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# **Innovative Cartography Standards for Web-GIS Portals: Case Study of the 'Survey of Israel's' Web-GIS Portal**

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**Key words:** Innovative Cartography, Web-based GIS, Web-based Cartography

## **SUMMARY**

Maps have been published on the world wide web since its inception (Cartwright, 1999) and are still accessed and viewed by millions of users today (Peterson, 2003). While early web-based GIS products lacked a complete set of cartographic capabilities, the functionality within such systems has significantly increased over recent years. Functionalities once found only in desktop GIS products are now available in web-based GIS applications, for example, data entry, basic editing, and analysis. Applications based on web-GIS are becoming more widespread and the web-based GIS environment is replacing the traditional desktop GIS platforms in many organizations. Therefore, development of a new cartographic method for web-based GIS is vital.

The broad aim of this project is to examine and discuss the challenges and opportunities of innovative cartography methods for web-based GIS platforms. The work introduces a recently developed cartographic methodology, which is based on a web-based GIS portal by the Survey of Israel (SOI). The work discusses the prospects and constraints of such methods in improving web-GIS interfaces and usability for the end user. The work also tables the preliminary findings of the initial implementation of the web-based GIS cartographic method within the portal of the Survey of Israel, as well as the applicability of those methods elsewhere.

# **Innovative Cartography Standards for Web-GIS Portals: Case Study of the 'Survey of Israel's' Web-GIS Portal**

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## **INTRODUCTION**

In the debate over printed versus digital maps, some geo-information specialists argue that paper maps will eventually be phased out by their digital counterparts. As the popularity of digital mapping applications increases, cartography faces diverse challenges. Classical theories (e.g. colouring, symbology, etc.) that were initially associated with paper maps need to be reconceptualised in order to address these new demands. One example is the significant difference within the cartographic design approach in translating from a CMYK scheme to a RGB scheme (colour absorption vs. colour screening). This paper provides an overview of the recent literature on web-based cartography methods and describes the implications of adopting such methods by the SOI (Survey of Israel). The paper also discusses preliminary conclusions on the potential use of these technologies elsewhere.

## **1. GIS AND MAPPING**

Analysing and mapping data from applications is becoming increasingly important in improving an organization's performance. Maps help stakeholders better understand how to improve decision-making by visualising and simulating spatial phenomena (Conway et. al., 2008). For example, spatial analysis can map socio-economic, demographic, and regional growth trends. Previous studies suggest that use of GIS technology in local governments has significantly increased in the past decade (Stern, 2002) as there is a rising demand for the technology in many sectors. The use of GIS increases efficiency by providing timely and rapid assessment of spatial patterns relevant to decision-making (Fonseca and Malheiros, 2005). GIS is an important tool for gaining insight into spatial distribution; however, to be effective, it is essential to expand its use. One of the ways to do so is by web-based GIS platforms.

### **1.1 Web-based GIS**

Web-based GIS should be based on three main components; usability, accurate data, and interactivity. Theseira (2002) noted that the flexibility and the ease of the use of the interface are critical for the successful implementation of these systems. It is essential that the data included must be clear to both professional and non-professional users. Users need to be able to query the spatial data and to print clear outputs for their own usage. Refaeli et. al. (2008) noted that increased usability increases interactivity, which in turn leads to more empowered users. A major challenge of these applications is to provide high cartographical standards.

Web-based GIS technologies are widely used by various organisations as more homes connect to the internet. Enabling the service on the internet provides access to a broad audience and resolves operational issues such as data accuracy. The number of web-based interactive map sites is increasing rapidly around the world and more industries realise the potential of map-based sites (Theseira, 2002). The growing interest in web-based applications encourages a rapid expansion of research, especially in online decision-making and planning

systems. Implementation of such applications in a variety of sectors provides new insights and increases public involvement and community empowerment.

## **1.2 Web-based Cartography and Implications**

Over the years, web-based technologies have transformed the world of cartography. What was once a paper-based field has encountered problems as mapmaking has moved to a web-based medium. The web and mobile mediums further increase the use of GIS for map production (Black, 2005). Many sectors such as private and public widely use web-based GIS and mapping applications.

With this widespread usage and evolution, many problems have arisen. For example, a large proportion of the new web mapping applications ignore important cartographic principles (Haklay, 2007). Despite claims that “GIS images are not maps” (Van Der Merwe, 2003), the reality is that most GIS products contain a range of functionality for the creation of high quality maps and cartographic products and are widely used for cartographic focused applications (Black, 2005). Specifically, products such as Maplex and Production Line Tool Set (PLTS) confirm the incorporation of cartography theory and practise within GIS products. While the last decade has experienced significant developments in web-based GIS technology, traditional cartographic approaches deal with paper-based maps. Therefore, new methods suitable for today's demands are essential.

## **2. CASE STUDY: THE PORTAL OF THE SURVEY OF ISRAEL**

Web-based GIS technologies have the potential to extend the sharing of mapping knowledge by serving as technical backbones. The literature argues that web-based GIS increases access to geographical data. However, as the use of web-based geographic data grows, new cartographical challenges arise. For example, incorporating traditional cartographical approaches may be inappropriate for the current web-based mapping demands. Different approaches have been applied in assessing the potential use of new cartographical approaches. Thus far, only minimal works deal with these cartographical challenges, yet few have utilised innovative approaches in a real case study. Thus, the main question of this work is to examine a new innovative cartographic method based on web-based GIS platform. The portal of the Survey of Israel (SOI) was selected as the case study for this work.

### **2.1 Background and Objectives**

The portal of the SOI was launched in 2005. The portal was developed and managed by the SOI, in coordination with the Inter-Agency Committee for Geographic Information (IACFGI). The establishment of the portal was part of a new strategy to move services and products to a web environment. The Israel Government Portal (IGP) is a part of the Israel E-Government project aimed at improving the connection between the citizens and the government of Israel. The IGP site presents a concentration of online services and information provided by the Israeli government and authorities.

The objectives and visions of the maps portal were as follows: reducing the costs and pricing of geographic data; extending the availability of geographic information (GI) to the public, government and public agencies; reducing government expenses and overall national expenditure; enhancing the inter-government cooperation by introducing mutual geospatial standards; and expanding the use of geographic data. The visionary principles affirmed by the SOI were embedded into the maps portal. Table 1 illustrates the guiding principles of the system (Srebro et. al., 2006).

<b>Guiding Principle</b>	<b>Description</b>
Usability	Intuitive operation of the user interface for presentation of geospatial data and for Meta-Data queries
Attractiveness	Clear and convenient user interface and an attractive cartographic design
Solidity	Focusing on applications
Internal Standardization	The user will feel familiar in any future environment which will be based on the maps portal
External Standardization	Following Windows and Internet standards as well as governmental standards
Privileges	Dynamic management of privileges for the end users

Table 1: Guiding principles of the maps portal

## 2.2 Database and Architecture

The maps portal includes about 100 layers of national geospatial data that have been collected since its early stage of operation (e.g. main GIS layers that are stored in various governmental offices). The portal is integrative and the data includes many topics, including basic mapping (roads, buildings, addresses, orthophoto, contours, hydrology, institutes, various scales of raster topographic layers, etc.); cadastral and planning layers (blocks, plots, town plans, master plans, land reserves, etc.); and tourist information layers (national resorts, national parks, hiking trails, forests, parking areas, etc.). The portal also includes information on administrative boundaries, transportation, infrastructure, security and national emergencies.

The SOI implants several architecture principles into the maps portal. Among those is the American Geospatial One Stop (AGOS), which integrates map services and extracts data using harvesting technologies that support the meta-data of the portal. In addition, the central system is based on distributed databases, which enables the maps portal direct accessibility to their data servers from various sources.

A second architecture principle that is tailored to the maps portal is the Data Ware House (DWH) concept. The DWH is concentrated in one database using Extract, Transform and Load (ETL) tools for populating and periodically updating the database. This is an adequate solution for meta-data updating procedures and requirements. Thus, the main reason for adopting the DWH architecture is that the process could be better controlled, since an initial validation could be made for the data, which are imported from various sources (Srebro et. al., 2006).

Figure 2 illustrates the architecture of the maps portal system. The data, received from government and public sources, initially passes through the internal ETL process, implemented within the SOI. This includes the integration of the incoming data with the topographic and cadastre data from the National GIS Database (e.g. No. 1). This environment (DWH) consists of the identical Hardware architecture of governmental internet servers' sites, and includes ArcIMS (soon to be replaced with ArcGIS Server) and SDE+Oracle (No. 2). This enables the system's administrators and developers to test and QA the portal prior to the web publishing stage. Once the portal version has been approved within the SOI, it is transferred off-line to the internet server's site (No. 3). At this point, it is installed and tested

on mirror servers (No. 4). From there, it is published for the public (No. 5) via the internet, and to the governmental network, via intranet web-services (No. 6).

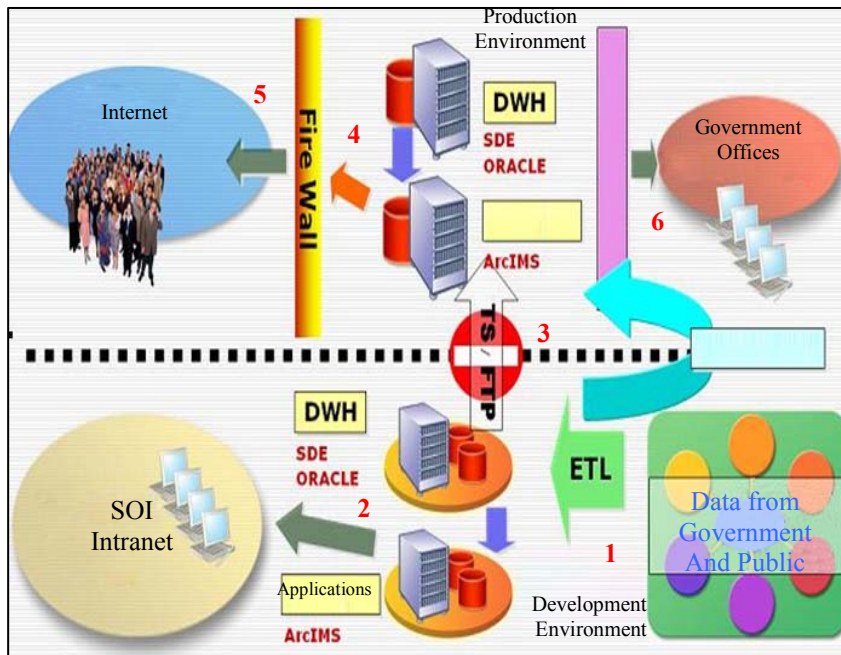


Figure 2: The architecture of the maps portal system

### 2.3 Web-Based Cartography in the Maps Portal

The current technology of the maps portal is based on the ESRI ArcIMS engine and the portal's cartography is based on its capabilities. Specifically, the cartography design is based on the ArcIMS Author tool. Figure 3 illustrates the opening page of the maps portal system. The map scale on the opening page is 1:300,000, and for that scale level, a map of 1:400,000 was modified to meet the portal viewing requirements.

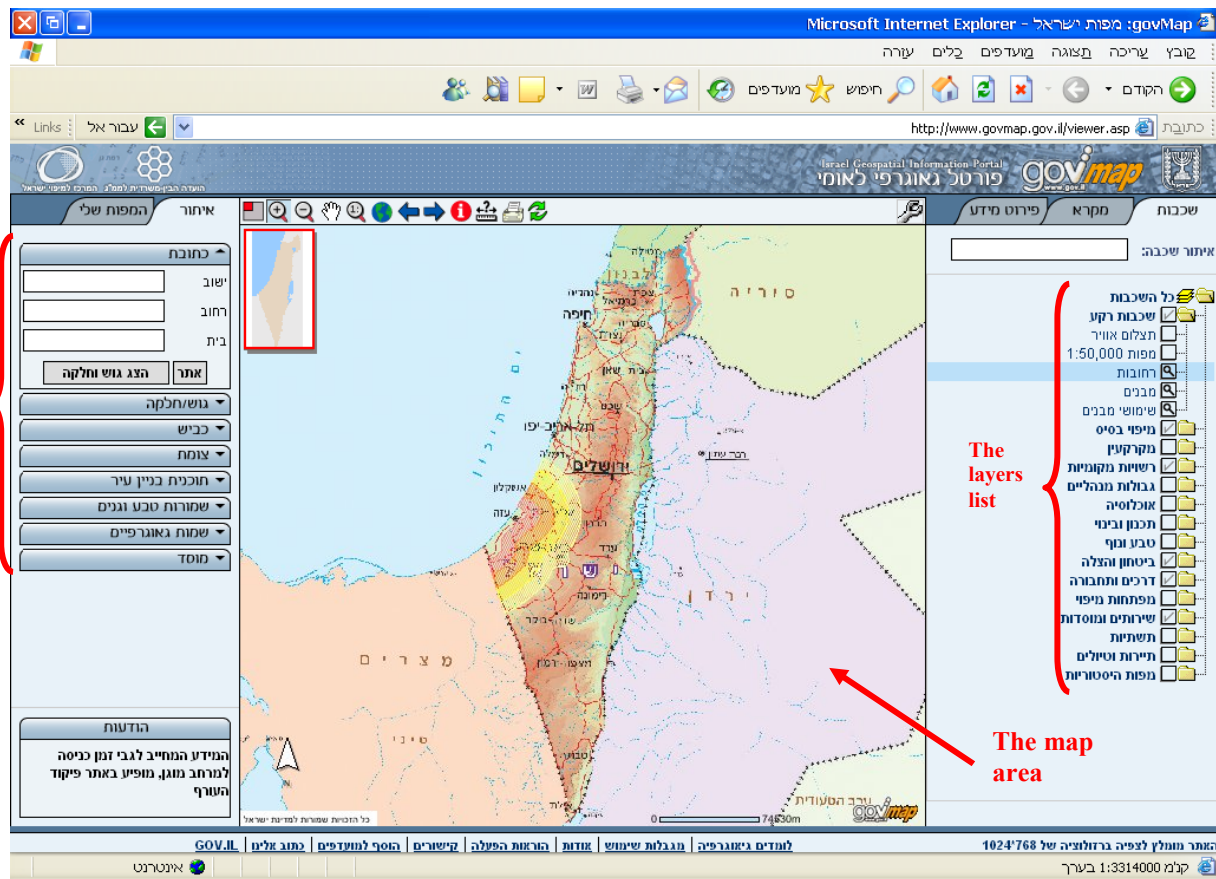


Figure 3: The opening page of the maps portal

Figures 4 and 5 illustrate the difference between a web-based map of Eilat (area of hotels) and a printed map. Both maps have a scale of 1:10,000, but while Figure 4 was composed of the direct reading of the national GIS vectors, Figure 5 was only loosely based on these vectors, creating the apparent differences in clarity.

After months of development it was clear that more research efforts, cartographical design and investment are vital for improving the map outputs in terms of harmony and quality for the end users.

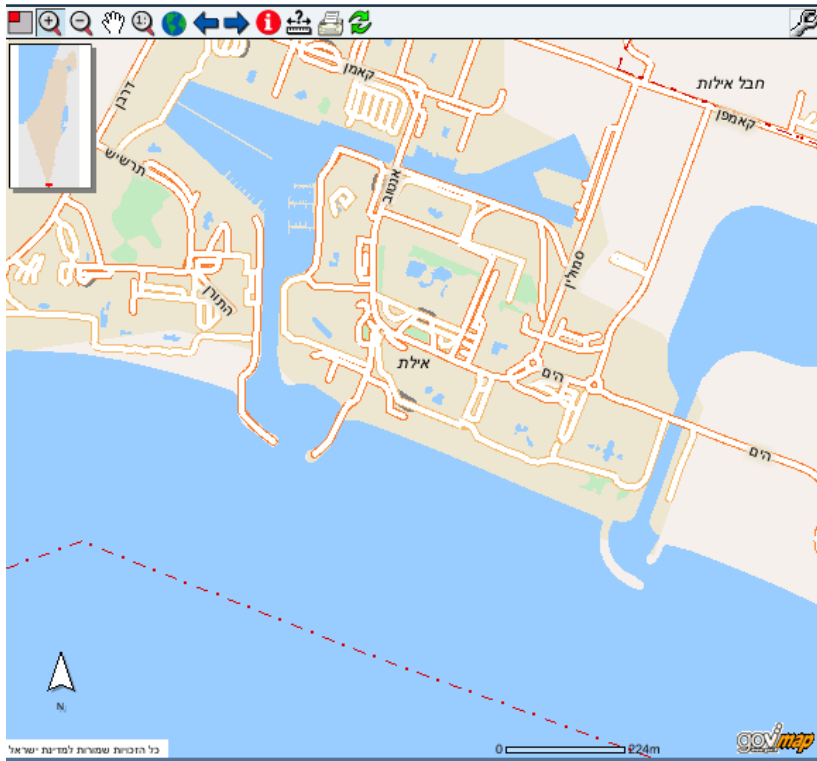


Figure 4: Eilat area of hotels (web-based), scale of 1:10,000



Figure 5: Eilat area of hotels (paper-based), scale of 1:10,000



## 2.4 Implementing Innovative Cartography Approaches

Since developing web-based cartography on the previous version was limited, the SOI decided to migrate from the old version (based on the ArcIMS engine) to a new one. Currently, the SOI is in advanced stages of migration to ESRI ArcGIS server technology, which is scheduled to be launched in August 2009. One of the main concerns during the innovative design was of the usability and the end-user experience, specifically the response and refresh times. Based on on-going statistics from the portal servers, and from the work of other researches, the SOI acknowledged that the end user will not tolerate poor performance, and will dispose of the portal in favor of different one (the competition factor). Concerning cartographic purposes, there are new advantages to the upgrade. For example, the new system includes an option to utilize the basic tools and features of the ESRI ArcGIS and to design the cartography based on a MXD template.

Additionally, SOI gained from the cartographic generalized layers developed earlier for the 'GIS Based Cartography' project. The first priority of the project was to develop automatic generalization tools for 1:50,000 scale maps. During the characterization process, it was discovered that the 'Intellectual Generalizations' implemented interactively by the cartographer were the most time-consuming. A typical 400 SQKm hydrology area took 3-4 weeks of interactive tasks. Within the automatic process that the SOI implemented, the overall time was significantly reduced to two days.

The cartographic production processes is divided into three stages. The first stage refers to the incoming data, mainly from the National Spatial Database (NSD) data, referred as the Digital Land Model (DLM). The DLM initially goes into the 'Integration and Conflation' stage. At this stage, all processes needed in order to QA the topology, the logic of the data and the integration between the different sources. During this stage, the automatic generalization process is taking place. This automatic tool includes the capabilities to generalize the layers of hydrology, transportation, buildings, built-up areas, and point features of all layers. The second stage is intellectual generalization, which is processed interactively by the cartographers on the outcomes from the automatic generalization. The outcome from this process is referred to as the Digital Cartographic Model (DCM). In this stage, the cartographic symbology and name placement are modified by using ESRI ArcGIS cartographic visualization capabilities. Finally, the third stage is the production and pre-printing process, where the DCM produces cartographic products, which is illustrated in the workflow diagram in Figure 6. Currently, the SOI finalized the following modules (layers) for a scale of 1:50,000: hydrology linear, hydrology polygonal, transportation, buildings, and built-up areas. Figure 6 illustrates the generalization process that SOI incorporated.

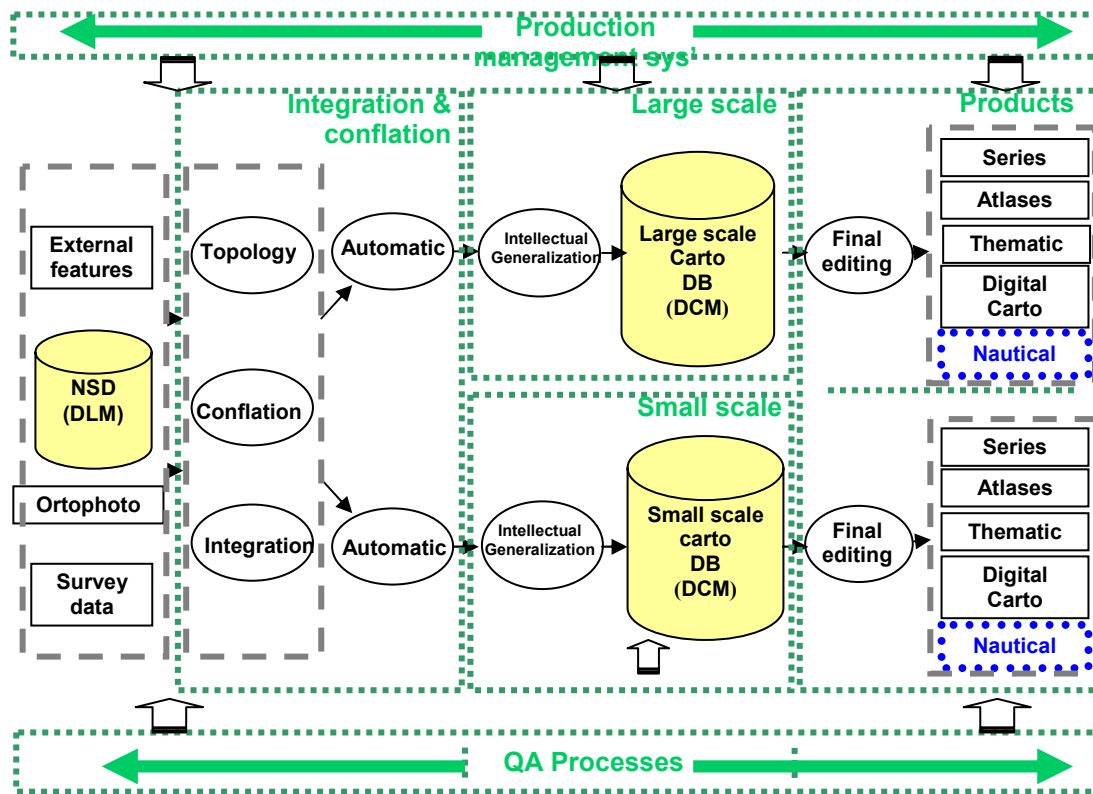


Figure 6: The cartographical generalization process workflow

Figure 7 illustrates the generalization process that was incorporated in the Hydrology layer for 1:50,000 scale maps. Notice (in the top snapshot) that the majority of the red features were cleared by the automatic generalization process.

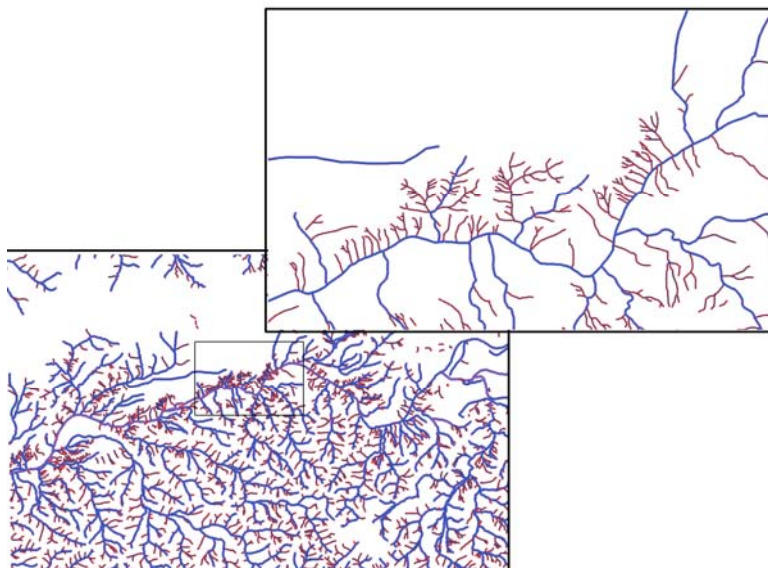


Figure 7: Hydrology layer before and after generalization process

## 2.5 Caching Mechanism

A major challenge for web-based GIS platforms is to efficiently distribute datasets composed of large graphics, such as rasters, ortophotos, and aerial imageries. Since the SOI maps portal is in the process of migration to an ESRI ArcGIS server, one of the new methods to deal with this challenge is to use a caching mechanism. As part of the guidelines for the new version (discussed earlier), highest priority was given to the usability and the response and refresh times. The caching feature, implemented on top of the geographic data layers, is designed to enable the system immediate response to data pulling queries. The process of preparing the caching includes: producing background maps based on template MXD's, designed by the National GIS layers; utilizing the cartographic generalization process; and integrating the appropriate symbology. In the next stage, these maps are automatically transformed to raster format (GIF), where the raster files are then preloaded to the maps portal cache storage. The end users have access to the pre-loaded maps. The SOI designs the caching maps for different scales and for various types of layers variations. The maps are divided into eleven group scales: 1:1,000, 1:2,500, 1:5,000, 1:10,000, 1:25,000, 1:50,000, 1:100,000, 1:250,00, 1:300,000, and 1:500,00. In addition, there are five types of caching: orthophoto; orthophoto and Hebrew maps; orthophoto and English maps; Hebrew maps; and English maps. Each map is divided into 256x256 pixel tiles. In sum, the caching mechanism shortens the wait-time for the end user during refreshing or other geospatial maneuvers of the maps. Figure 8 illustrates the pre-loaded maps in different scales for the area of Haifa.

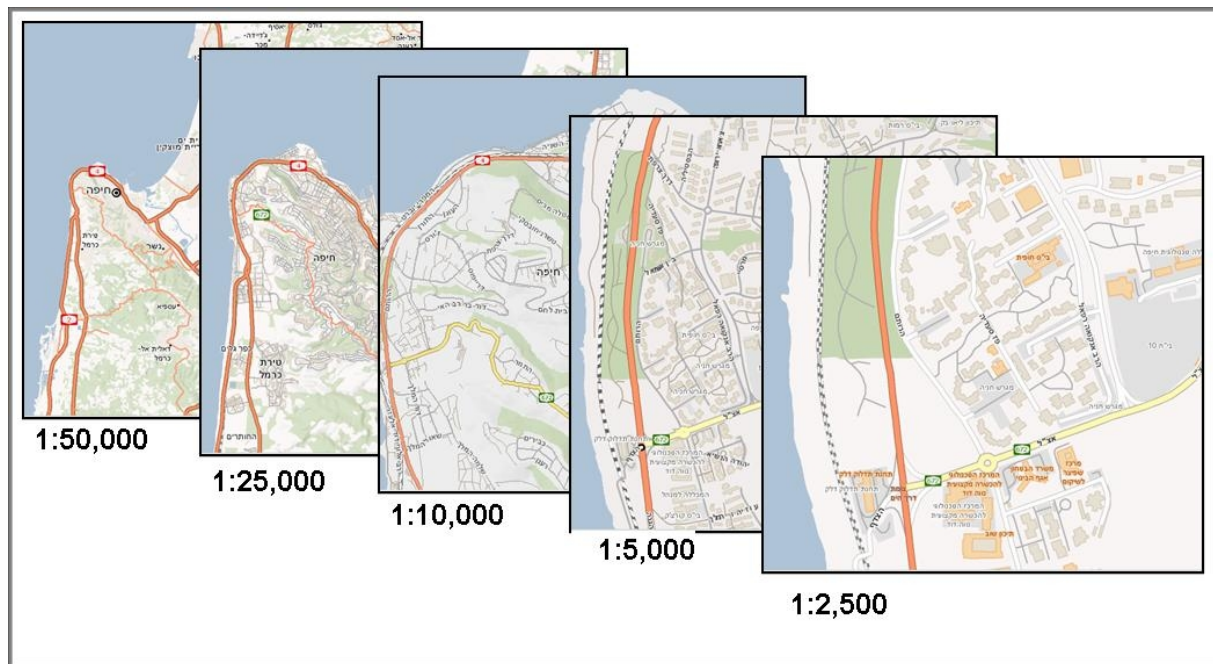


Figure 8: Pre-loaded maps in different scales for the area of Haifa

### 3. CONCLUSIONS AND FUTURE RESEARCH

From the cartographic perspective, the main practical target of the newly designed portal is to harmonize the different maps and media produced within the SOI. The study investigates the challenges of web-based cartography and the opportunities within new innovative features. This paper highlights the importance of developing new cartographical approaches and discusses the different implications of a new method adapted by the SOI. The cartographical generalization process used in the study is at the forefront of technological advancement. Adopting new features such as the 'Caching Mechanism' (substantially) improves the performance for end users. This creates a visionary web-based GIS service for the benefit of the public. Cartographical generalizations and caching mechanisms are innovative tools to address several of the modern cartographical challenges. However, the literature indicates that a large proportion of the new web mapping application ignores important cartographic principles (Haklay, 2007). Thus, cooperation between stakeholders, cartographers, universities and professional organizations are vital for creating standards for the next generation of cartography. Therefore, another objective is to improve this participatory mechanism for the professional.

A few important issues are likely to be considered in the future work of this project. The first addresses sharing cartographical services. A second deals with searching for solutions for reducing the time of the 'intellectual generalization' process. Last but not least, the project should look at the role of the new approach to cartography within the increasing use of portable handsets and tablet PC's for mapping applications. In sum, this project is a first step toward integration of visionary cartographical approaches. Combining new theories and adopting new developments is a useful long-term tool for dealing with the challenges and opportunities of tomorrow's cartography.

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## BIOGRAPHICAL NOTES

**Mr. Ori Gudes** holds a M.A. in GIS from Ben-Gurion University of the Negev, Israel. He has a diverse knowledge of GIS and over eight years of work experience in private consulting, government and academia in Israel. He is currently a Ph.D. student at the School of Urban Development, Queensland University of Technology Brisbane, Australia, and a senior research assistant at Griffith University, Australia. The main foci of his research are developing web-based decision support systems for urban planning and healthy cities promotion. These two broad research areas are clustered around several themes: web-based decision support systems, urban development, public participation and health planning. Mr. Gudes received a prize (2007) for his M.A. work from the Israeli Planning Association. He also worked for the SOI cartographic generalization project under the supervisory of Yoav Tal for one year.

**Dr. Tan Yigitcanlar** has a multi-disciplinary background and over two decades of work experience in private consulting, government and academia. Currently holding a senior research and teaching position at the School of Urban Development, Queensland University of Technology, Brisbane, Australia, the main foci of his research are advocating and promoting knowledge-based urban development and sustainable urban, infrastructure and transport development in city-regions. These two broad research areas are clustered around several themes: knowledge economy, knowledge city frameworks, knowledge-intensive activities, local governance, civic engagement, sustainable urban development, sustainable urban and regional infrastructures, urban and transportation modelling, accessibility planning, online decision support systems, ubiquitous city infrastructures, and understanding urban structures, processes and driving forces in the knowledge era. Dr. Yigitcanlar is one of the leading researchers in the field of 'Knowledge-based urban development', and he has been responsible for research, teaching, training and capacity building programmes on urban and regional planning, transport modelling, environmental science, policy analysis and information and communication technologies in respected Turkish, Japanese and Australian universities.

**Mr. Yoav Tal** is the GIS department manager at the Survey of Israel. He has more than 23 years experience in cartography, automated mapping (AM), and GIS. Currently, he leads the SOI's "GIS based cartography" project and the NSD modernization project, which is responsible for the overall GIS operation of the SOI. He has also worked for the US Census Geography Department, acting as the project manager for the TIGER modernization project, where he lead a group of GIS specialists working on updating and enhancing TIGER vectors, utilizing conflation and Q/A methods from accurate and current GIS data coming from the different GIS departments. Mr. Tal spent more than 6 years as senior project manager in the Israeli telecom company GIS project and 10 years in the IDF mapping unit as a senior officer managing the GIS and AM operations.

**Mr. Jacob Bar-Lavi** established the GIS department at the Central Bureau of Statistics in 1992, in preparation for the 1995 census. At the Survey of Israel, he started as senior project manager on several projects, among them the cadastre GIS, addresses and buildings usage DB. He was also a senior partner in the National Spatial Metadata standard. Currently, he

serves as the Spatial Portal Department Manager, where he is in charge of developing the national maps portal and the integrated SOI website and is a member of the Inter-ministry Committee for Earthquake Preparedness.

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