# GIS technology

## Trend Report

Edward Verbree & Elfriede M. Fendel

GISt Report No. 47 July 2007

GIS TECHNOLOGY

TU Delft

OTB Research Institute for Housing, Urban and Mobility Studies

Delft University of Technology

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# Summary

This report has been composed within the framework of the four-year cooperation contract with the Adviesdienst Geo-Informatie en ICT– Rijkswaterstaat (AGI-RWS). After a short introduction (section 1), the research area and mission of the GIS technology section are described. In section 3 special attention has been paid to the 'Ruimte voor Geo-informatie' (RGI) projects in which the section takes the lead and/or participates. A number of other important projects are described in section 4. Finally the involvement and motivation of AGI-RWS towards the RGI program and projects can be found in section 5.

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# Content

# 1 Introduction

In 2006 a four-year cooperation contract with AGI/RWS (Advisory Service Geo-information and ICT of the Directorate General for Public Works and Water Management) has been signed. Besides the GIS technology section, the Geo-information and Land Development section and DEOS (Faculty of Aerospace Engineering) participate in this cooperation. Within the framework of this contract, the GIS technology section advises, gives second opinions, realises trend reports and carries out research in the field of Location Based Services (LBS), OpenGIS, 3D-GIS/CAD, geo-DBMS, OpenSource and INSPIRE. A specific example is giving advice on the production of data models for GML that comply with ISO and OGC standards.

# 2 Research area and mission of the GIS technology section

The most important innovations in GIS technology research are characterised by infrastructure concepts for handling geo information. By analysing specific GIS applications, our researchers trace deficiencies in the current technology and knowledge gaps. Through scientific research, improvements and solutions are developed that are tested in practice. The realisation of the Spatial Information Infrastructure (SII) will result in a strong increase in the number of (non-) professional users. The SII will enable the effective sharing of resources (spatial information and spatial services).

The mission of the research in the GIS technology section is to underpin the realisation of the SII by laying its technological foundations based on developments in the field of geo-ICT, with the geo-Database Management Systems (geo-DBMSs) as core enabling technology. Research areas related to this core are 3D spatio-temporal modelling, computational geometry (spatial data structures and algorithms), distributed GI processing (network protocols/ interoperability/ web services), mobile GIS (LBS), and knowledge engineering (ontology/ semantics).

## 2.1 Structure of the research of the GIS technology section

From 2007, research in the GIS technology section (GISt) has been organised into two application-oriented theme groups: 'Crisis management' and 'Spatial Information Infrastructure', which share the geo-ICT base technologies.

**A. Theme groups (application oriented research)**

***A1. Crisis management***

The theme group on Geo-information for Crisis Management (CM) focuses on building advanced frameworks, developing solutions and testing prototypes, allowing knowledge-based use of geo-information to assist the decision-making process in crisis situations. The research of the theme group is derived from, and therefore shared with the fundamental technological research scope of the GIS technology section on geo-DBMS.

***A2. Spatial information infrastructure***

The theme group on Spatial Information Infrastructure (SII) focuses on the technological aspects of realising SIIs. Important elements of the SII are the foundation of data sets, such as topographic and cadastral information. These elements are part of the architecture of an overall SII. There are currently SII developments at several levels; e.g. the set of authentic registrations (and the relationship to the NEN3610 'base model geo-information) in the Netherlands and INSPIRE at European level.

## B. Geo-ICT base technology

### *B1. Core research theme: geo-DBMS*

The GIS technology section carries out fundamental research concerning the use of spatial data types, operators, functions, clustering and indexing in Database Management Systems. The importance of the geo-DBMS is increasing in the transition to the SII, because not only one organisation depends on it, but the (geo-) information community as a whole. Research topics within this theme are: topology structure management within the DBMS, handling 3D, temporal and dynamic objects within the DBMS, large point cloud data sets, comparative functional and performance benchmarks and XML (eXtensible Markup Language) support at the DBMS level.

### *B2. Additional research themes, but all linked to geo-DBMS:*

*B2a. 3D spatio-temporal modelling*

This research topic focuses on the challenges related to modelling of data (static and dynamic) in various systems (geo-DBMS, GIS, CAD, etc.) as well as investigating new concepts for representation and modelling. Research on 3D spatial modelling and 2D spatio-temporal modelling is going on, whereas some initial research on 3D spatio-temporal modelling has been started.

Furthermore, various aspects of data integration and data harmonisation are extensively investigated.

*B2b. Computational geometry (spatial data structures/algorithms)*

Linking GIS to computational geometry, spatio-temporal modelling and simulation models result in a more simplified, fast, powerful and flexible use. An important related theme is generalisation. The temporal component plays an important role in these models, leading to the development of dynamic geographic information systems.

*B2c. Distributed GI processing (network protocols/interoperability/web services)*

This theme emphasises research in the field of distributed GIS, data transfer between various systems, interoperability, geo-information standards, spatial models and query languages. Geodetic quality control for processing geo-information should also be used in the phases after or following data capture: data modelling, analysis and visualisation. Aspects like components and storage of quality, meta data and error propagation have to be taken into account.

*B2d. Mobile GIS (LBS)*

Mobile GIS or Location Based Services involves the integration of at least three types of technologies: positioning (GPS, Galileo), wireless communication (GSM, GPRS, UMTS) and GIS (geo-DBMS, geo-coding, routing, user interface, small-display cartography). Due to the dynamic and mobile aspects, this type of environment brings obvious potential benefits to a number of applications (navigation/travel support, localised news services, traffic and fleet management, field observations/data collection, etc.), but also has its own research challenges (architecture, design of these systems).

*B2e. Knowledge engineering (ontology/semantics)*

Agreeing on the syntax and formats of spatial data and the development of systems handling these is the first step towards interoperability. This does not mean we do understand each other's information as for this we also have to agree on the domain (or thematic) models. The semantic aspect of information (what it means) is not only important for human beings to

understand each other, but semantics is also essential if we want machines to do useful things with this information. Therefore, the semantics will have to be formalised; semantic web, ontologies, etc. (OWL).

***B3. Supporting research themes (and technologies):***

*B3a. Spatial data capturing*
*B3b. Positioning (and geo-info)*
*B3c. Geo-visualisation*

The programme of the section is embedded in the Delft Centre Sustainable Urban Areas (SUA) of Delft University of Technology.

# 3 'Ruimte voor Geo-Informatie'

## 3.1 Introduction

The realisation of many spatial developments demands a sound geo-information infrastructure and knowledge base. To achieve this objective, the Bsik knowledge project Ruimte voor Geo-Informatie (RGI) ('Space for Geo-information') aims to enhance the current situation, as well as the necessary innovations for the future. The knowledge project boosts the knowledge economy of the Netherlands through a well-thought-out balance between geo-science and geo-practice. The mission of the project reads:
'Enhancement and innovation of the geo-information infrastructure and the geo-knowledge community in the Netherlands towards sound and efficient public administration and a robust business'.

## 3.2 RGI projects managed by the GIS technology section

The GIS technology sections leads the following RGI projects.

*RGI-011 3D Topography*

*Theme: National Geo-Information Infrastructure*

The need for real 3D topography for a broad range of applications is ever increasing. On the basis of four cases (Municipality of Den Bosch, Google Earth at AGI-RWS, Lekdijk dike control and 3D TOP10NL) research is carried out to realise a new 3D topographic model and to define new methods and techniques for collecting, storing and analysing topographic data.

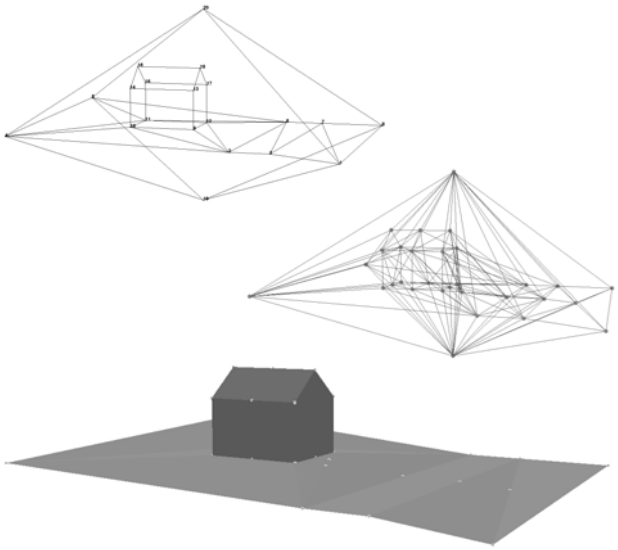

**Figure 1: Input data (top), the resulting tetrahedronisation (mid) and as output the constrained triangles, i.e. the feature boundaries (bottom) (RGI-011)**

*RGI-011A Top-up Comparing different 3D models*

*Theme: National Geo-Information Infrastructure*

Setting up a world-class network of 3D geo-information modelling research groups. The project will make 3D model requirements explicit (type of data, model implementation, model creation, model use, model update, etc.) in order to provide a comparison framework; including a benchmark scenario/data set.

*RGI-011B Top-up*

*Theme: National Geo-Information Infrastructure*

The overall objective of the RGI-011 project (leading party Delft University of Technology) on 3D Topography is to make available 3D polyhedron representations of topographical objects from 2D and height data input, and to store these objects through a Constrained Tedrahedronized Irregular Network (TEN) based representation for a broad range of applications. The first objective of this project is to research the validation and repair algorithms by means of the tetrahedral Delaunay mesh generator TetGen (made available by WIAS, Berlin). The second objective is the use of the Conforming Delaunay Tetrahedronization for efficient storage and dissemination of 3D polyhedron representations.

*RGI-026 LBS-24-7: definition study on Location Based Services with respect to Public Safety*

*Theme: Public Order & Safety*

A definition study on Location Based Services for the enforcement of legal order and aid has been carried out. Aim of the project was to get insight in the following aspects of geo-information for police, fire brigade, relief workers and emergency services on the spot:

1. user requirements;
2. geo-information (services),
3. location methods and techniques.

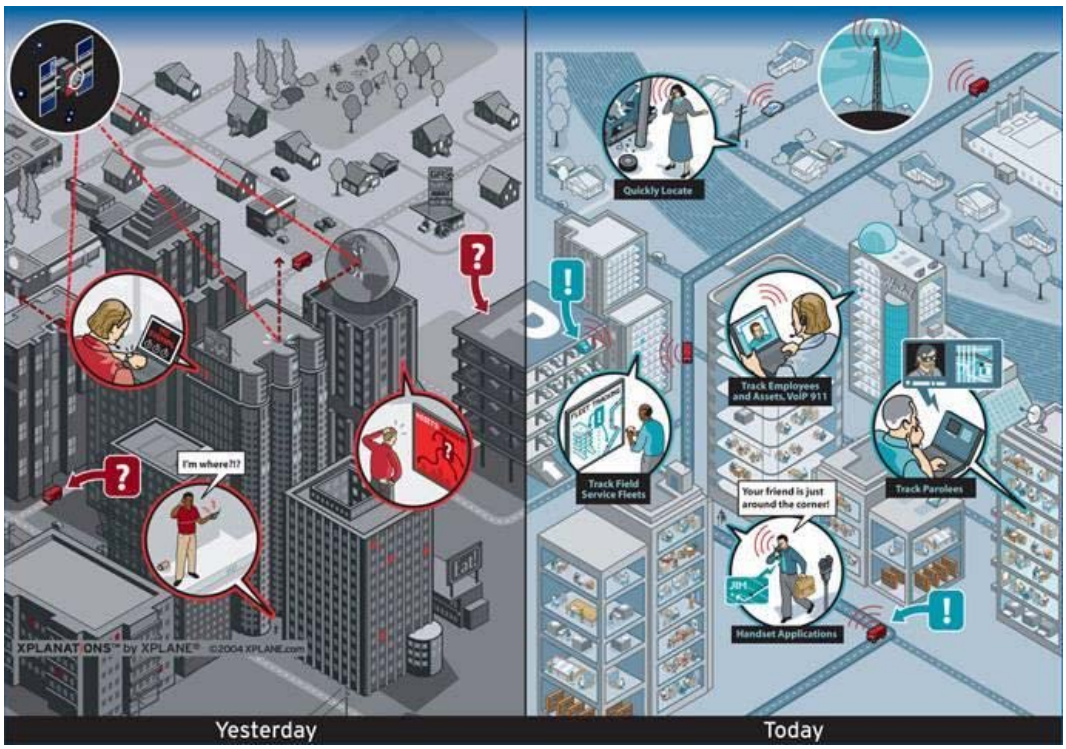


**Figure 2: Location Based Services**
**(RGI-026)**

The results of this project, were among other things an inventory of the current systems and solutions and an overview of the wishes, requirements, and expectations.

*RGI-026A Top-up LBS-24-7*

*Theme: Public Order & Safety*

In this top-up an update of the results of the RGI-026 project, a fine-tuning with other initiatives of the safety domain and an actual sequence in the form of a combination of statistic and dynamic information for safety services presented in Google Earth will be given.

*RGI-149 Geo-info-to-go*

*Theme: Public Order & Safety*

The problems regarding supply oriented (push) geo-information on the spot are studied. The main question is: 'Which geo-information and in which form should be available during the operational action on the spot to maintain public order and safety. One of the important themes is the issue of the functionality of current and future PDAs, Smart phones and dashboard systems. In this respect research concentrates on the – by its size physically restricted - cartographic creation of images and the – by pressure of time limited – interaction possibilities during the operational action that is directed via the emergency room and the crisis centre.

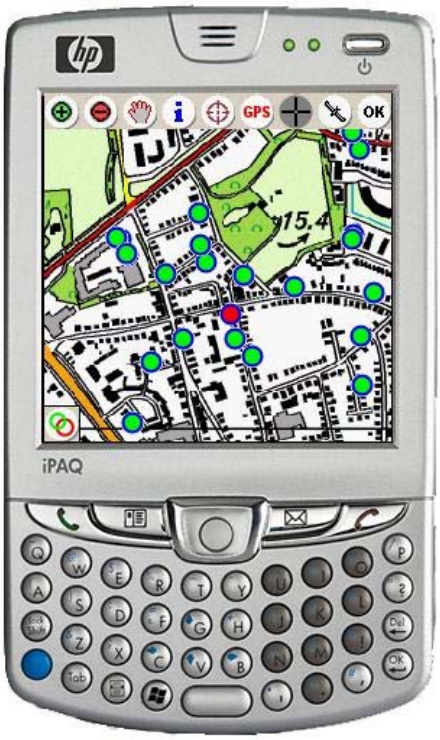


**Figure 3: Application 'Buiten Beter': use case for geo-info-to-go (RGI-149)**

*RGI-150 3D positioning infrastructure in built-up areas*

*Theme: Public Order & Safety*

With the advent of the Global Positioning System (GPS) personal navigation and positioning has become widespread. Both accurate and reliable positioning in indoor as well as in outdoor built environment (urban canyons) is however still problematic because the GPS signals are blocked or attenuated. Together with research partners, in the RGI-150 project the possibilities and applicability of several positioning techniques (photogrammetric, indoor and high-sensitivity GPS, Galileo) are

investigated for location-based services: services that are given depending on the location of e.g. a customer. The GISt section gives special attention to the applicability of GPS fingerprinting, a technique that uses geographical data to aid in the positioning algorithms. The Schiphol Group is partner in this project because they want to facilitate services for passengers and personnel in and around the terminal buildings. An inventory of positioning applications at Schiphol Airport was made, and Schiphol Airport will also be a test location.

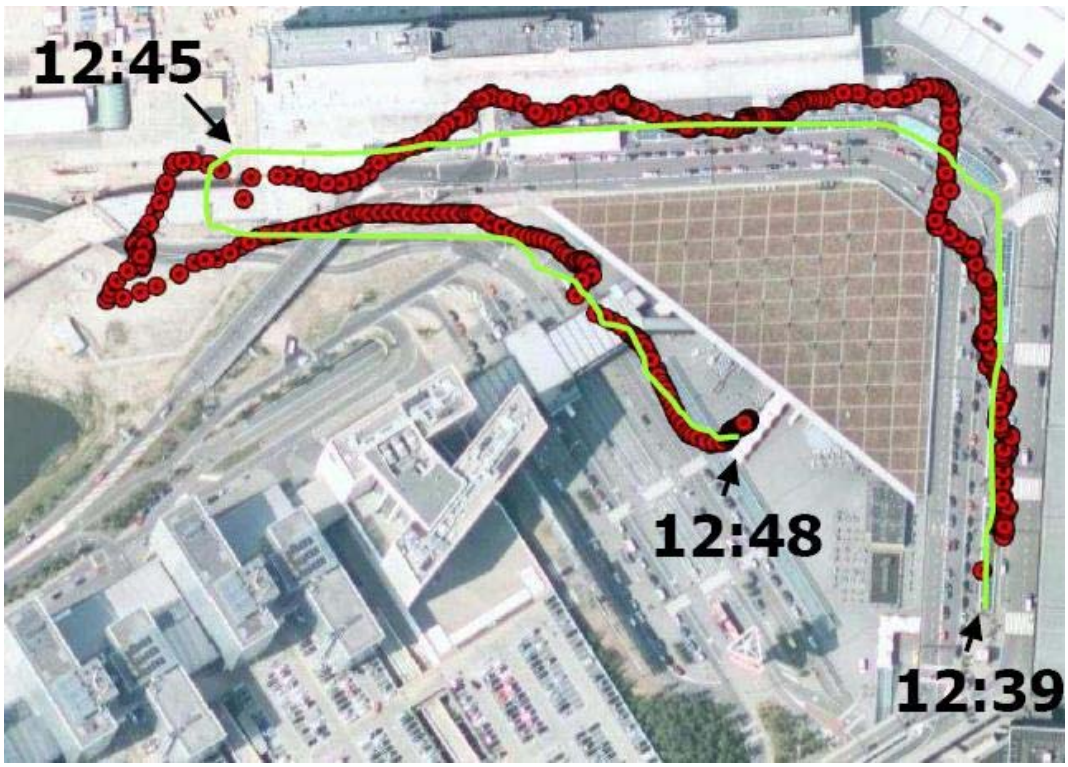


**Figure 4: High Sensitivity GPS Experiment at Schiphol Plaza (RGI-150)**

*RGI-150A Top-up 3D location infrastructure in built-up areas*

*Theme: Public Order & Safety*

Because GSM signals have a much higher signal strength than GPS signals, mobile phones can be used in indoor and other environments where classic GPS receivers have no reception. Because most people wear mobile phones anyway, they are ideal for positioning of groups of people. Rough positioning with mobile phones is possible using the cell ID. In this project the use of fingerprint information for more precise and reliable positioning with GSM is investigated in cooperation with a private company. Fingerprint information concerns cell connectivity (to more than one GSM tower) and signal strengths which are stored in a database together with coordinates.

*RGI-232 GeoInfoNed: a multimedia geo-database infrastructure*

*National Geo-Information Infrastructure*

Database management systems have become the nucleus of spatial information systems. They provide the infrastructure for both the storage of spatial data and associated administrative data to aid the user in his quest for valuable information. Currently no generic Database Management Systems are available that provide the performance and scalability needed for such a system. The GeoInfoNed project brings together two internationally leading research teams to develop a reference

platform for multi-media enriched Spatial Database Management System using GML as an interface. A spatially enhanced XQuery implementation provides a stepping stone to link into the emerging visualisation tools, e.g. Google Earth.

**Figure 5: The GeoInfoNed project aims at improving performance of spatial DBMSs (RGI-232)**

*RGI-233 Usable (and well-scaled) mobile maps for consumers*

*Theme: Consumers & Students*

Today we see a huge increase in the use of geo-information by mobile devices. However practice (e.g. ANWB) learns that users quickly lose their orientation owing to, amongst other things, the small screens size. Further, all current solutions are based on static copies that are stored in the mobile device. This makes dynamically adapting the map to new information and to the changing circumstances of the user impossible. With the availability of high bandwidth wireless connections (such as UMTS) better, more dynamic, solutions are possible: The server generates a proper, up-to-date map of the region of interest at the right level of detail for display and adjusted to the needs of the user. For a mass market (consumers of mobile maps) the human factors aspect is very important. The currently available mobile maps solutions still have insufficient user-interfaces. Extremely important is the issue of context as the user gets 'lost' very easily on the small mobile displays when zooming and panning. With generalisation techniques attempts are made to give the user – despite these limitations – a good insight. Among others things this is done via animation techniques that allow smooth zoom-in and -out. Based on a selection of use cases (navigation, tourist support, etc.), User-Centered Design techniques will be applied to develop small prototypes / simulations and the interaction and the quality of the maps in these prototypes / simulations will be evaluated.

**Figure 6: Mobile, scalable maps**
**(RGI-233)**

*RGI-233A Top-up Usable (and well-scaled) mobile maps for consumers*

*Theme: Consumers & Students*

The main research and technology ingredients in the current project RGI-233, 'Usable and well-scaled mobile maps for consumers', concern progressive transfer (between server and mobile client) based on generalization principles and smooth-zooming. One of the most active Universities in these areas, the Leibniz University of Hanover, has been working on related topics and it is therefore that their participation will very much strengthen the current RGI-233 project. The result of the proposed international top-up project will be enhanced theory (published in joint scientific publications) and prototype implementations.

| Project number | Project title | Fits within GISt research theme | Project leader GISt | Partners |
|---|---|---|---|---|
| RGI-011 | 3D Topography | B2a. 3D spatio-temporal modelling | Van Oosterom | AGI-RWS/AHN/ITC/NedGraphics/ TD Kadaster/Oracle |
| RGI-011A (top-up) | Comparing different 3D models | B2a. 3D spatio-temporal modelling | Van Oosterom | Department of Natural Resources and Water, Queensland Government, Australia/ City University London/ University College London, UK/ University of Glamorgan, UK/ TU Wien, Austria/ L. Elmgård (private company Sweden) |
| RGI-011B (top-up) | 3D Topography | B2a. 3D spatio-temporal modelling | Van Oosterom Verbree | Weierstrasse Institute for Applied Analysis and Stochastics (WIAS), Berlin, Germany |
| RGI-026 | LBS-24-7: definition study on LBS with respect to Public Safety | B2d. Mobile GIS (LBS) | Verbree | AGI-RWS/Atila/Atlis/Nieuwland/NLR Pandora |
| RGI-026A (top-up) | LBS-24-7 | B2d: Mobile GIS (LBS) | Verbree | Web Integration |
| RGI-149 | Geo-info-to-go | B2d: Mobile GIS (LBS) | Verbree | Atlis/Mobi-Spot/Nieuwland Province of Gelderland/Yuca |
| RGI-150 | 3D location in built-up areas | B3b. Positioning | Verbree | Luchthaven Schiphol NV/NLR TU Delft: Faculty of Aerospace Engineering (sections MGP and OLRS)/TU Dresden |
| RGI-150A (top-up) | 3D location in built-up areas | B3b. Positioning | Verbree | TU Delft: OTB (section SRO)/Web Integration |
| RGI-232 | Geo-Info-Ned: a multimedia geo-database infrastructure | B1. Core theme: GeoDBMS B2c. Distributed GI processing | Quak | AGI-RWS/Cyclomedia/ University of Amsterdam: CWI |
| RGI-233 | Usable (and well scaled) mobile maps for consumers | B3b. Positioning | Van Oosterom | ANWB/City of Amsterdam/ESRI/LaserScan/ ITC/TNO: Defense, Security and Safety |
| RGI-233A (top-up) | Usable (and well scaled) mobile maps for consumers | B3b. Positioning | Van Oosterom | Leibniz University of Hanover, Germany |

**Table 1: Overview of RGI projects managed by the GIS technology section.**

## 3.3 Participation of the GIS technology section in other RGI projects

*RGI-001 Definition study geographical dimensions of risk management*

*Theme: Public Order & Safety*

The research focuses on information supply during risk prevention and emergency response. The basic idea is to develop/apply SDIs that have the capability to support spatial decisions in both risk prevention and emergency response. The information requirements of the involved actors were investigated in several use cases.

*RGI-002 Generating and use of base maps for integrated querying of digital spatial plans*

*Theme: Environmental Planning & Design*

The requirements to enable an integrated querying of spatial plans at various scale levels is investigated in this project. In this case integrated querying refers to simultaneously querying of spatial plans at different levels (national, provincial and municipal). For this the base maps have to be adjusted in order to make it possible to zoom in and out between the national and local level. These adjustments deal with generalisation: in which way is it possible to generate from large scale base maps, small scale base maps?

*RGI-008 Dealing with uncertainty in spatial plans*

*Theme: Environmental Planning & Design*

The emphasis lies on the improvement of the comparability of plan objects from various spatial plans. This is often a problem, because the objects can be subject to different kinds of uncertainty as far as their spatial, temporal, scale and thematic (rules on land use) characteristics are concerned. This project seeks for solutions to deal with uncertainty in spatial plans. Moreover specifications are defined and implemented in the national geo-information models. Use cases form an essential part of this research.

*RGI-013 Virtual reality and urban safety*

*Theme: Environmental Planning & Design*

The presentation of geo-information in a 3D virtual reality environment increases the accessibility of government plans and improves the insight in the spatial environment. This project develops methods for the efficient collection of such 3D geo-information from terrestrial recordings of a laser scanner and a panoramic camera.

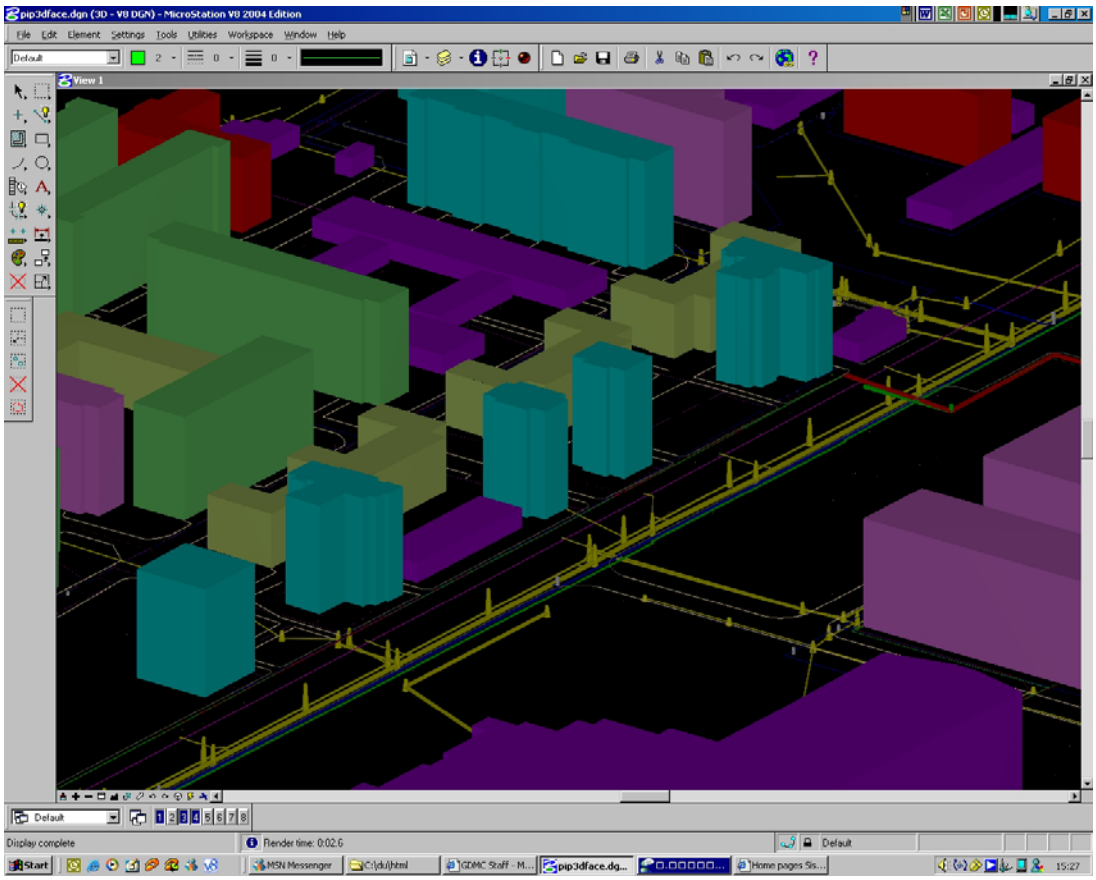


**Figure 7: 3D Visualisation of cables and pipelines.**
**(RGI-013)**

*RGI-029 Geo-information management in large civil engineering works*

*Theme: National Geo-Information Infrastructure*

Aim is to facilitate and harmonise the information flows during the whole life cycle (exploration, planning, design, realisation, management and abandonment) of large civil engineering works. This is realised via the development of a geo-information management system that guarantees the reliability, availability, traceability, accessibility, workability and integration of information.

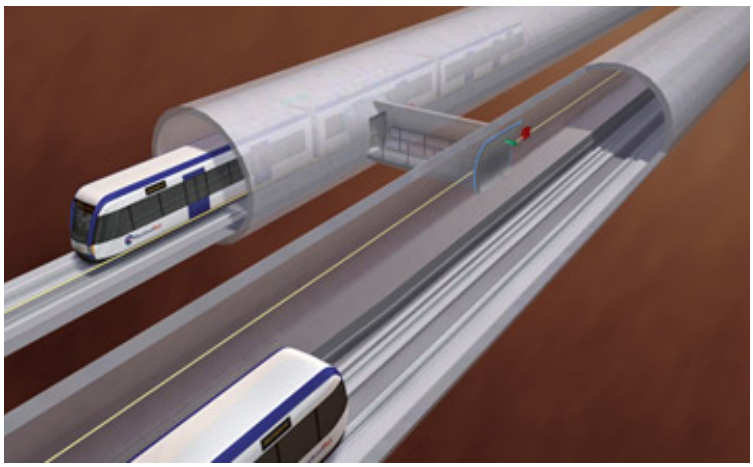


**Figure 8: Drilling tunnel Rotterdam**
**(RGI-029)**

*RGI-128 Geo-information for risk prevention*

*Theme: Public Order & Safety*

The project focuses on developing a conceptual model for handling safety risks to support the decision-making process in land-use planning. The concepts of land-use planning will be linked with safety and risk prevention criteria, employing largely geo-information technology. The model will be tested in several use cases.

*RGI-239 Geospatial data infrastructure for disaster management*

*Theme: Public Order & Safety*

The goal of this project is development of Geospatial Data Infrastructure at regional level for support of emergency response. The emphasis is on generic services, management of dynamic information and appropriate interfaces for the first responders. The research is compliant with recently reported developments with several large European and national projects such as INSPIRE, ORCHESTRA, NCGI and NEN.


**Figure 9: Visualisation on mobile (RGI-239)**

Goal of the project is to increase the geo-awareness by introducing education to appealing innovations from the geo-sector all the time. By investing in education the foundation for the future will be laid.

The GeoFort Foundation aims at becoming sustainable attractive location to keep lecturers easily informed about the latest developments in the field of geo-information. Besides lecturers GeoFort also likes to attract students (especially from secondary schools). GeoFort wants to make them enthusiastic for geo-ICT via innovative geo-attractions.

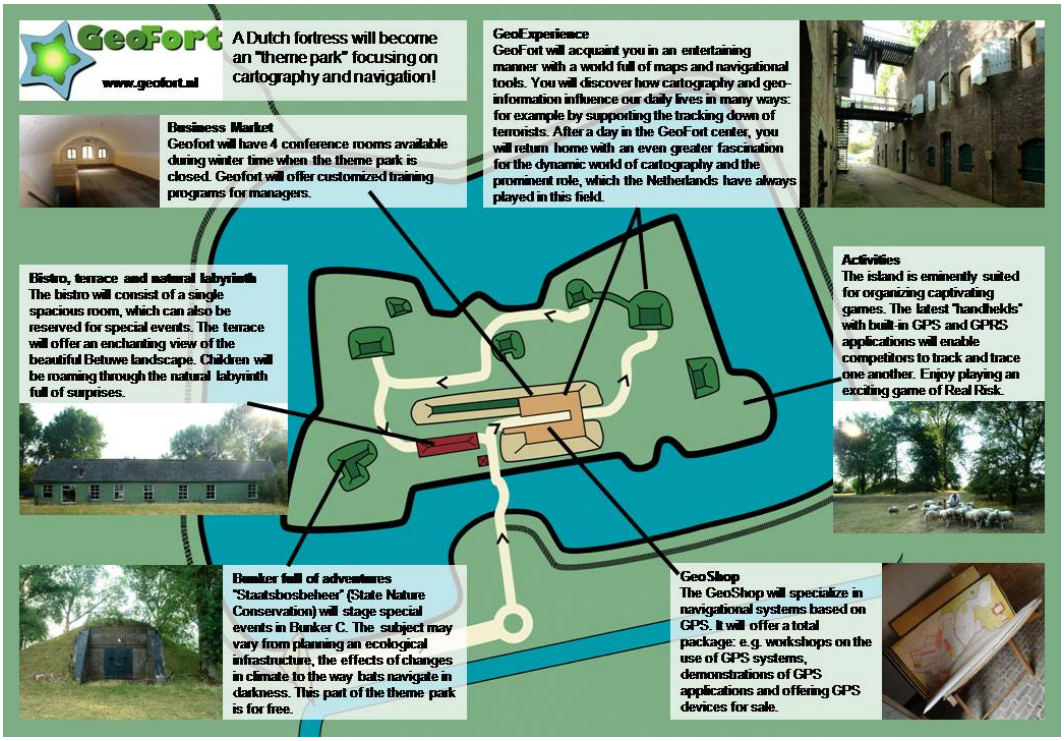


**Figure 10: 'GeoFort'**
**(RGI-330)**

| Project number | Project title | Fits within GISt research theme | Leader | Responsible within GISt |
|---|---|---|---|---|
| RGI-001 | Definition study Geographical Dimensions of risk management | A1. Crisis Management | Wageningen University | Zlatanova |
| RGI-002 | Generating and use of base maps for integrated quering of digital spatial plans | B2b. Computational geometry (spatial data structures/algorithms) | ITC | Van Oosterom |
| RGI-008 | Dealing with uncertainty in spatial plans | B2a. 3D spatio-temporal modelling | Wageningen University | De Vries |
| RGI-013 | Virtual reality and urban safety | A1. Crisis Management | ITC | Zlatanova |
| RGI-029 | Geo-information management in large civil engineering works | B2a. 3D spatio-temporal Modelling | TNO-NITG | Zlatanova |
| RGI-116 | Survey of innovations of geo-standards for NGII | A2. Spatial information Infrastructure | Ravi | Quak |
| RGI-128 | Geo-information for risk prevention | A1. Crisis Management | Wageningen University | Zlatanova |
| RGI-239 | Geographical data infrastructure for disaster management | A1. Crisis Management<br>B2a. 3D spatio-temporal modelling<br>B2c. Distributed GI processing | VU Spinlab | Zlatanova |
| RGI-330 | Innovative Geo Education | B3a. Spatial data capturering | Geofort | Van Oosterom<br>Verbree |

**Table 2: Overview of RGI projects in which the GIS technology section participates.**

# 4 Other projects

## 4.1 Kadaster

Networks of cables and pipes in the cadastral registration. The project deals with networks for, among other things, gas, electricity, water, oil and telecommunications. A data model has been developed to support the delivery, management, information supply and consistency control of data. Advice has been given on how to develop a sustainable 3D registration of networks of cables and pipes.

## 4.2 TD Kadaster

The project TOPNL – generalization is carried out in cooperation with ITC, Enschede. The goal is to develop a model for all map scales. The GIS technology section is working on:

- Determination of the criteria and functionalities of the prototype TOPNL;
- Drawing up the model rules UML;
- Designing the TOPNL model in UML;
- TOPNL model with multi-scale test data sets (GML/XSD).

## 4.3 Ravi

There has always been strong cooperation with Ravi in the field of standardisation and information models. The section gives input to the national geo-information base model, including domain specific information models, like Topography, Cultural History and Water.

## 4.4 ITC/Dutch Cadastre: CCDM

A standardised core cadastral domain model (CCDM), covering land registration and cadastre in a broad sense (multipurpose cadastre), will serve at least two important goals: (1) Avoid re-inventing and re-implementing the same functionality over and over again, but provide an extensible basis for efficient and effective cadastral system development based on a Model-Driven Architecture (MDA), and (2) enable involved parties, both within one country and between different countries, to communicate based on the shared ontology implied by the model. Important conditions during the design of the model were and still are that it should cover the common aspects of cadastral registrations all over the world, it should be based on the conceptual framework of Cadastre 2014, it should follow the international ISO and OGC standards, and at the same time the model should be as simple as possible in order to be useful in practice. The work is carried out in cooperation with ITC under the umbrella of the FIG and will be submitted to ISO TC 211 for formal standardisation.

## 4.5 INSPIRE

Since the formal take-off on 3 October, 2005 Prof. P.J.M. van Oosterom has participated in the core drafting team 'Data Specifications and Harmonisation' of INSPIRE ('Infrastructure for Spatial Information in Europe'), which aims to harmonise spatial information across Europe.
By the end of November 2006 the Council of Europe and the European Parliament reached an agreement on the INSPIRE directive, which will result in the establishment of an infrastructure for spatial information in Europe. The amended text has been published in the European 'Official Journal' in spring 2007. After a number of years of preparation, this brings INSPIRE into the transition phase, which will take two years. In this phase, the national legislation of the EU countries has to be adapted to INSPIRE. Moreover, the directives will be elaborated. The directives comprise five categories: meta data, data specification (34 themes), network services, data and service accessibility (politics), and INSPIRE monitoring and reporting. The section has been requested to make the first set-up for an INSPIRE 'Common UML model' (the EU equivalent of NEN3610).
http://www.eu2006.fi/news_and_documents/press_releases/vko47/en_GB/175161/

## 4.6 HUMBOLDT

The HUMBOLDT EU project started in October 2006. Its main goal is to facilitate a cross-national harmonisation of spatial data. Under the direction of the Fraunhofer Institute for Computer Graphics, 27 partners from 14 European countries are working in the four-year project with a total volume of 13.5 million Euros. The GISt section is responsible for the Data Harmonisation Work Package.
As proof of the concept of data harmonisation and service integration in the emerging European Spatial Information Infrastructure, HUMBOLDT will develop and validate a set of software components embedded in an overall infrastructure framework. In doing so, HUMBOLDT will address a number of research topics: visualisation, data transfer, interoperability, spatial analysis, web services, spatial databases, and data modelling and semantics of spatial data. The software tools and processes created will demonstrate the feasibility and advantages of an Infrastructure for Spatial Information in Europe as planned by the INSPIRE initiative, meeting the goals of Global Monitoring for Environment and Security (GMES).
(website: http://www.esdi-humboldt.eu).

# 5 Involvement and motivation of AGI-RWS towards the RGI program and projects

The mission statement of the 'Space for Geo-information' (*Ruimte voor Geo-informatie, RGI)* program as expressed in the Bsik knowledge project proposal dated February 2003, reads: "Enhancement and innovation of the geo-information infrastructure and the geo-knowledge community in the Netherlands towards sound and efficient public administration and a robust business". This proposal has been constituted by a steering committee compiled by the key-players of the Dutch geo-information community, i.e. Alterra, Kadaster, Ravi/TU Delft, Wageningen University (chairman), TNO-NITG and also the *Meetkundige Dienst Rijkswaterstaat V&W*, the previous name of AGI-RWS.

Although AGI-RWS happens to be one of the founding partners of RGI, they are not listed as one of the parties listed in the Consortium contract dated February 2005. The Dutch Directorate for Public Works and Water Management (*Rijkswaterstaat)* is however one of the (more than 150) consortium partners within RGI. RWS is involved within many RGI projects; the project database of the RGI website currently lists 15 results in which RWS in one of the consortium partners. As RWS is a government organization they are not entitled to receive RGI funding themselves, but the effort (i.e. hours) they contribute to a project will benefit (i.e. grant) the other project members. This grant should be of course not the motivation for a project to ask the AGI-RWS as one of the consortium partners; the knowledge they have towards, and the embedding within, the geo-information community has to be the reason for the involvement of AGI-RWS within the various RGI projects.

To inquire this involvement and motivation AGI-RWS has towards the RGI program and projects a kind of an opinion research had been conducted. The project leaders of the 15 RGI projects RWS is involved have received a short questionnaire with the following questions:

1. Who is the current AGI-RWS representative within your RGI project?
2. What is your expression of opinion towards the involvement of AGI-RWS? Please consider the presence and inspiration during the execution of the project, i.e. providing suitable user-cases, feedback on project-documents, the number of changes of the person in charge and the internal hand over of the project.
3. What is your opinion about the surplus values AGI-RWS should have gained during the execution of your project? Please consider the added value AGI-RWS has given during the execution of the project, as also the advantages AGI-RWS should have had themselves in being involved in the project.

This questionnaire has been answered by several project leaders. Some project leaders were reserved in answering these questions, as the contribution of AGI-RWS is considered as an internal matter. Given that response, and the more or less confidential answers this report will only summarize the findings into more or less generalized conclusions and recommendations.

The user-cases AGI-RWS provided gave some grip to the matter of the project objectives.

The involvement of AGI-RWS is, given the limited role of AGI-RWS within RGI, restricted to response and advice on what has been conducted during the project execution. In some cases this worked very well, with constructive input and responses during the full project period by one representative.

In other cases the representatives did not attend the meetings nor did they give valuable feedback. During the project execution there were many changes of the representative in charge. Even worse: some project lacks a representative from AGI-RWS as no one is taken this responsibility.

This negative attitude is not understood as each RGI project covers a part of the overall RGI program and as being so the involvement of AGI-RWS is considered as important.

Although the (limited) participation of a AGI-RWS representative is honored, the common feeling is the AGI-RWS management is not committed to RGI at all. That attitude is not understood as the RGI program in itself is important for the enhancement and innovation of the geo-information infrastructure, and thus should the RGI projects be supported by AGI-RWS in a more serious way.

The surplus value for AGI-RWS in taken part of a RGI project is described as limited, as some project were restricted to feasibility studies only. In other cases the project objective is described as important and to be supportive for the primary work processes of AGI-RWS, and thus the lack of support and involvement is therefore again regarded as being disappointing.

# Appendix A Research staff of the GIS technology section

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# Appendix B Relevant Information

Relevant information (project descriptions, reports, articles, presentations, etc.) dealing with the RGI projects can be found on:

- www.rgi-otb.nl
- www.rgi.nl

Whereas information with respect to the GIS technology section can be found on:

- www.otb.tudelft.nl
- www.gdmc.nl
- www.gdmc.nl/publications

Other relevant websites are:

- www.sua.tudelft.nl
- http://www.esdi-humboldt.eu
- http://www.eu2006.fi/news_and_documents/press_releases/vko47/en_GB/175161/

# Appendix C List of abbreviations

| | |
|---|---|
| 2D | Two Dimensional |
| 3D | Three Dimensional |
| AGI-RWS | Adviesdienst Geo-Informatie en ICT – Rijkswaterstaat (Advisory Service Geo-information and ICT – Directorate General for Public Works and Water Management) |
| AHN | Actueel Hoogtemodel Nederland (Actual Height Model of the Netherlands) |
| ANWB | Algemene Nederlandse Wielrijdersbond (Royal Dutch Touring Club) |
| Bsik | Besluit subsidies investeringen kennisinfrastructuur (Decree subsidies investements knowledge infrastructure) |
| CAD | Computer Aided Design |
| CCDM | Core Cadastral Domain Model |
| CWI | Centrum voor Wiskunde en Informatica (Center for Mathematics and Computer Science) |
| CM | Crisis Management |
| DBMS(s) | Database Management System(s) |
| DEOS | Department of Earth Observation and Space Systems |
| EU | European Union |
| FIG | Fédération Internationale de Géomèmetres (International Federation of Surveyors) |
| FP6 | Sixth Framework Programme of the European Union |
| GDMC | Geo-Database Management Centre |
| geo-DBMS | geo-Database Management System |
| geo-ICT | geo-Information and Communication Technology |
| GI | Geo-Information |
| GIS | Geographic Information System |
| GISt | GIS technology section |
| GMES | Global Monitoring for Environment and Security |
| GML | Geography Markup Language |
| GPRS | Global Packet Radio Services |
| GPS | Global Positioning System |
| GSM | Global System for Mobile Communications |
| HUMBOLDT | Project for cross-national data harmonisation and service integration in the emerging European Spatial Information Infrastructure, 6th Framework Programme of the EU |
| ICT | Information and Communication Technology |
| INSPIRE | Infrastructure for Spatial Information in Europe |
| ISO | International Organisation for Standardization |
| ITC | Institute for Geo-Information Science and Earth Observation |
| LBS | Location Based Services |
| MDA | Model-Driven Architecture |
| NCGI | Nationaal Clearinghouse Geo Informatie (National Clearinghouse Geo Information) |
| NEN | Nederlandse Norm (Dutch Standard) |
| NGII | National Geo-Information Infrastructure |
| NLR | Nationaal Lucht- en Ruimtevaart Laboratorium (National Aerospace Laboratory) |

| | |
|---|---|
| OGC | Open Geospatial Consortium |
| ORCHESTRA | Open Architure and Spatial Data Infrastructure for Risk Management |
| OTB | Research Institute for Housing, Urban and Mobility Studies |
| OWL | Web Ontology Language |
| PDA | Personal Digital Assistant |
| PhD student | Doctoral student |
| Ravi | Overlegorgaan voor vastgoedinformatie (Dutch council for geographic information) |
| RGI | Ruimte voor Geo-informatie programma (Space for Geo-information programme) |
| RWS | Rijkswaterstaat (Directorate General for Public Works and Water Management) |
| SDI | Spatial Data Infrastructure |
| SII | Spatial Information Infrastructure |
| SUA | Sustianable Urban Areas, Delft Centre |
| TC | Technical Committee |
| TD Kadaster | Topografische Dienst Kadaster (Topographic Survey Cadastre of the Netherlands) |
| TEN | Tetrahedronized network |
| TetGen | Tetrahedral Mesh Generator and Three-Dimensional Delaunay Triangulator |
| TIN | Triangular Irragular Network |
| TNO | Netherlands Institute of Applied Geoscience TNO |
| TNO-NITG | Netherlands Institute of Applied Geoscience TNO – National Geological Survey |
| TOPNL | Topografische kaart Nederland<br>(Topographic map of the Netherlands) |
| TOP10NL | Topografische kaart 1:10.000 Nederland<br>(Topographic map 1:10.000 of the Netherlands) |
| TOP10vector | Topografisch vectorbestand 1:10.000 Nederland<br>(Topographic vector database 1:10,000 of the Netherlands) |
| TU | Technical University |
| TU Delft | Technische Universiteit Delft (Delft University of Technology) |
| UDMS | Urban Data Management Symposium |
| UMA | UitwisselngsModel Aquo (Exchange Model Aquo) |
| UML | Unified Modeling Language |
| UMTS | Universal Mobile Telephone System |
| UN-Habitat | United Nation- Human Settlements Programme |
| UN OOSA | United Nationas Office for Outer Space Affairs |
| V&W | Verkeer & Waterstaat, Ministerie van<br>(Transport, Public Works & Water Management, Ministry of) |
| VSNU | Vereniging van Universiteiten (Association of Universities in the Netherlands) |
| WIAS | Weierstrasse Institute for Applied Analysis and Stochastics |
| WG | Working Group |
| XML | eXtensible Markup Language |
| XQuery | eXtensbile Markupe Language Query |
| XSD | XML Schema Definition |

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