the GPU memory, and the number of partitions was minimized. The results of each simulation cycle were ready in 54.6 s and the whole task, with 1,000 simulation cycles, was completed in a little over 15 hours. When the number of GPUs was raised to 30, allowing underuse of memory resources, one simulation run took only 20.6 s, meaning that the whole task would have been ready in five hours and 45 minutes. Still, when applying the new NLS DEM2 (2 m grid) based on airborne laser scanning to similar tasks, these figures need to be multiplied by at least a factor of 25.

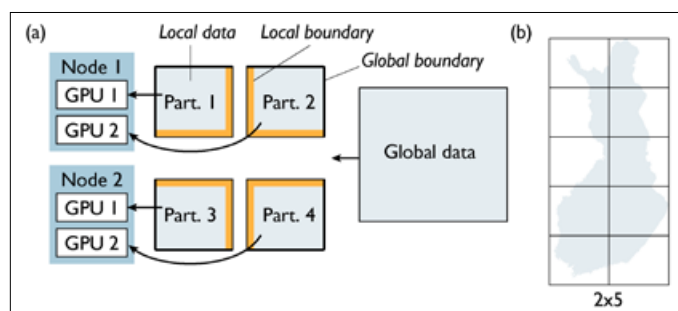


Figure 1. (a) An example of dividing data into partitions and assigning them for processing in a multi-node multi-GPU environment. In advanced geocomputation, appropriate handling of local boundaries is essential. (b) An example of a regular data partitioning for the uncertainty-aware catchment delineation for the country-wide DEM10 of Finland.

## Interactive solution for regional-level analysis as a QGIS plugin

To demonstrate the use of the same computational principles as part of an interactive session on generic GIS software, we created a plugin for QGIS (Figure 2).

The plugin serves as the front end for the catchment delineation program: it allows interactive selection of stream segments, setting of DEM error model parameters, and number of partitions and simulation runs, after which the system makes the uncer-

tainty-aware catchment delineation and displays the result in a map window. The example in Figure 2, where an area of  $20 \text{ km} \times 20 \text{ km}$  ( $2,000 \times 2,000$  elevation points on DEM10) was used, 100 simulation runs took 10 s on a computer with an NVIDIA GeForce GTX TITAN GPU. For larger DEMs, the tool also allows the study area to be divided into smaller partitions. The benefit is that less memory is required to perform the analysis; however, for such small areas, running out of memory is rarely a problem, and the analysis time often increases due to the communication needed to keep the partitions in synchronization.

These results demonstrate that we have reached a situation where uncertainty maps of drainage basins for user-selected pour points can be computed efficiently as part of interactive analysis sessions on a local workstation, and even for the whole country in a HPC environment. Potential users of the tool are in national and regional environmental administration, where it could be used for water management, conservation and research, as well as national and international reporting and information system work related to water resources.

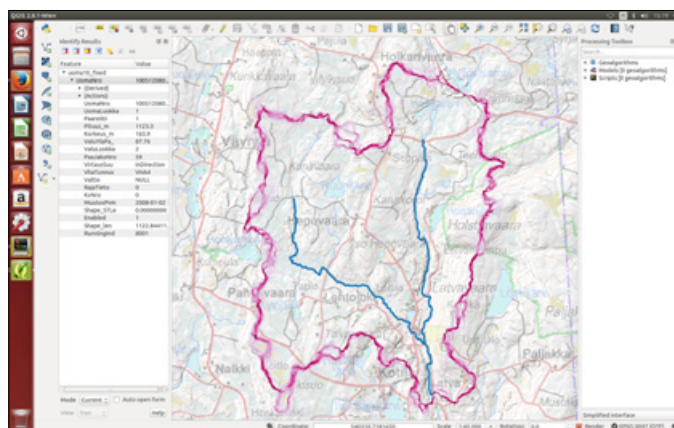


Figure 2. Uncertainty-aware catchment delineation of Lake Latvajärvi (Puolanka, Finland) calculated using our GPU-enabled QGIS plugin.

DR. JUHA OKSANEN IS A RESEARCH MANAGER AND A LEADER OF THE RESEARCH GROUP ON ANALYSIS AND VISUALISATION OF GEOSPATIAL DATA AT FINNISH GEOSPATIAL RESEARCH INSTITUTE FGI, NATIONAL LAND SURVEY OF FINLAND.

DR. VILLE MÄKINEN IS A RESEARCH SCIENTIST AT FINNISH GEOSPATIAL RESEARCH INSTITUTE FGI, NATIONAL LAND SURVEY OF FINLAND.

PROF. TAPANI SARJAKOSKI IS A HEAD OF DEPARTMENT IN FINNISH GEOSPATIAL RESEARCH INSTITUTE FGI, NATIONAL LAND SURVEY OF FINLAND.

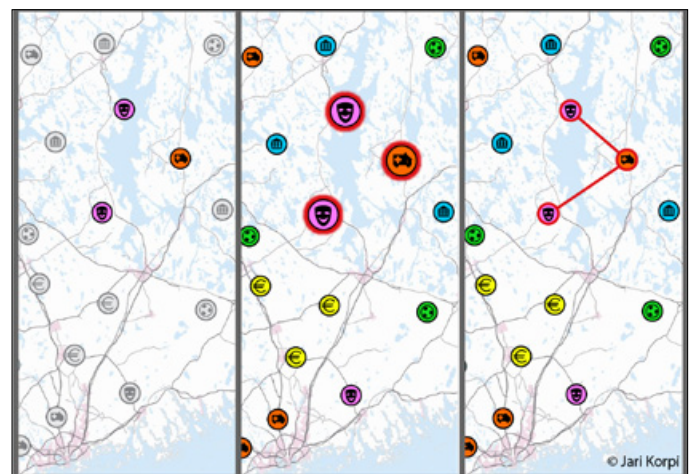
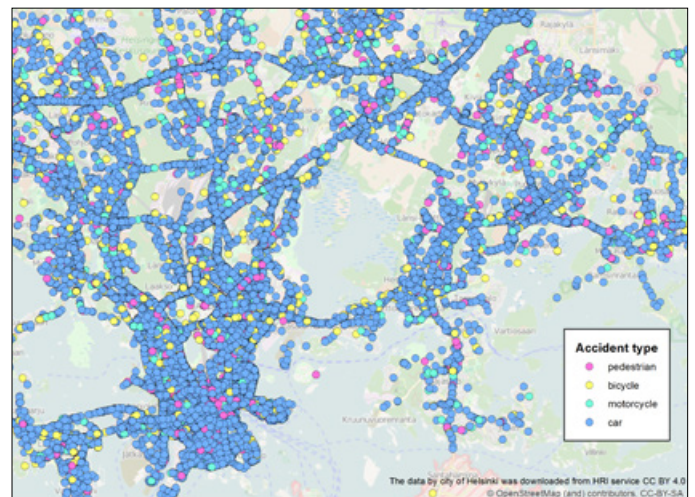
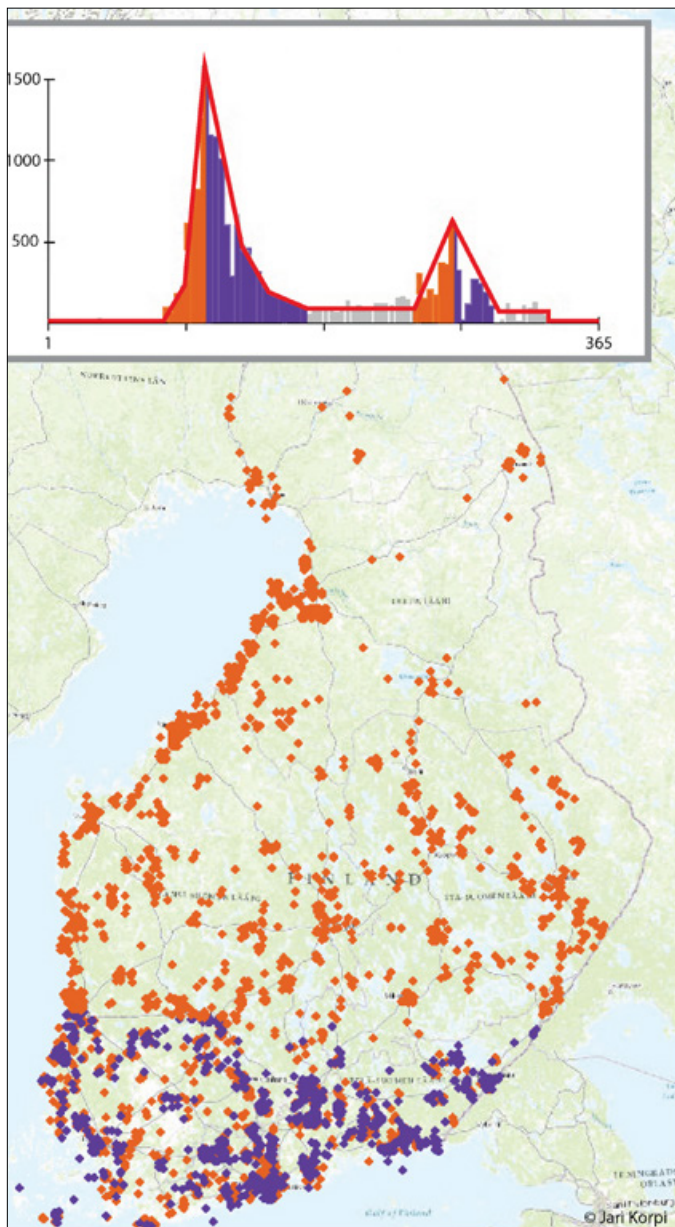
PROF. JAN WESTERHOLM IS A LEADER OF THE HPC GROUP IN ÅBO AKADEMI UNIVERSITY, FACULTY OF NATURAL SCIENCES AND TECHNOLOGY.

FIRSTNAME.LASTNAME@NLS.FI  
JAN.WESTERHOLM@ABO.FI



# Highlighting the most important

- Visual analysis lends a hand when the nature of the phenomenon is not yet clear.



- On left: A map of Finland, showing spring migration of geese. The number of geese observations per day is already decreasing in the south, while it is still growing in the northern part of Finland. Data: Global Biodiversity Information Facility / [www.gbif.org](http://www.gbif.org).
- On top right: An example of a crowded map: traffic accidents in Helsinki from year 2000 to 2013.
- On bottom right: Examples of three highlighting methods that were tested.

**T**he amount of information collected from our environment is growing rapidly. Citizens carry smartphones that automatically record exact locations of places or observations. Even more, the data collected by individual users is then made available for others via the Internet.

For example, after massive earthquakes people have started to contribute to OpenStreetMap and use Twitter to inform about victims trapped under collapsed buildings. Simple use of data may be straightforward, but more advanced use of massive and complex datasets requires efficient tools.

Analysis of large datasets consisting of multi-variable data of objects with temporal dimension is a challenging task for visualization. Visual analysis is in its strongest in exploratory tasks when the nature of the phenomenon is not always clear.

With these kind of tasks, the user should be able to use, for example, the so-called linked views in which multiple visualization methods provide different views and reveal different aspects of the data. Even with multiple linked views, though, the visual analyst starts the exploration with an overview before zooming in and filtering the data. It is possible to visually highlight patterns from the spatially and temporally congested data chaos. To find these potentially interesting patterns, we can use our previous a priori knowledge or computational methods, concerning either the dataset we are about to study, or another dataset assumed to behave in a similar way than the studied one.

Our research group has worked for several years to support the visual analysis process of a user and to find solutions that help to perceive different aspects of spatio-temporal point-type datasets. This is done by testing the efficiency of different visualization solutions. Our research has focused on 1) the problem of spatial congestion of symbols on a map, 2) interactive highlighting of symbols on a map, and 3) temporal transformation and classification of objects to support animated maps.

## Design of symbols is no guarantee against overcrowding

The maps for visual analysis that aim to include as much data in the display as possible tend to suffer from visual overload. A certain degree of complexity has to be tolerated, because a single symbol peeking out from behind another one can make an important contribution to detecting a pattern during an analysis. We have studied the means for coping with the overcrowding of the symbols in two studies.

First, we arranged an experimental setup in order to reveal the degree to which the point symbols can be partially occluded by other symbols while still being accurately identified, and how much the design of the symbols affects the occlusion tolerance. The results showed that the efficiency of the symbols begin to decrease when the symbols get occluded by other symbols regardless of the design of the symbol. However, accurate observations can be made, though with higher effort, even from half occluded symbols. The symbols visualized with colour hue seem to tolerate the occlusion best. These results can be used when designing the symbolization of map mash-ups and the overcrowding management techniques in visual analysis.

In the second study, we collected range of different overcrowding management techniques from the literature and formulated a set of criteria that define the requirements for these techniques. Because of varying objectives, all criteria are not relevant in every case. The different techniques were evaluated against each of the

criterion in order to reveal the strengths and limitations of different types of approaches. For example, aggregation is not suitable if attribute values must be preserved. The results can be used in selecting the suitable overcrowding management techniques that best meet the needs of a specific case of visual analysis.

## Highlighting the important information

In visual analysis the user can select certain symbols to be highlighted on a (map) display while the rest of the symbols are left as a reference. Highlighting gives the highest prominence to the most essential information and offers one solution to manage the visual overload.

Three methods, following three highlighting strategies, were tested. The results showed that highlighting should be visualized either by making the highlighted symbols more prominent or by making the non-highlighted ones less prominent rather than by bringing additional connecting elements such as lines into the map.

In the subjective grading after the test, the majority of the test users preferred the method that downgraded the visual prominence of the non-highlighted symbols.

## Temporally transformed animation can help reveal patterns

We have studied two methods in order to ease the analysis of map animations with different temporal structures. If a dataset includes time periods with very dense events, and, on the other hand, periods with very few or no events at all, viewing the animation can be very tiring. Human attention can be overloaded as easily as it can be lost.

We tested a method derived from the equal density transformation known in traditional cartography. The timeline of the dataset was modified so that the gap between every two consequent events became equal. This method spreads congested periods allowing better analysis, and removes the empty periods. The user testing proved that while the non-manipulated, original animation is essential for understanding the temporal structure, the temporally transformed animation can help reveal patterns from the data which would otherwise stay hidden because of the congestion of events.

In another animation study, we wanted to highlight the temporal behaviour of the dataset. The timeline was divided into periods where the phenomenon behaved more or less constant: when the number of events per day was increasing, when it was decreasing, and when it was steady. The events on the animated map got their colours according to these periods.

Over 40 experts of the field of phenomenon tested the understandability of this classification compared with the conventional visualization. The order in which the animations were seen had a great effect on the analysis: classified animation was more useful when seen after the traditional one. The user group which saw the animations in this order made more thorough analysis of the phenomenon than the group which studied classified animation first and the traditional one after that.

The rapid growth of data volumes and utilization areas raises a clear need for thoroughly designed and tested techniques.

SALLA MULTIMÄKI M.SC. (TECH.)  
and JARI KORPI M.SC. (TECH.)  
ARE DOCTORAL CANDIDATES IN  
AALTO UNIVERSITY, SCHOOL OF  
ENGINEERING.

FIRSTNAME.LASTNAME@AALTO.FI



BY JANI KYLMÄÄHO, THE NATIONAL LAND SURVEY OF FINLAND

# Oskari brings maps to your website without programming

- Oskari software makes the utilization of distributed SDI easier and more efficient.

**S**patial data and maps are integral parts of many modern web services. While many applications still today use centrally stored data, an increasing amount of important and interesting data sources are being made available via various kind of spatial data infrastructures.

Oskari has been developed to make utilization of distributed spatial data infrastructure (SDI) easier and more efficient. Even standards-based SDIs like the European INSPIRE can be difficult to take advantage of. Simultaneously, pressure is increasing to save costs, introduce eGovernment services and gain benefits from the investment made in INSPIRE. Oskari leverages on the existing and developing distributed SDIs and provides means to create new, innovative web services even without programming skills. It is mainly used in information services and various kinds of eGovernment services, including innovative ones where the map fluently interacts with other parts of the service.

Once Oskari has been set up and data sources connected, it is very easy to create embedded maps to other websites using the provided WYSIWYG wizard. No programming is necessary – simply select the map layers and the tools you want to make available for the map user. The resulting map client can be embedded in any website by copy-pasting the HTML snippet provided by the wizard.

## Streaming data from the original source

Standard OGC interfaces, such as WMS, WMTS or WFS, can be utilized as data sources. INSPIRE schemas for various themes are supported. In addition, you can upload your own data in shape file, GPX, KMZ or MapInfo formats to complete the data offering. The map data is streamed from the original source, so it always remains as up-to-date as possible. The map client loads to user's browser from the Oskari server as SAAS (Software as a Service), so any software updates are instantly in use after they have been deployed. ►►►





BY RINA TAMMISTO, STATISTICS FINLAND

# Open Statistics meets Oskari

- The Finnish national geoportal created by the National Land Survey of Finland has clearly achieved the level where the joy of seeing data has turned into a need to use data in various kinds of analyses.

**A**long with visualising geospatial data and spatial statistics as maps, there is also a need to have access to pure statistics and to visualise data as graphics and data tables.

Statistics Finland has published the datasets obliged by the INSPIRE directive as open data ([http://tilastokeskus.fi/tup/rajaapintapalvelut/index\\_en.html](http://tilastokeskus.fi/tup/rajaapintapalvelut/index_en.html)). These are published among other spatial datasets on the Oskari-based national geoportal. The PSI directive of EU and national open data policy in Finland have increased vast data reserves of additional open statistical data.

The datasets published concern, among other themes, population distribution. At the most accurate level, population has been aggregated to a grid of 1 km<sup>2</sup> cell size. Along with spatial statistical datasets, boundaries of statistical areas have been published as open data, and population data is available also for these statistical areas. Oskari geoportal uses WFS/WMS interfaces offered by Statistics Finland, and the data are viewable or downloadable by requests.

## Tools for using open statistical data

Statistics Finland and the National Land Survey of Finland run a joint EU granted project Spatial Statistics on Web (SSW). The project is to develop tools for using open spatial statistical data, especially gridded data, on Oskari-based map applications. During the project in 2014–2015, spatial analysis tools have been created.

Users can filter or select gridded data by existing or free-drawn areas. Reports of statistical key figures of the selected areas or themes can be computed. Users can make buffers around selected targets and get a summary of the statistical figures by the created zones, and moreover, users can divide the buffer zones in a selected number of sectors for more precise figures. Gridded datasets of two different dates can be compared and the change over time can be calculated. The analysis tools are still under development in the national geoportal. ►►►



Interactive services can easily be developed on top of embedded maps with the help of Oskari's RPC interface. It enables communication between the map client and the embedding website. For example, the user can click on the map and the coordinates or the address can be populated on a form on the webpage. The user may make selections on the website, and data related to the selection is instantly displayed on the map.

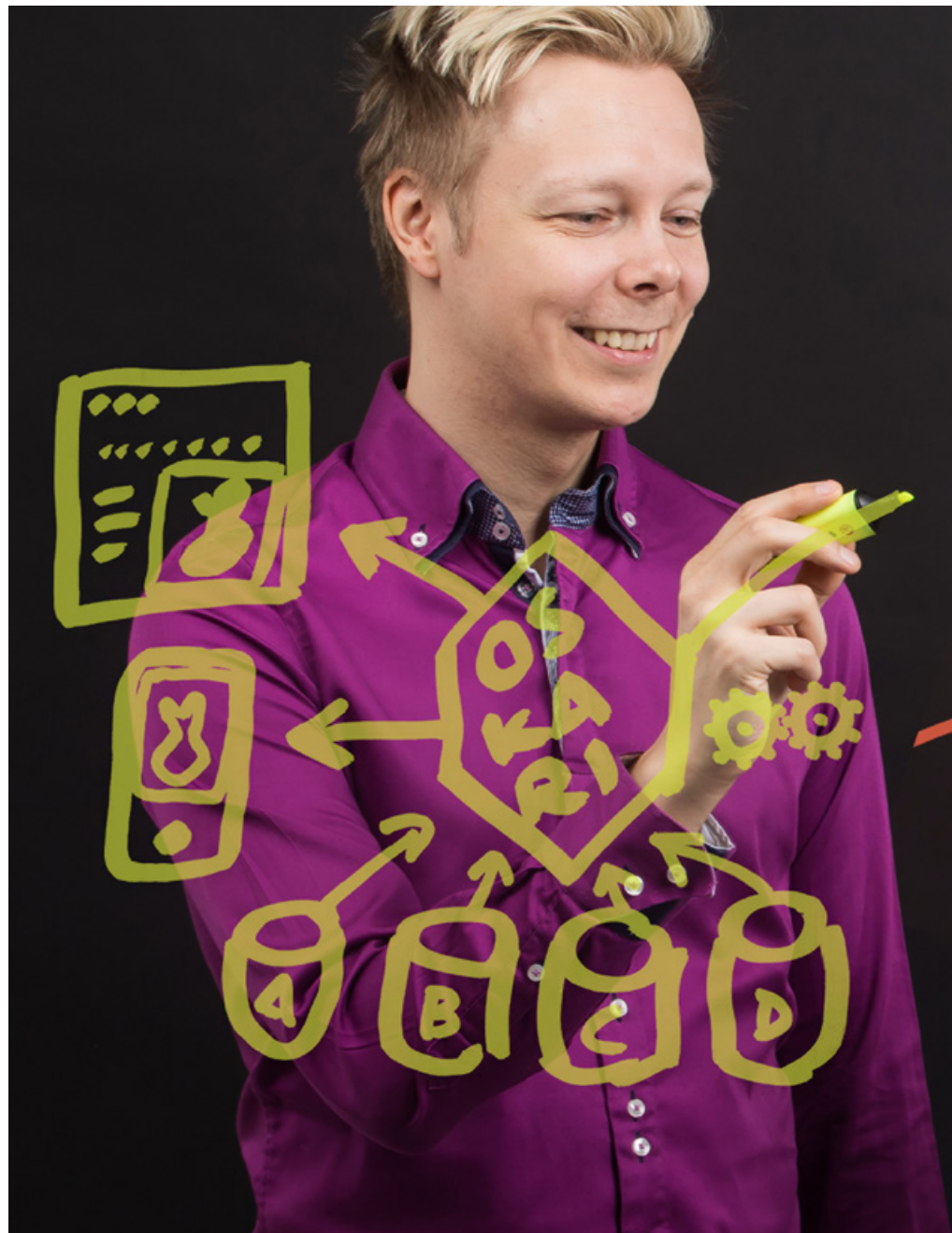
### Thematic mapping

Advanced features of Oskari include thematic mapping based on statistical data as well as various spatial analysis functions, which are currently in beta phase. Thematic maps and the results of the analyses can already be published as embedded maps.

One of the key success factors of Oskari is the project's flexible open source licensing policy. Users can choose between EUPL and MIT licensing, so both public sector organizations and private companies can use the software as they see fit best for their needs.

Oskari is being used both in national and international projects. International cases include the Arctic SDI and European Location Framework (E.L.F.) initiatives. In the previous one, Oskari is deployed as a geoportal for disseminating thematic data related to the arctic region in a co-operation effort of the circumpolar nations. In the latter, the Oskari-based ELF Showcase application provides access to harmonized data across Europe. To facilitate these cases, Oskari user interface will support all major European languages.

Co-operation around Oskari in Finland is organized through the Oskari network. The network coordinates the development of the open source project and has 27 memberships from both public sector



institutions and private companies. A product lifecycle management plan has been developed to support the activities around Oskari.

#### OSKARI IN BRIEF

- ▶ Connects to distributed SDI data sources
- ▶ Supports major OGC standard interfaces
- ▶ WYSIWYG embedded maps wizard
- ▶ Open source with MIT/EUPL dual licensing
- ▶ Oskari network coordinates the software development
- ▶ More information:  
[www.oskari.org/oskari](http://www.oskari.org/oskari)

**JANI KYLMÄÄHO** IS A SENIOR EXPERT AT FINNISH GEOSPATIAL RESEARCH INSTITUTE, NATIONAL LAND SURVEY OF FINLAND, SPECIALIZING IN DEVELOPMENT OF SPATIAL DATA INFRASTRUCTURES AND TOOLS FOR SDI UTILIZATION.

JANI.KYLMAAHO@NLS.FI





### Direct access to statistical data resources needed

According to a user survey, users of the national geoportal tend to be quite content with the service while professionals working with statistical data seem to have less benefit of its usage. This came up in the project Map Service for Knowledge management (<http://julkictlab.fi/en/pilot-projects/map-service-for-knowledge-management/>). In the project, municipal and ministerial professionals were interviewed and it came out that the professionals working with statistical data only got half way in

their work with the data included in the national geoportal. Direct access to statistical data resources, data mining, and interoperability with geospatial data and spatial statistics were needed. These items require development on the Oskari platform, but even more development is needed on the data structure of statistical data.

INSPIRE type development on the structure of data and interface services would be required also for statistical data offered on the open service interfaces. Lack of specifications makes statistical data bulk with little intelligence. To be more

usable, the data should be structured in a standardised way, and it should have links to other data that explain the data themselves and their relations to other data. When properly structured, data can be found, machine-read, combined, and compared.

Statistics Finland has produced meta-data for the datasets and services obliged by INSPIRE. However, concerning the capability to describe statistics, INSPIRE metadata descriptions are quite inadequate. The schema does not allow descriptions of statistical variables. Supplementing metadata is needed to cover all spatial statistical data. For pure statistical data there is no fixed way to offer metadata of statistics or statistics on a service interface. It is highly significant that when these standards and data specifications for statistical data are developed, consistency with INSPIRE specifications is taken into account.

A method to link statistics and geospatial data and metadata may, however, be on its way. Data compliant with the INSPIRE specifications are to be produced between 2017 and 2020. In those data specifications producers are introduced to unified identifiers. By them, objects are not only identified but relations between them are also recognisable, describable and linkable. For statistical data, unique identifiers would be needed for indicating statistical themes, statistical variables and classifications used in statistics – and, of course, for links to geospatial data.

A uniform structure describing the consistency of geospatial data, spatial statistics and statistics would create interoperability between datasets. It would allow fixed solutions in application design and assist further development for Oskari to meet the needs of decision-makers better.

**RIINA TAMMISTO** IS A SENIOR STATISTICIAN AT STATISTICS FINLAND AND RESPONSIBLE FOR THE TASKS RELATING TO INSPIRE IMPLEMENTATION AT STATISTICS FINLAND. SHE IS THE REPRESENTATIVE OF STATISTICS FINLAND IN THE OSKARI STEERING COMMITTEE.

RIINA.TAMMISTO@STAT.FI

BY SAMPO SAVOLAINEN, SPATINEO INC.

# Spatial web services growing in Europe

- High quality of services is of no use if the service isn't running. Spatineo visualises the availability of spatial web services across Europe.

**A** Finnish company called Spatineo has launched a freely accessible visualisation of the availability of spatial web services organized by a country or an administrative area. This tool provides never before seen insight into the development of the European Spatial Data Infrastructure (SDI) and INSPIRE, particularly how the scope and availability of these services have developed over time. Spatineo offers SaaS tools, such as Spatineo Monitor, for the analytics and quality assurance of spatial web services.

## Service availability is vital for SDIs

The vision and goal of the INSPIRE legislation is to simultaneously open more data and increase its use. We at Spatineo believe it is crucial to show that organisations are working hard to fulfil their obligations. This transparency is necessary to inspire the private sector to discover and trust the spatial web services that can enable companies to both innovate and build new businesses that utilize the open spatial data.

Accurate and timely information on service quality lets data providers react faster and steer development resources more efficiently. Spatineo has helped numerous organisations improve the quality of their services by providing them with indispensable information on both what the actual service level of their services is and what factors influence their services availability. Until now, no one has even attempted to assess this on the SDI level. For instance, the advancement of INSPIRE has thus far only been tracked through manually compiled annual reports, which have not been publicly visualised or aggregated to form a big picture.

The technical quality of a web service is most often expressed in terms of its availability – gener-

ally, the percentage of time the service has been operational.

Clients and suppliers often use availability as a benchmark in service level agreements, and European INSPIRE legislation compliance requires a level of 99% availability. There are many other factors underlying the quality of a spatial web service, such as spatial accuracy or comprehensiveness and consistency, but if a given service is inaccessible, no other qualitative measures apply since the data is altogether unavailable to users. Moreover, availability can also be compared across a wide range of different service types and classes; therefore it is ideal for evaluating a wide variety of services at once.

## Global data for quality assurance

Spatineo monitors tens of thousands of spatial web services globally. Quality assurance is the heart of our business and we pride ourselves in being a trustworthy neutral party who provides unbiased results. We have also participated in the development of both Open Geospatial Consortium (OGC) specifications and INSPIRE technical guidance documents. This puts us in the unique position of being able to build a tool that efficiently visualises all the hard work of the GIS community in Europe.

Spatineo harvests available spatial web services from service catalogues and search engines to keep its registry up to date.

For the purposes of the map, services are broadly defined as any service endpoint that is described by a single service description document of a particular service type. For example, each WMS Capabilities document describes a single service. All services within our catalogue are continuously monitored. This monitoring procedure is compliant with the INSPIRE normalized testing procedure for availability and has provided us with data spanning back

SAMPO SAVOLAINEN IS  
R&D DIRECTOR IN SPATINEO  
INC RESPONSIBLE FOR THE  
DEVELOPMENT OF SPATINEO  
MONITOR AND THE AVAILA-  
BILITY MAP.

SAMPO.SAVOLAINEN@  
SPATINEO.FI



to 2012. To construct the map, availability results for each service are continuously tested month-by-month against the 99% availability threshold (not counting pre-announced maintenance windows) consistent with INSPIRE requirements.

Our service registry is enriched by additional information on the organisations providing these services. Service availability monitoring data and organisation information is then aggregated based on the sphere of influence of each organisation to provide summaries for each country.

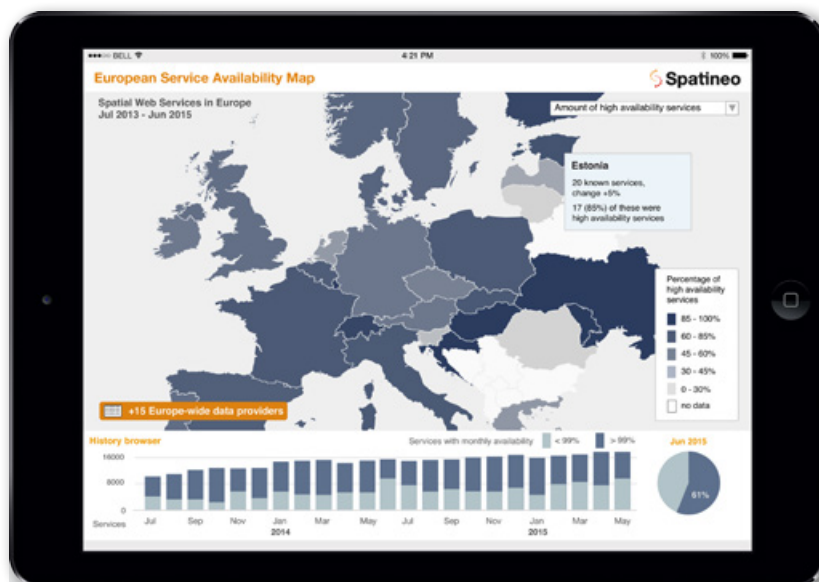
### Current status on a map

The availability map is accessible through an easy to use website that lets users view both the current status of European SDI development and overall trends. Users can examine Europe as a whole or focus on specific countries to compare different administrative areas.

Not only does this tool aggregate data by geographic areas, it also provides insight into the top spatial data providers in Europe. Top organisations are listed according to their average service availability and the number of services they each provide. Additionally, data providers that have recently increased the availability or quantity of their services are highlighted.

The high level SDI status data shown on the map immediately reveals that there is healthy growth in this sector. The quantity of spatial web services has continued to grow steadily over the past two years and the number of compliant services available is very promising. We recommend that you visit <http://servicemap.spatineo.com> to explore the map yourself. The data used for the map is constantly improved as new organisations and services are identified.

The technology behind this map can also be applied to more specialized cases. For instance the



*The shading of each country indicates the percentage of high-availability services while the bars on the bottom show the number of both total services and high-availability services over time. Users can choose to inspect either the current month or any previous month. The data in this screenshot is preliminary, please visit the website <http://servicemap.spatineo.com> for more accurate results.*

European Location Framework project (ELF) uses another map based on the same software. Their project amasses services from multiple countries and multiple service providers into a single harmonized map interface to guide decision making, drive eServices development and empower citizens. Our availability map provides a high level view on the services involved and helps assess the strategic success of their project.

### Public sector next?

We have not yet seen wide adoption of the spatial web services provided by the public sector. Achieving widespread use requires not only good quality data and services, but also that the existence of these services be communicated and advertised to companies and private citizens. Our availability map promotes openness, which should increase public scrutiny of current service quality.

It is also important to remember that the whole is the sum of its parts. The availability map is merely a visualisation while the quality of the actual services is key. For the actual service quality to improve, data providers should look for tools to monitor and analyse the quality of their services.

# From national land cover mapping to European wide information

- ▶ Copernicus land monitoring service provides geographical information on land cover. In Finland, a high resolution national land cover classification is produced and then automatically generalized to the European standards.

**C**opernicus, previously known as GMES (Global Monitoring for Environment and Security), is a European programme coordinated and managed by the European Commission for monitoring the Earth. The services, based on remote sensing and in-situ measurements, address six thematic areas: land, marine, atmosphere, climate change, emergency management, and security.

The Copernicus land monitoring service provides geographical information on land cover/land use and on variables related to the state of vegetation and the water cycle. The services have been divided into different components according to their geographical coverage and level of detail.

The global component provides near real time bio-geophysical products on

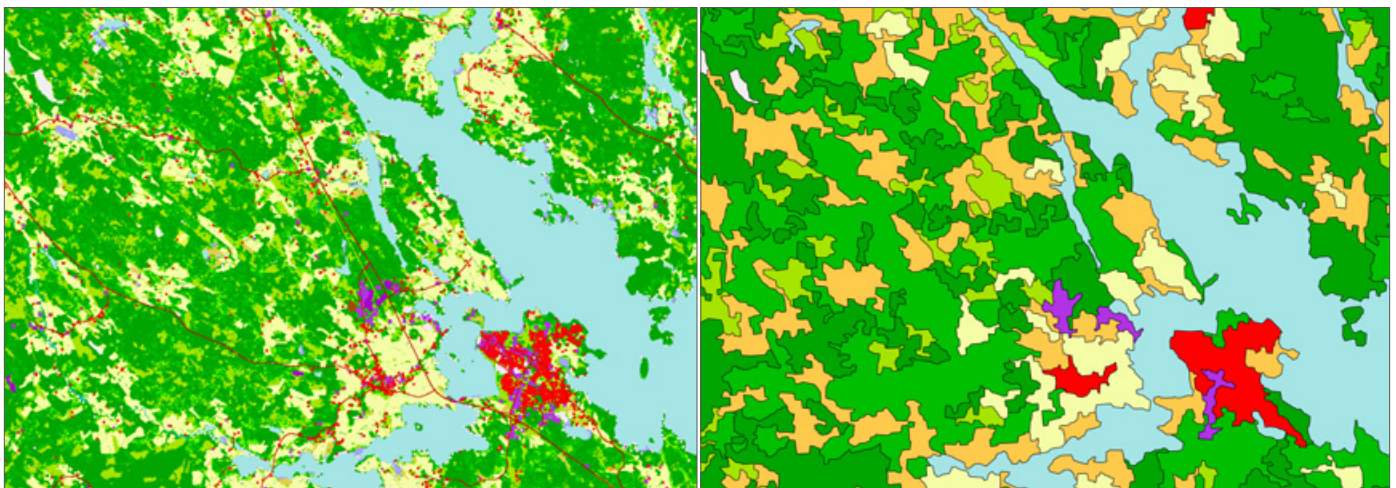
the status and evolution of land surface. The pan-European component provides CORINE Land Cover classification as well as high resolution data sets describing the main land cover characteristics, including artificial surfaces (e.g. roads and paved areas), forest areas (tree crown coverage, main tree species), agricultural areas (grasslands), wetlands, and small water bodies. The local component provides specific and more detailed information from hotspots, such as urban or riparian areas.

Copernicus land monitoring is now operative in Europe and its funding (totally 87 M€ to the services) is agreed until 2020. The European Environment Agency (EEA) coordinates the implementation of Copernicus Land Monitoring Service in Europe.

## High resolution classification for national use

According to the instructions of EEA, the CORINE Land Cover (CLC) classification is produced using visual interpretation of satellite images. The mapping scale is 1:100 000 and mapping accuracy at least 100 m. The minimum mapping unit is 25 hectares and the minimum width of units is 100 m. Only the area elements are classified. The classification nomenclature is hierarchical and contains five classes at the first level, 15 classes at the second level, and 44 classes at the third level. There can also be a national level of 4 classes.

Finland joined the CORINE programme late 1990's, and thereafter land cover of Finland has been mapped in reference years 2000, 2006 and 2012. Additionally, land



Finnish high resolution CLC is on the left and generalized European version on the right. This example is from Ikaalinen, Southern Finland. Scale 1:50 000



cover changes from 2000 to 2006 and from 2006 to 2012 have been detected. The Finnish Environment Institute has coordinated the work in Finland and been responsible for the data production since 2000.

The CLC is made differently from the European standards in Finland as well as in some other countries, such as Sweden, Norway and the United Kingdom. Reasons for the different approach are the needs to produce a more detailed version for national use, to utilize the best local datasets and expertise, and to avoid overlapping work nationally.

There are several organizations producing spatially and thematically high resolution databases covering the whole of Finland. These databases are based

on information acquired from ground or interpretation of aerial images. The spatial resolution of the European CLC is too coarse for national use, and the classes are too general especially in the forests and wetlands. Therefore, a high resolution national CLC is produced and then generalized to the European CLC standards.

### Data from multiple sources

The Finnish CLC is a combination of existing digital geographic data and land cover interpretation based on satellite images. The source data comes from various data producers the most important ones being the National Land Survey of Finland and

the Natural Resources Institute Finland LUKE (previously Finnish Forest Research Institute METLA).

The changes in land cover are defined by combining the areal extent of detected changes in image-to-image comparison and the thematic differences of multi-temporal land cover datasets. Some specific changes in artificial surfaces, arable lands and regrowth in forests, are based mainly on multi-temporal land cover datasets, since these changes are not visible in image-to-image comparisons.

After the high resolution CLC is constructed, it is generalized to the European version. The automatic generalization procedure is based on Arc/Info raster and vector operations. Heterogeneous classes, such as complex cultivation, are produced during the generalization process.

### CORINE LAND COVER 2012

As the result of CLC2012, the following products are available:

- Finnish high resolution Corine Land Cover 2012 classification (raster, 20 m pixel size), with source and age meta-data
- Finnish high resolution Corine Land Cover changes 2006 – 2012 (0.5 – 1 ha minimum mapping unit)
- Finnish European Corine Land Cover 2012 classification (vector, 25 ha minimum mapping unit)
- Finnish European Corine Land Cover changes 2006 – 2012 (5 ha minimum mapping unit)
- IMAGE2012 satellite image mosaic

The following services are made available in order to enable easy access to the data:

DOWNLOAD, WEB MAP SERVICES, META-DATA AND FEEDBACK:

<http://paikkatieto.ymparisto.fi/gis>

VIEW:

[www.paikkatietoikkuna.fi/web/fi/kartta](http://www.paikkatietoikkuna.fi/web/fi/kartta)

WWW PAGES:

[www.syke.fi/hankkeet/corine2012](http://www.syke.fi/hankkeet/corine2012)

EUROPEAN DATA SETS:

<http://land.copernicus.eu/>

In 2014, the download services for the land cover data sets (CLC2000, 2006 and 2012) were used over 2 500 times and there were more than 750 000 WMS-INSPIRE map requests.

### New satellite missions will benefit Finland

Time series of homogenous land cover data covering the whole of Europe is requested by the Commission in order to detect the impacts of European common policy on the environment in different member states. It addresses the data and information needs of a wide range of policies, such as environment, agriculture, regional planning, transport, energy, as well as climate change. The main user of land cover data is EEA.

Information on land cover and land cover changes are needed in Finland in numerous applications in environmental R&D and provision of information services. These include evaluation of ►►►

sustainability of land use and the built environment, ecosystems services and biological diversity, and sustainable management of the Baltic Sea and freshwater resources.

The number, thematic content, timeliness, and accuracy of information services included in the Copernicus land monitoring is increasing. They will cover new areas of interest such as Natura2000 sites, green liner features and coastal zones as well as monitoring of snow cover. Datasets will be updated regularly: the local components and high resolution layers in every three years (next 2015,

PEKKA HÄRMÄ IS A SENIOR RESEARCHER AND MARKUS TÖRMÄ A RESEARCH ENGINEER IN FINNISH ENVIRONMENT INSTITUTE SYKE

PEKKA.HARMA@YMPARISTO.FI  
MARKUS.TORMA@YMPARISTO.FI

## THE FINNISH METEOROLOGICAL INSTITUTE IS DEVELOPING FACILITIES AT SODANKYLÄ FOR RECEIVING, PREPROCESSING, ARCHIVING AND DISSEMINATING SENTINEL DATASETS.

2018), and the Corine land cover in every six years (next 2018).

The European Space Agency (ESA) is presently taking into use a new family of satellite missions called Sentinels (1–6) specifically for the operational needs of the Copernicus programme. Each Sentinel mission is based on a constellation of two satellites to fulfil revisit and coverage requirements. This is especially important in Finland with cloudy weather conditions that can hamper acquisition of cloud-free satellite datasets when needed. Datasets received by Sentinel missions will be freely available. The Finnish Meteorological Institute is presently developing facilities

and services at Sodankylä for receiving, preprocessing, archiving and disseminating Sentinel datasets for national users.

In order to involve users of land cover information into Copernicus programme, user forums have been established both nationally (<http://cufin.fmi.fi>) and at the European level. The purpose of these forums is to collect data needs and feedback from different end-user groups interested in Copernicus services. Since these services should be useful not only at the European level but also nationally and even locally, user forums should be active and provide feedback to the Commission in order to get full benefit from the Copernicus programme.

FOR MORE DETAILS ON COPERNICUS, SEE [WWW.COPERNICUS.EU](http://WWW.COPERNICUS.EU) and [LAND.COPERNICUS.EU](http://LAND.COPERNICUS.EU)

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BY PAULA AHONEN-RAINIO, AALTO UNIVERSITY

# Modelling the impacts of open topographic data

► The impacts of opening the topographic data in Finland has been studied in Aalto University.

In Finland, the National Land Survey (NLS) maintains topographic data in a modern information system and provides good quality data consistently for the whole country. The latest step of development was the opening of their topographic data resources to use free of charge and for any purpose, even commercially (CC 4.0 license), in May 2013. These data resources include topographic maps in vector and raster formats, topographic database, DEMs and laser scanned data, geographic names, and orthophotos. See more at [www.maanmittauslaitos.fi/en/file\\_download\\_service](http://www.maanmittauslaitos.fi/en/file_download_service).

## New users have found topographic data

Before deciding the next development steps, the National Land Survey wanted to gain information about the impacts of open topographic data in the Finnish society, and therefore, funded a research project for this purpose. The research was done in Aalto University, in the research group of geoinformatics.

Research data was gathered first by interviewing representatives of 20 major user organizations of topographic data. This part of the study revealed the most important subsets of topographic data and how these varied between public and private user organizations. It also showed a variety of ways how topographic data benefits these organizations or their customers as well as factors that hinder the benefits in more extent.

More research data was collected in a survey that was responded by over 3 700 users of the NLS open data. These responses were studied separately for professional users and citizens. The professional users were further categorized into representatives of public organizations, large enterprises, and SMEs. The responses indicated that new ways of using topographic data had emerged in many professional organizations, and new users had found topographic data along the wide publicity that the opening of topographic data attracted in Finland.

Also citizens had downloaded open topographic data frequently, but it was clear that citizens require easy-to-reach and easy-to-use applications rather than raw data. Students, as a subgroup of citizens, form an exception in this sense. An extensive list ranging from safer outdoor activities of individual person to new business possibilities was gathered as benefits.

An expert panel evaluated the significance of trends, identified in topical literature, to the future of topographic data. The panel then elaborated the five areas of development, identified in the earlier phases of the research, into five proposed development decisions.

These decisions, the most important subsets of topographic data, the main user groups and the ways of using topographic data were finally composed into an impact system that indicate how the decisions would influence on the various subsets of data, and how the use of these data would carry on to economic, environmental, and social impacts in the society.

DR. PAULA AHONEN-RAINIO IS A SENIOR UNIVERSITY LECTURER IN AALTO UNIVERSITY, SCHOOL OF ENGINEERING. SHE CARRIED OUT THE RESEARCH TOGETHER WITH PROF. KIRSI VIRRANTAU AND DR. JAANA MÄKELÄ

PAULA.AHONEN-RAINIO@AALTO.FI

BY ANTTI JAKOBSSON, THE NATIONAL LAND SURVEY OF FINLAND

# New National Topographic Database on the horizon

► A goal for the new National Topographic Database is set for 2018.

**T**he National Land Survey (NLS) has had a digital topographic database (TDB) since 1992. It is following a long tradition of topographic surveying, and many of its features are based on the Basic Map created by a surveyor Mauno Kajamaa in 1947 and first completed in 1977.

The basis for the renewal of the topographic database was started by investigating the value of the TDB, a study made by the Aalto University in 2014 (see a separate article in this magazine) and a study on the new TDB system 2030 published by the Ministry of Agriculture in 2015.

## A common data model agreed

The focus on the new TDB 2030 study was to make a proposal on what the TDB system should look like in 2030. The goal was to increase the use of the data and save costs. The co-ordination should still be kept within government but all other options were considered. 74 organizations in total were interviewed in this study.

The main outcomes of the interviews were that the TDB and municipalities base data should share a common data model and that it should be interoperable with other public topographic data. Updating may be shared with other organizations. Unique identifiers should be set for main features. 3D and life cycle rules are needed, while universal classification of land cover is not seen necessary. Planning information should be maintained in a separate dataset. Base information should be financed by the government and it should be possible to charge for a massive use of data for commercial use. Use conditions may vary and separate legislation should be introduced.

The full study is available from the Ministry of Agriculture.

## First experiments in Tampere

In 2014 the NLS and the city of Tampere, the third largest city in Finland, agreed to start investigating how the common data model with 3D support could be achieved. During 2014 two studies were started. One of them is concentrating on the data modelling aspects and the other one on creating a 3D model using the NLS's standard point clouds from laser scanning. Figure 1 represents first data modelling results. Only data from city of Tampere was used.

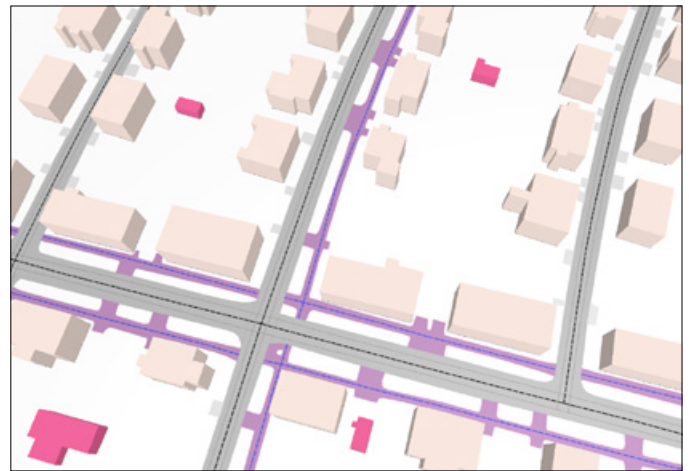


Figure 1. Data Modeling Results in the City of Tampere.

© CITY OF TAMPERE

## The work has started

In 2015 the NLS established a programme for creating the new National Topographic Database (NTDB). The target for this programme is set for 2018. By then we should have the first new operational system in place.

The NTDB also supports 3D and 4D, and is considered to be a basic registry linked with other basic registries. Co-operation is the key in creating the new database: updating is linked with processes where information originates and existing data is used and linked to the system.

All feature types are critically reviewed. Only the needed data should be included. This could mean for example that only basic geometry is included and all other attribute information is kept somewhere else.

The user needs of public safety authorities has a high priority in the programme. Data is open but data protection is also enforced for sensitive and personal data.

As a starting point three projects within the programme were initiated. The first project is a pilot project on buildings. We will demonstrate the whole process from data collection to data use. In this project open source solutions have a priority. The second project is defining a new data quality management process for the NTDB and the third project defining the unique IDs (see an article in this magazine).

ANTTI JAKOBSSON IS  
A PROGRAMME MANAGER  
FOR THE NTDB. HE IS WORKING  
AS A CHIEF ENGINEER AT THE  
NATIONAL LAND SURVEY OF  
FINLAND.

ANTTI.JAKOBSSON@NLS.FI



### Levels of detail may differ

For feature level of details (LoD) we follow the CityGML classification. The basic idea on level of details is as follows:

- Class A: A city centre, features are represented in LoD2 (or better if available from plans).
- Class B: Other densely populated area or industrial area, features are represented in LoD2. Class B may also contain shore areas with recreational activities.
- Class C: Other area, features are represented in LoD1 or LoD2

The class A and B areas should have data from the municipalities and class C areas are coming from the NLS.

The National Land Survey's goal is to prevent duplication of work. If a municipality is keeping their basic geographical information up-to-date then the NTDB will have access to this data. There are possibilities where a municipality and the NLS agree to share the costs of creating a new data model with 3D for example in class B areas, or the municipality agrees that the NLS should take the responsibility for the updating. This option is probably relevant for smaller municipalities.

### Technical architecture

As the project is yet in the beginning phase, we only have a draft specification for the technical architecture available. Figure 2 illustrates the basic principles. The existing NLS's TDB updating system will be continued at least until 2020. It will be used for periodical updating of the NTDB. For the municipalities two options are offered. They may utilize the NTDB directly with an editing interface or they may create an interface using they own GIS solution. The number of modules needed for the NTDB has also been identified.

The modules should be open source and available for all different players. For publishing the NTDB we will use the OSKARI platform ([www.oskari.org](http://www.oskari.org))

A website for following the development of the NTDB will be created shortly and will be available

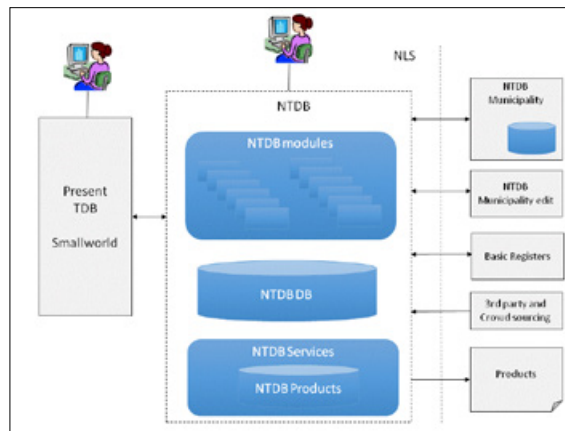


Figure 2. The basic principles of the technical architecture. The NTDB modules should be open source and available for all. Municipalities can utilize the National database in two different ways.

#### MODULES NEEDED FOR THE NTDB

- Plan: Management of schemas and data models
- Edit: Editing, including a 3D Edit
- Validate: Validating a schema
- CoordinateTransfer: Co-ordinate transfer
- SchemaTransfer: Schema transferring service (mainly in the first phase when using existing systems)
- Quality: Validating data quality
- Change: Change management (if persistent ID is not managed)
- GeoSync: Changes updated to and from the NTDB with changes log and persistent ID
- Publish: publishing a product
- Generalize: making a generalized product (like 1:50 000)
- UserFeedBack: management of feedback
- ProcessEngine: management of processes
- API: Application Programming Interface.

through [www.paikkatietoikkuna.fi/web/en](http://www.paikkatietoikkuna.fi/web/en). Return on investment analysis will be conducted, and we expect to start new projects in the beginning of 2016 for the implementation of the NTDB. First results should be available in 2018.

BY MERJA KARSIKAS, KARTTAKESKUS OY

# Taking Digiroad to the next level

- Finland has had a head start in gathering street and road information to one database. In an agile development project Digiroad will have new improved applications.

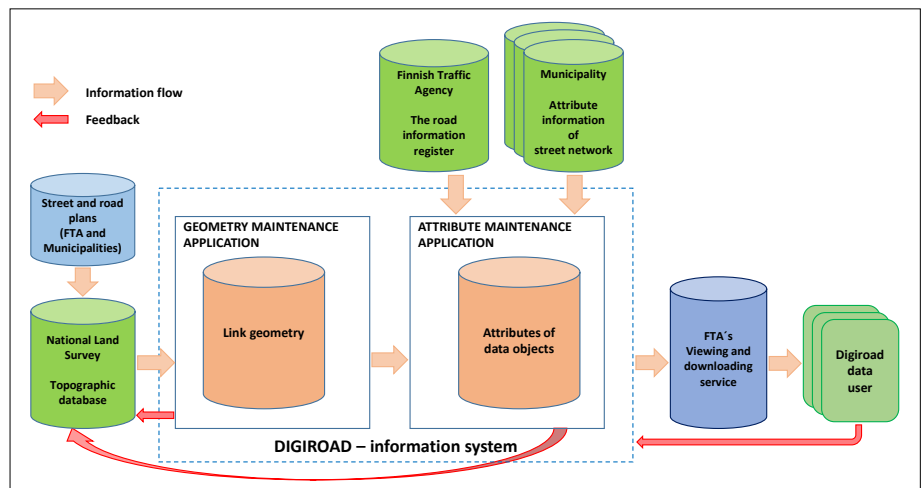
**D**igiroad®, the national road and street data system of Finland, contains accurate center line data of 483,000 kilometres of public roads, streets and private roads as well as their most important physical features. Full coverage, uniform presentation of the data, and relevant data content for the needs of transport services are the main strengths of the system.

The Finnish Transport Agency (FTA) is responsible for the maintenance and development of Digiroad. FTA, The National Land Survey of Finland (NLS) and the municipalities of Finland are the main data producers for the Digiroad database.

How to gather all the street and road information to the same database, is a current topic in many European Union countries because of the demands of INSPIRE determined in Data Specification to Transport Networks. Finland has had a head start thanks to the Digiroad legislation. The framework for the processes has existed for over 10 years. However, to respond to the INSPIRE demands and the challenges of the aging technology of the current system, a development project of Digiroad was started in 2012.

## An agile development project

The Digiroad development project is divided into two parallel parts: the Geometry application for the maintenance of the



*The Digiroad information system and obligated actors.*

network geometry, based on ESRI technology and the Attribute application for the maintenance of attributes of road and street segments, based on Open Source web technologies.

The development is carried out as an agile project. In an agile project, it is possible to publish ready parts of the application without waiting until the whole application is ready. It is also possible to take instant user feedback into account and reprioritize development tasks according to changing circumstances.

The geometry application downloads up-to-date link-node geometry of the centre lines from the NLS WMS interface once a day. The attribute application reads geometry through a REST interface; the geometry is not saved in the attribute application but

the attribute data refers to the segments of centre lines, and these are linked together in the publication process. Attribute data is produced by FTA for road segments and by municipalities for street networks.

The inclusion of geometry of planned streets and roads in the Digiroad database is one of the essential attempts to serve data users better. Also the micro geometry, e.g. of service areas, will be part of the Digiroad data in the future.

The most visible result of the development is a new browser-based Digiroad attribute maintenance application. It provides tools for editing attribute data of the data objects, such as the type and functional class of the road, speed limit, various access restrictions, and road surface. The changes made in the data are

MERJA KARSIKAS IS A DIGIROAD SERVICE MANAGER IN KARTTAKESKUS.

WWW.DIGIROAD.FI  
INFO@DIGIROAD.FI



published in the FTA's viewing and downloading service and thus directly available for all Digiroad data users.

## Harmonization of two road networks

The development project has so far highlighted one unpredictable challenge: assimilation of the two Finnish road network datasets, maintained by two authorities (FTA and NLS) and partly differing in their geometry.

FTA's operational road data system is based on the link sequencing and the linear referencing of the attribute data. The data is produced and used for the road maintenance purposes. In the NLS's road and street network data the center line geometry and its attributes are collected. It is produced for the national mapping purposes.

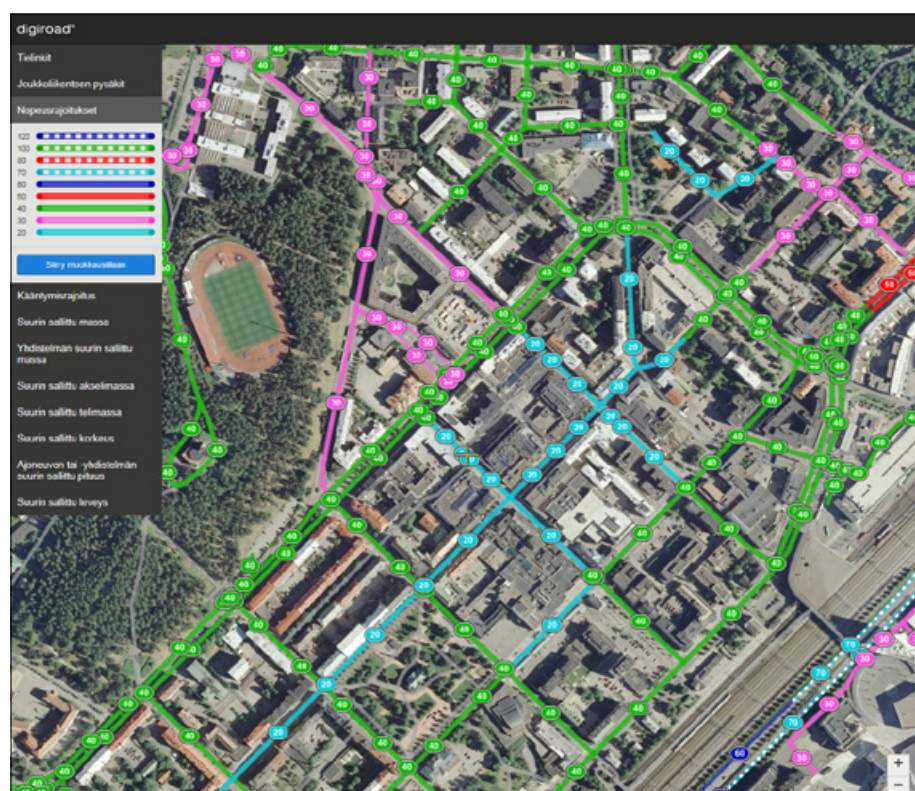
"The most demanding part of this assimilation work is to harmonize the geometry used in FTA and NLS databases. At the moment they have a different lane geometry, but a shared and common specification is under construction. Even though compromises cannot be avoided, we believe that at the national level there is no reason to maintain separate geometries in two organisations", says FTA's Development Project Manager Markus Melander.

## Co-operation with the municipalities

The maintenance application has been developed in close co-operation with users in municipalities.

"This was a conscious decision, because the lack of street attribute data from municipalities has been a prolonged weakness of Digiroad data. While the law obligates municipalities to make a contract with FTA, it does not obligate them to provide data", says Project Manager Matti Pesu from FTA.

FTA has outsourced the Digiroad service operation. Karttakeskus has been the operator since 2007. The operator is, among other tasks, responsible for improving the co-operation with the municipalities. The operator provides training through online webinars, phone



*A new browser based application provides tools for editing attribute data such as speed limits, restrictions and road surface. Speed limits (km/h) are shown on the map in different colors.*

service, newsletters, and Digiroad web pages in order to help the municipalities in their maintenance work.

The aim of the interaction is to make municipalities understand their important role in the maintenance chain and to encourage them to use the Digiroad data also in their own operations, such as planning and service production.

### Delivery of the transport network data product

To fulfill the INSPIRE demands of the transport network data product delivery, a new viewing and downloading service was set up by FTA in the autumn of 2014. Digiroad data

is now available via WMS and WFS interfaces and as a traditional zip file. Digiroad products have been available free of charge since the beginning of 2014, and they can be utilized by anyone under the license 'Creative Commons by 4.0'.

The new Digiroad information system offers improved usability of the user interface, user-friendly tools for gathering, maintaining and distributing of road and street data. This development enables Digiroad to offer more comprehensive and up-to-date information for all those who use the Digiroad data in their own projects or produce applications and services based on this constantly updated data.

### COMMON EFFORT TOWARDS UP-TO-DATE INFORMATION

The ongoing development project of Digiroad information system is the joint effort of several Finnish organizations and companies.

- Finnish Transport Agency provides the framework and makes the development project possible
- National Land Survey of Finland produces the base geometry and is an important actor in the harmonization process
- Municipalities give valuable feedback to the project and maintain the Digiroad attribute data
- Tieto Corporation is responsible for the development of the geometry maintenance application
- Reaktor is building the web browser based maintenance application
- Dimenteq works on the FTA's viewing and downloading service
- Karttakeskus offers expertise and know-how and acts as the Digiroad operator

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BY KIRSI MÄKINEN, THE NATIONAL LAND SURVEY OF FINLAND

# Unique identifiers for spatial data

- In Finland, a national recommendation of unique identifiers for spatial data is almost complete. The draft version of the JHS Public Administration Recommendation contains a description of the structure of the identifier and instructions on the formation of such identifiers. This also conforms to the demands of the INSPIRE directive.

**T**he use of unique identifiers makes it possible to utilise and combine data from different sources and across organisational boundaries. Unique identifiers facilitate the reuse of data and make it possible to decrease data collection and the number of registers containing the same data.

According to the INSPIRE directive, unique identifiers must be applied to some datasets that fall within the framework of the directive. Uniform identifier practices ensure interoperability of spatial data not only nationally but also within Europe.

## Structure of unique identifiers

INSPIRE practices have been defined in the Generic Conceptual Model (GCM). According to this document, identifiers must be unique, persistent, traceable and feasible. The format of the identifier is HTTP URI (Uniform Resource Identifier).

Unique identifiers for spatial data are data system independent URIs published by the organisation that provided the data. The URI consists of a network identifier, identifier type, dataset identifier of the spatial object and the local identifier of the geographic feature.

In addition, the URI can contain a version number (voluntary) that is compliant with the life-cycle rules of the geographic feature in question.

The *network identifier* of the spatial data URIs is <http://paikkatiedot.fi>. A redirection service is located at [paikkatiedot.fi](http://paikkatiedot.fi). The service redirects URI queries to the data provider's service, which returns the actual data.

The *identifier type* identifies the type of information resource:

- 'id' – real-world object
- 'so' – spatial object
- 'def' – concept (definition)
- 'doc' – documentation describing the object or concept, different presentation formats, for example

The *dataset identifier* identifies the data source of a spatial object. The national discovery (metadata) service's dataset identifier is used as the dataset identifier of the URI.

The *local identifier* is unique in the namespace, that is, no other spatial object in the dataset has the same identifier. The local identifier can be an established identifier used in that specific dataset, for example a permanent building identifier or property identifier.

Changes in data items are managed with the help of the *version number*. Life-cycle rules are needed for handling different versions. These rules determine whether a change in a spatial object causes a change in its identity and unique identifier or merely a change in its version number.

The structure of a spatial object's URI is as follows:

`http://paikkatiedot.fi/so/{dataset identifier}/{local identifier}/{version number}`

The identifier type 'so' identifies the feature as a spatial object.

## URIs will shortly be taken into use

The working group responsible for drafting the recommendation is currently finalising the draft and it is expected to be published in the autumn of 2015. The next step is to take the recommendation into use in the ICT systems of organisations.

At the National Land Survey of Finland the work started in spring 2015, as a project to renew the Finnish Topographic Database. One part of the project involves the creation of a system of unique identifiers for topographic data, a significant step forward for the interoperability of data. Similar projects are also to be expected in other areas of applications.

KIRSI MÄKINEN IS AN EDITOR IN CHIEF OF POSITIO-MAGAZINE AND A SENIOR EXPERT AT THE NATIONAL LAND SURVEY OF FINLAND.

KIRSI.MAKINEN@NLS.FI

BY KATRI ISOTALO, VIESTINTÄ ISOTALO OY

# A blue cap has been found!

► The voluntary rescue operations are being improved by a tracking system developed *pro bono*.

**T**he Voluntary Rescue Service participated in rescuing 195 lost persons last year in Finland, 172 of them alive.

– Most often we are called to search for an elderly person who has memory problems. The search will always start near the places where the person was spotted the last time, explains Disaster Management Coordinator Heikki Väättämoinen from the Finnish Red Cross.

Väättämoinen is responsible for the coordination between the Voluntary Rescue Service and the Finnish rescue authorities. The need for such coordination became evident in early 1960s when hundreds of volunteers were searching for a 5-year-old girl in Lapland, and found her too late.

Today, some 20,000 volunteers in 1,300 local emergency response groups are involved in the Voluntary Rescue Service (Vapaaehtoinen pelastuspalvelu, Vapepa) coordinated by the Finnish Red Cross. Among the volunteers are 50 organisations from different sectors of life such as car clubs, sport divers, radio amateurs and WWF Finland.

The authorities most commonly need help in searching for missing people, but Vapepa can also be called out to help after serious traffic accidents, flooding, environmental disasters or fires.

## Free and easy to use

When Heikki Väättämoinen returned from his summer vacation two years ago, and started to go through his e-mails, he almost hit the delete button for a message from an unknown sender named Sami Heinonen. However, something in Heinonen's message

caught his eye. It was an offer for a tracking system which would be free and easy to use.

During his summer vacation Sami Heinonen had seen voluntary rescuers in a nearby forest, and this triggered an idea of developing a tracking system for the rescue service. It would be based on the solution Heinonen had already developed to his friends for paintball games. This time the motivation was purely philanthropic.

Heinonen and Väättämoinen started to throw ideas and solutions to each other, and after a very flexible R&D process a service called Vapepa Radar was born. Väättämoinen estimates that 85 per cent of the work took place outside working hours.

Vapepa Radar allows the leader of the rescue operation track the patrols in real time.

## Real-time monitoring

When the rescue patrol or a group joins an operation, it logs into Vapepa Radar on the mobile phone. The patrol then uses the menu to tell the service whether it is a foot patrol, a dog patrol or a car patrol. After this the system locates the phone and starts sending information on the path of the patrol to the leader of the operation. In addition to phones, a GPS tracker attached to a dog can also be used.

Vapepa Radar also tells the leader the local weather conditions.

Should a cap or some other possible personal item of the lost person be found on the ground, the patrol clicks that on the menu, and the service automatically informs the leader of the operation about the object and its location. Photos can also be sent.





If the lost person can be located with a smart phone, he or she can be sent a text message telling that he or she has been tracked and can shut down the phone to save the batteries.

### Better planning

Vapepa Radar allows the leader more efficiently to plan how and when to send, for example, a foot patrol in the forest without disturbing the dog patrol searching the same area. Tracked routes can be forwarded to the local rescue authorities, who can also be given temporary user rights to the system.

In theory, a rescue operation could be led even by phone anywhere in the world. In practice, the leader of the operation normally sits in a local community centre, in a hunting hut or in a police van.

The information on the locations and the tracks of the patrols is filed on the Vapepa server. Also the maps are downloaded on Vapepa's server from where the patrols, in turn, download them to their phone when joining the operation. The solution uses mainly maps of the National Land Survey of Finland. Near the national boundaries and when very detailed city maps are needed, HERE and Google maps can also be used. It is also possible to use a specific map such as a map of a large festival area.

### Coding at night

Sami Heinonen, who developed the Vapepa Radar, is an IT-expert by profession. However, the Radar was put together mainly at night when his family was asleep.

Vapepa Radar can be used by Apple devices, Android or Windows Phones as well as by older Nokia Symbian phones. The application is implemented using HTML5, which enables automatic view scaling according to the device in use.

The maintenance of Vapepa Radar is mainly done by Sami Heinonen, while the code for non-commercial use is owned by Finnish Red Cross.

### Printed maps still number one

After several tests, Vapepa Radar was first used at the Ruisrock Rock Festival in Turku last summer. The service has also aroused international interest at least in Iceland, where voluntary rescue troops play an even larger role in searching operations than they do in Finland.

– Vapepa Radar is of great help for us, but it is still only a help, not the basis for the rescue operations, stresses Heikki Väättäminen. Rescue operations are still based on paper maps given to each patrol on the spot with the hand drawn boundaries for each patrol.

A significant improvement is, of course, the possibility to monitor all patrols at the same time. According to Heikki Väättäminen, the most significant improvement brought by Vapepa Radar is that it speeds up the decision making. The solution makes it possible for the leader to see if a car patrol misses a turn it should take, for example, and new orders can be given immediately. Especially in winter, but in Finland often in summer, too, every minute counts.



# 15+ Years Terrasolid LiDAR Processing Software to Niche Market

*Terrasolid is one of the Finnish success stories in geo-business. The Terrasolid software packages are the market leaders and a well-known brand in airborne LiDAR world.*

At the end of 1990 it was clear that Finland or Europe only is not a sufficient market area to make a specific software for LiDAR data processing. So there were good reasons to set the whole world as the target business area. Airborne laser scanning, today generally known as LiDAR, was a new, promising technology to land surveying. It was efficient and could detect ground also in forest and other objects like power lines, which was not possible by other means. Therefore many mapping operators were developing their own scanners and software. It was also a new opportunity to system integrators, like Leica, Optech and Riegl, to develop commercial LiDAR systems as well as to Terrasolid to develop powerful business software packages.

The breakthrough of LiDAR mapping took place in North-America at the beginning of 2000 and quite soon that after in Europe and Japan. There were also a couple of active LiDAR operators in Russia. The increase of LiDAR mapping reflected directly in our sales. Many LiDAR operators replaced quite soon their own software with Terrasolid packages. Also many new companies started LiDAR business.

Of course we were lucky but also risks were involved. If our Chief Technical Officer did not visit continuously several big operators to help them to resolve their data processing issues, we did not survive. At that time there were no clear workflow but it had to develop together with the software. Luckily due to new technology there were no fixed rules, standards or formats as an obstacle to the development. Terrasolid's binary format of point clouds was in a long time 'world standard' until LAS was published.

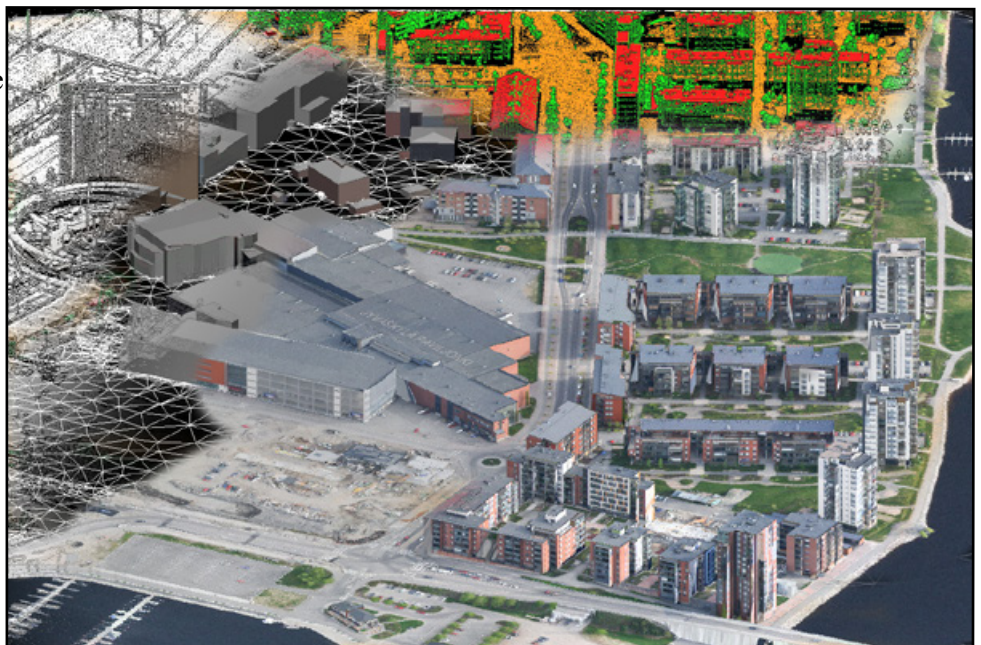
During the last 15 years Terrasolid has sold licenses for LiDAR data and image processing in more than 50 countries. Thanks to the system integrators a nice number of the licenses were bundled with the total delivery of their systems. Naturally this was clear, because pure, non-classified point clouds did not offer any benefits to the users. The final customers need DTMs, orthophoto

mosaics, vectorized transmission lines and their towers. Today vectorized 3D city models are typically created from LiDAR points.

In data processing one must first calibrate separate point clouds to form a uniform dataset, which has an exact geo-referenced position in customer's co-ordinate system. Secondly the points must be classified into different point classes like ground, vegetation and buildings. Due to a huge amount of data all the processes must be automatic or semi-automatic. Manual work should be minimized: only to check calibration, edit the point classification, seam lines of images, building vectors, contours and such as. To use images as reference helps a lot to control the automatic processes and manual editing. On the other hand, LiDAR data helps images processing.

The communication, invoicing, license registration and user's support through Internet were the prerequisites in global marketing and sales also for 15 years ago. One should neither neglect congresses and exhibitions. Terrasolid is surely one of the most likely participants in many international geo events. In Intergeo, the world biggest geo-exhibition, Terrasolid has participated annual since 1997.

The pure business idea of Terrasolid is to sell software packages and support users to use them. User's support happens mainly by emails. To train by themself by watching only some training videos is in general a hard job.



*By developing point clouds to vectorized 3D city model is like skimming different levels. On the top are non-classified laser points, then come classified points and a surface model, on third level are shaded building vectors and finally a textured building and surface model depending on the availability of images.*



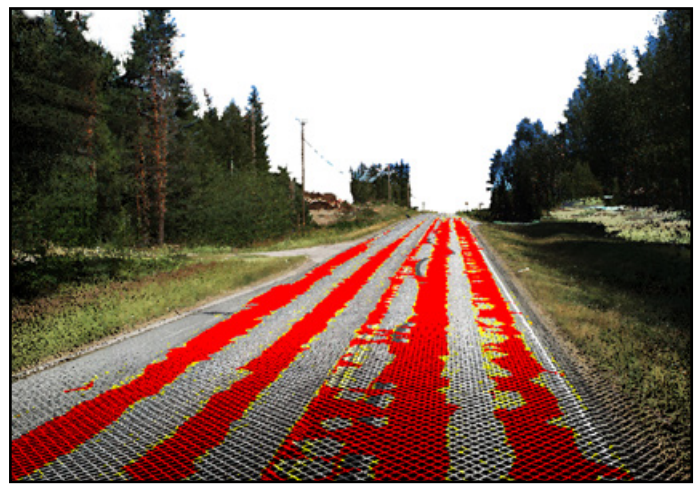
The workflow – especially in mobile data processing – is complex. To speed up learning we recommend the starters to participate in Terrasolid's training courses, which are available free of charge in our office in Espoo. To visit Espoo can be an excellent occasion to change the mind of the software with developers. We appreciate any user's feedback.

To train users in their house is a good selection, if the distance is long, number of participants is high and we can solve possible local survey problems during the training.

Terrasolid does not offer any consulting services like data processing. Instead we are eager to support customers in their own projects. To listen customers' ideas in developing the packages and help them in problem hunting is a part of Terrasolid software maintenance. Mostly the problems can be resolved in indirect ways. Sometimes it is necessary to develop new software functions.

To get experience to the software development Terrasolid has carried out by our self or participated as a member into projects as follows:

1. To survey the tram line model by a mobile mapping system, Helsinki in 2011. The target was to archive a very accurate ( $< 2\text{cm}$ ) tram line model including the rails, street kerbs and overhanging power line wires as vectorized elements.
2. To analyze the quality of tarmac roads, identify the geometry components of existing roads and move them to design packages to plan an optimized milling model for asphalt renovation. Several projects were carried out in 2013 in Finland.



*Mobile LiDAR let control the quality of the road asphalt. Red areas are water puddles.*

3. Street survey in Helsinki for an advanced point cloud coloring. These dense points clouds form the most accurate model with details, which the scanners can detect in the street environment. Such model is cheap and easy to create due to the minimal manual work.

In the last 4.5 years our focus has been to optimize the same packages also for processing data and images from mobile mapping. In airborne LiDAR the sensors have been placed in an aircraft or helicopter whereas in mobile mapping they are on a roof of a vehicle. The workflow in both solutions are very similar. The biggest difference is data calibration, which is more demanding in mobile mapping. Especially in urban areas the GPS access is poor due to high buildings and trees. By applying a sufficient number of control points and driving twice the accuracy issues can be resolved.



*Advanced colored point cloud from Helsinki city 2014.*



*Information, service and  
research about the land*