UPDATING MAP SERIES OR GIS DATABASES?

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Abstract

The updating of digital databases, in theory and in practice, is evolving for a wide range of applications, including mapping purposes. Several methods are in use, but lately, the main approach involves automatic change detection and incremental updating and versioning.
An important question is: Should we update a map whenever we have to reprint a sheet? Is it not better and wiser to update the database, and thus be able to serve an ample range of applications and users?
Until today, maps were updated before printing, according to technical specifications and current working methods. These are usually scale-dependent and differ from those used during the original process. The outcome may present discrepancies and differences in an updated location, displayed in two distinct scales.
This incoherence prevents the use of an updated series of maps (in one scale) to update another. Therefore, the updating process of each series is time-consuming and demands a great deal of human and capital resources. The result of this extended process is an outdated printed map.
The ideal mapping product is one that can be produced in real time, directly from an updated GIS database, from which the consumer can choose the map scale and technical specifications.
Consequently, it is preferable to focus on the continuous updating of the GIS database, with well-defined specifications (defined for the largest scale decided upon).
However, this task is labor-intensive because of the detailed requirements, carefully examinations needed, field verification, etc.; hence, it is very time consuming.
Therefore, for the short term, an intermediate solution is necessary for the updating of mapping products, produced in different scales (e.g. in the range of 1:25k- 1:100k). The solution proposed should be based on a more expedient method, as follows: (1) preparing the minimal technical specifications for updating each map series. (2) Creating symbol libraries, for any desired scale, each one on its own platform. (3) Producing the interface for the generalization, appropriate for the above mentioned scales. (4) Adapting computerized graphic tools in order to perform local/regional adjustments and to solve spatial conflicts. (5) Generating a vector file based on the oldest map-sheet (because it is unacceptable to skip non-updated changes). This file will be the most detailed one (based on the specifications prepared for the largest map-scale). The file obtained will serve as the Master, from which files, suitable for each scale, will be derived each time it is necessary to update and print a map.
Utilizing the outlined process, the incoherence between updated map products in different scales could be prevented.
The Master file and its continuous updating, under minimal requirements, will make the production process of updating maps shorter, more efficient, more coherent and without major discrepancies.

Introduction

An enormous amount of maps were produced during the last decades. Many changes occurred in the process of updating since the first edition until the present version. Data were collected, compiled, documented, and moved from one edition to another. Updating of future map series is an essential task. Future updating will include more accurate topographic data collected with advanced technologies, information on the changing land cover, the improving transportation network, the expanding built-up areas and other land uses. The updated material should be presented in any new series of maps.
A complete and renewed process of updating databases consisting of the accumulation of details, in traditional and conventional methods, is expensive, time-consuming and demands a great deal of human and capital resources. Therefore, it is impossible to update maps quickly, in real time and to fill customers' demands. The result of this very long process is an outdated printed map.
Consequently, it is crucial to change the updating process to one that is computerized, faster, more efficient, modern, and will take all map series into consideration.
The purpose of this article is to offer a quick, efficient way, to update series of maps, by using a database, which was built by modern tools and suitable technologies. Comprehensive models of updating should be used, and at the same time linking between alternative databases. Those models and linkages will encompass several scales, series and versions of maps.

The Present Situation

In many of the mapping and surveying institutes around the world, a great number of topographic map series, in diverse scales and produced in different times, were updated according to current procedures and sometimes in conformance with clients' demands. Those map series were planned, worked out and drawn manually. In the transition from one edition to another of the same scale, or maps of the same location but in different scales, many changes occurred. Data were added or erased, terrain detail was selected, generalized or adapted from other sources such as fieldwork, surveying, and interpretation of aerial photographs or analysis of satellite images. Perhaps time constraints did not enable the coordination needed to prevent data representation.

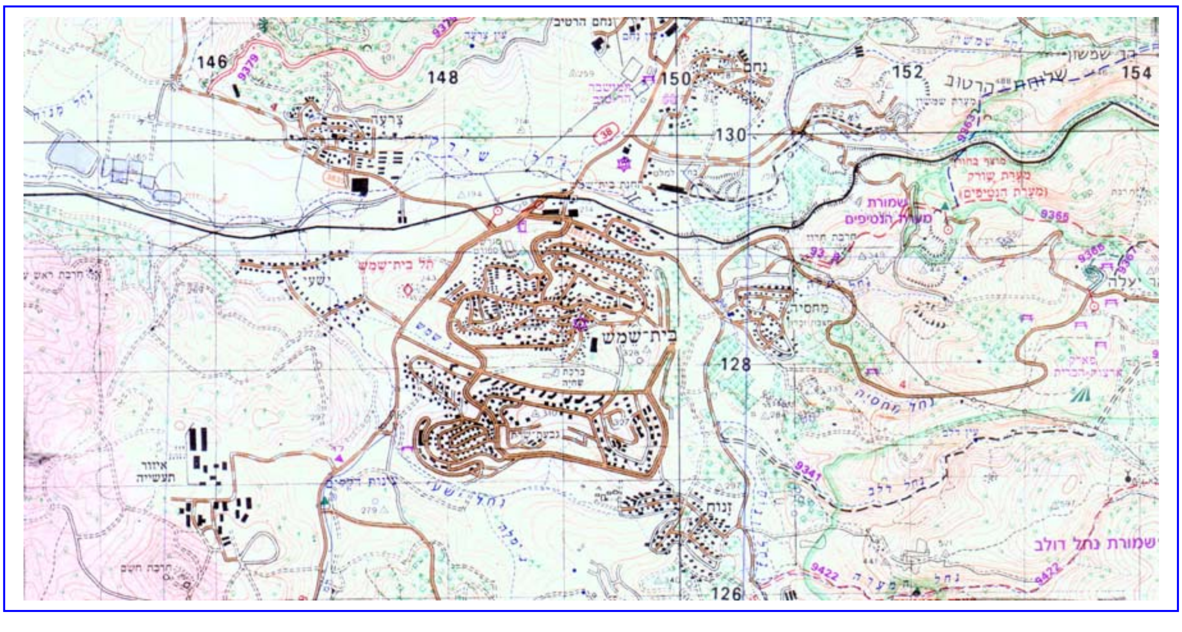
Cartographers, well trained and skillful, carrying out the updating projects in manual techniques, were described as devoted craftsman and even as artists. Those manual processes of graphic updating included drawing, erasing, carving, peeling, developing and changing the scale of positive and negative films, in addition to the coordination needed to overcome conflicts between thematic data and map-scale differences. This manual and subjective work was but one of the reasons which caused the alteration or modification of data or distinct interpretation during the processes of generalization and adaptation. In addition, the inevitable human mistakes should not be forgotten. These mistakes were copied from one edition to the other. Changes in climatic conditions (temperature, humidity) during the storage of films and other materials in which 'originals' were kept, affected and distorted them. Thus, another type of distortion was added to the manual process. All of the above caused damage to map originals and degradation, through the years, of their graphic quality and generated an accumulation of errors, which were transferred and enlarged from one edition to the other.

The following are a few examples of some map sheets and their updated and generalized versions, chosen at random. Examples like these exist and are common in maps produced all over the world.

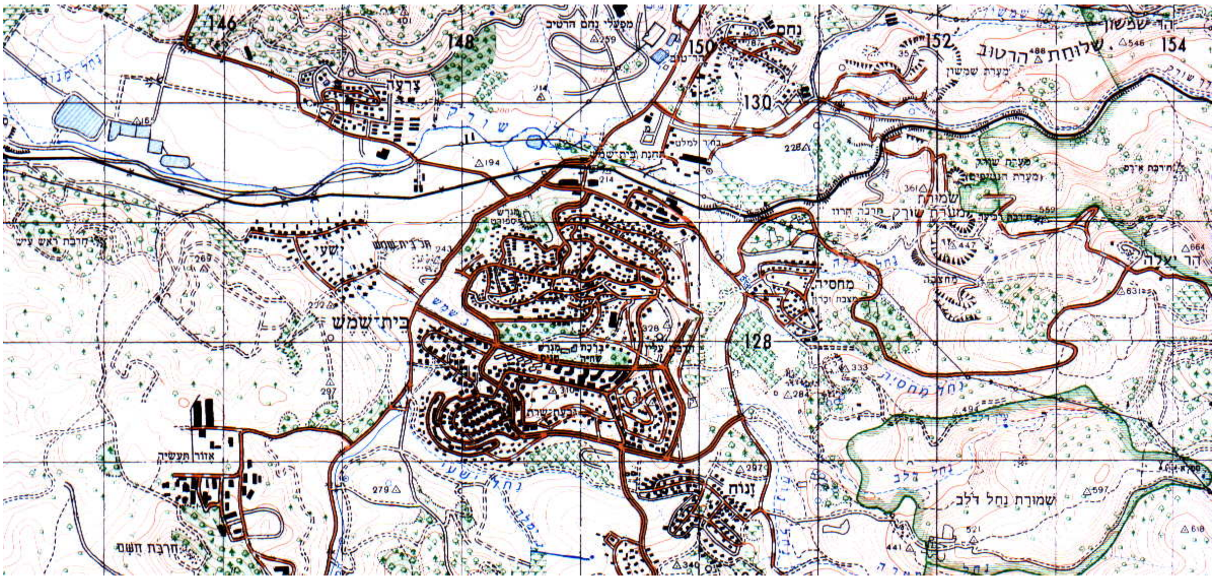
Maps in the Same Scale but in Two Different Editions

Two maps representing the Bet-Shemesh region will be introduced as follows. Both are at the same scale – 1: 50,000, but in different versions. One is a standard topographic sheet and the other is a hiking map. Careful observation reveals the differences in the presentation of details and their updating. For instance, in both maps a large building is located at 150/129. On the standard sheet, a road extends from this building in a northeastern direction. On the hiking map, the same building is connected to a quarry by an old and unused railroad. In other words, two different routes lead to the quarry from the same building. In addition, one can see that a large building located at 147/129.5, but its shape and size is different in both sheets.

Hiking Map 1:50,000-scale, Sheet # 9, published by the Society for the Protection of Nature and the Survey of Israel, produced and printed by the Survey of Israel, 3.1998, partly updated 1997



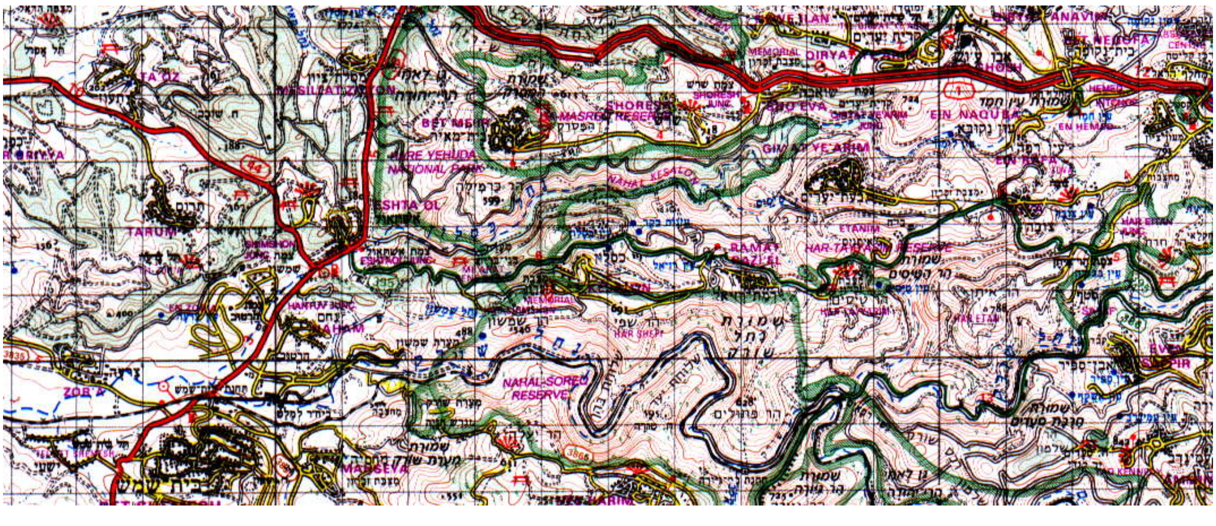
Map of Israel 1:50,000-scale, sheet # 11-I, Bet-Shemesh. Produced, published and printed by the Survey of Israel, 10.1999, partly updated 6.1999



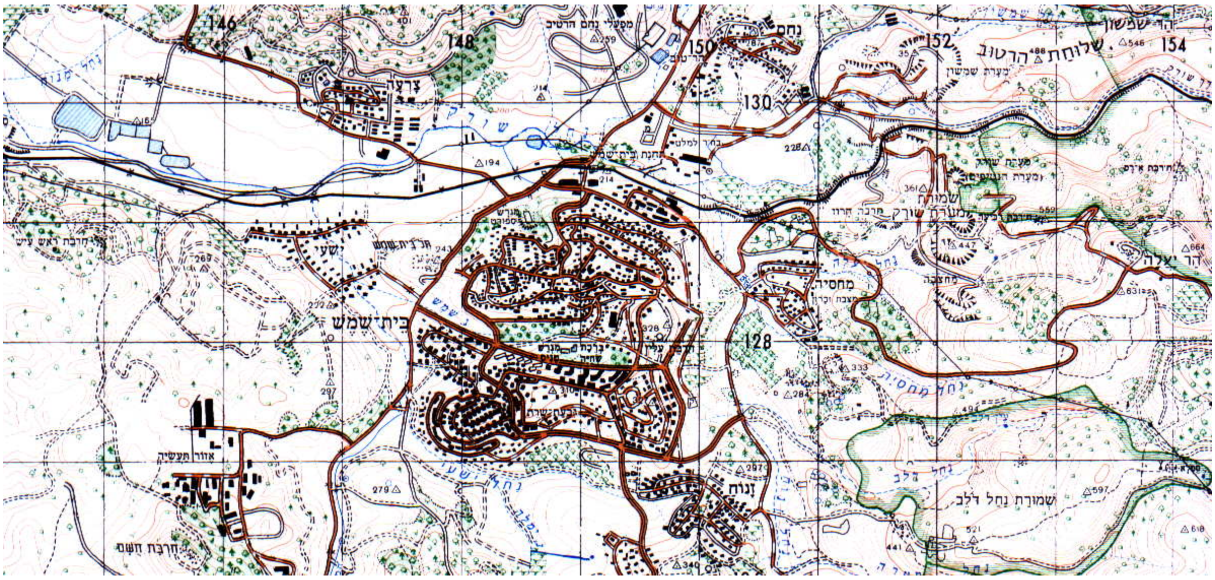
Maps at Different Scales and Editions

Three maps of the Bet-Shemesh region are inspected, each one in a different scale, all published by the Survey of Israel: scale 1: 100,000 [2000, partly updated 1999], 1: 50,000 [10.99, partly updated 6.1999], and 1: 25,000 [4.1997, partly updated 3.1997].

Map of Israel 1:100,000 sheet # 11-12, Jerusalem. Produced, published and printed by the Survey of Israel, 2000, partly updated 1999

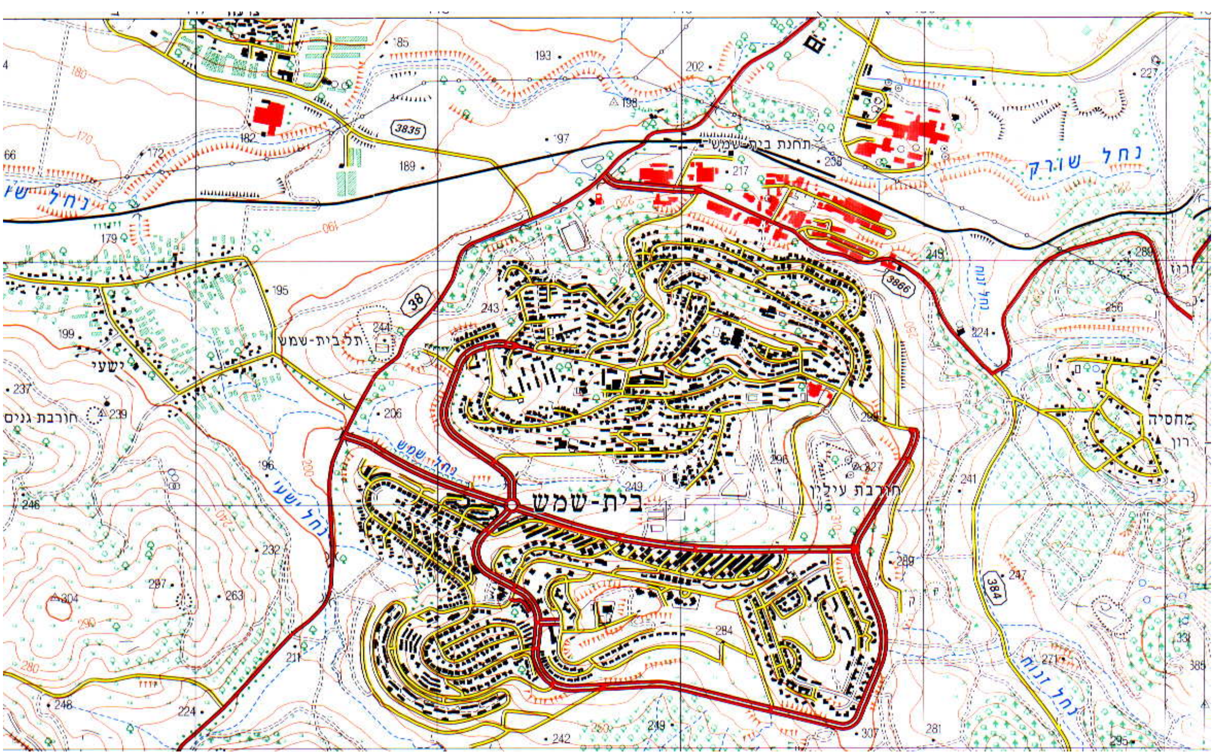


Map of Israel 1:50,000-scale, sheet # 11-I, Bet-Shemesh. Produced, published and printed by the Survey of Israel, 10.1999, partly updated 6.1999



Looking again at the course of the above mentioned railroad reveals: 1. At the larger and most detailed scale, it is evident that the railroad was removed before 1997. 2. At the middle scale, the railroad doesn't exist at all. 3. At the smaller scale (the most recently updated), not only does the railroad exist, it connects the quarry to another, larger railroad – The 'resurrection of the dead'?
The above-mentioned building is not present at the smaller scale (perhaps because of generalization); at the middle scale-map, it is represented by a small symbol compared it to its size and shape in the larger scale-map.
Are the updating sources of these three maps different? Is it necessary to unify the databases of all maps to one unique database? Alternatively, should the databases be efficiently linked to one another?

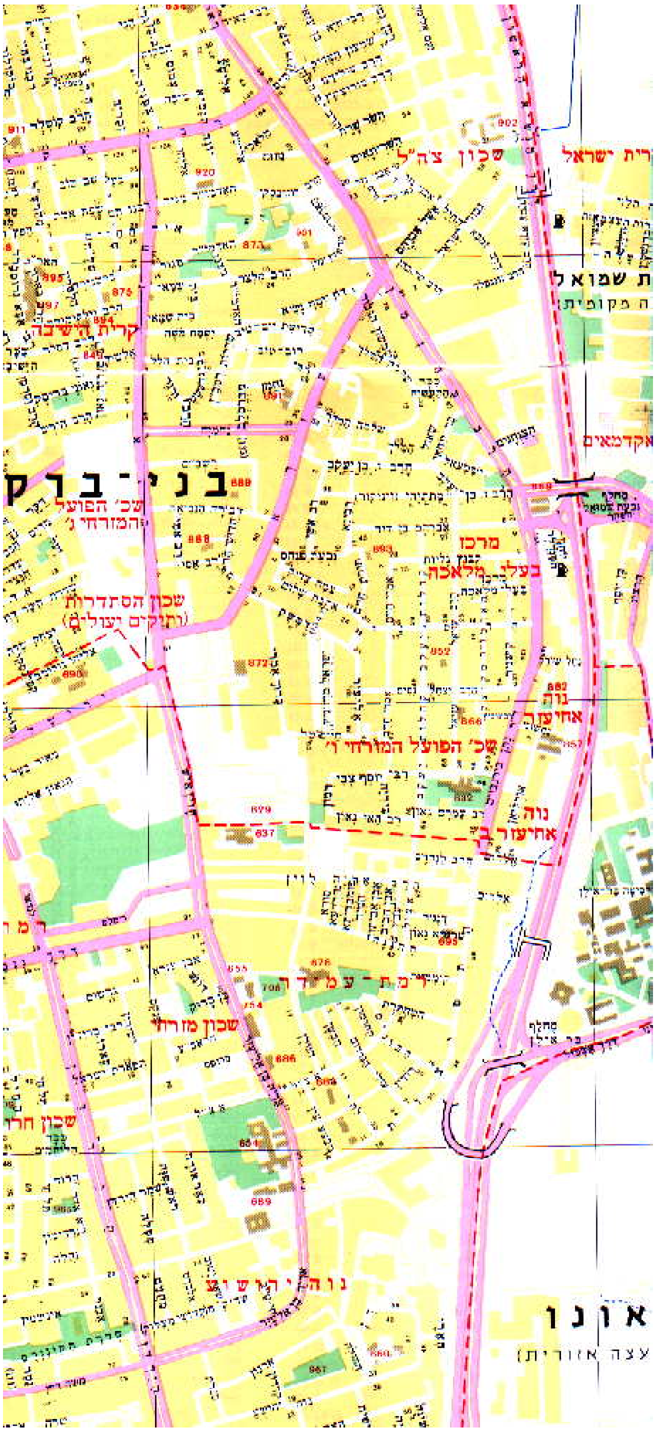
Map of Israel 1:25,000-scale, Bet-Shemesh. Produced, published and printed by the Survey of Israel, 4.1997, partly updated 3.1997



Urban Maps at the Same Scale, in Neighboring Areas

Two nearby cities are represented in two maps at the same scale, both created by the Survey of Israel in a manual production process. They are at a large scale [1: 12,500] and have overlapping areas. One is the city of Tel-Aviv [7.1998, partly updated 10.1997] and the other is the city of Petah-Tiqwa [10.2000, partly updated 5.2000].
An examination was made of the area around the Bar-Ian interchange (squares: T.A.- 20/17; P.T.9/17). The routes connecting the interchange are similar, but the length of the bridges and their pattern are different.

City Map of Tel Aviv-Yafo, 1:12,500-scale. Produced, published and printed by the Survey of Israel, 7.1998, partly updated 10.1997



City Map of Petah-Tiqwa, 1:12,500-scale. Produced, published and printed by the Survey of Israel, 10.2000, partly updated 5.2000

Another examination was made of the southeastern portion of the same interchange, bringing up two names to the same space: in the Tel-Aviv map, the area is called Ono [Regional Council]; and in the Petah-Tiqwa map, the area is called Efal [Local Council]. Is it allowed to change the delimitation of the councils' borders? Did the urbanization process reverse? In the most updated Petah-Tiqwa map, the Efal area is represented as an agricultural zone with secondary roads; in contrast, in the less updated Tel-Aviv map, the Ono regional council is a built-up, urban area, with a principal road and without land parcelation.
Are the updating databases of those maps so different? Is there any connection between the updating of those two maps of the same series? Is it necessary to unify the databases of all urban maps to one?

In the cartography departments all over the world, it is common to maintain a variety of versions of maps at the same scale, produced for different customers, in diverse periods and for special requirements. Each version is independently updated and usually does not go through a process of coordination and comparison, because each version has its own portfolio and due to time constraints.

The Problem

Until today, maps were updated before printing, according to technical specifications and current working methods. These were usually scale-dependent and differed from those used during the original process. The outcome often presented discrepancies and differences in an updated location, displayed in two distinct scales, or in two versions of the same map, if these versions were updated at all. This incoherence prevented the use of an updated series of maps (in one scale) to update another. Therefore, the updating process of each series has been time-consuming and has demanded a great deal of human and capital resources. The result of this extended process has been an outdated printed map.
An important question is: Should we update a map whenever we have to reprint a sheet? Is it not better and wiser to update the database, and thus be able to serve an ample range of applications and users?

Theoretical Background

Map updating was achieved, at first, by graphical, manual techniques only; then computerized methods were developed, aided by peripheral equipment such as scanners and digitizers. These interactive methods involve intensive manpower. Today, in the digital and computerized era, updating of digital databases, in theory and in practice, is evolving for a wide range of applications, in addition to mapping purposes. Several methods are in use: establishing a new national GIS database, by re-mapping rather than digitizing existing maps; producing huge, unique and unified databases in large-scale; working on large-scale updating and maintenance. The main approach lately, involves automatic change detection and incremental updating and versioning. This means automatically detecting, identifying and updating only these changes, which have occurred on the earth surface (Peled & Haj-Yehia, 2000; Peled & Raizman, 2000).
The need for real time updating is presented in many researches. There are two approaches for updating spatial databases: a. Remapping the entire area, establishing a new, alternate, and updated database, which will replace the old one; b. Remapping limited areas ("patches"), incorporating the new data into the database (Croitoru, Doytsher, 2000).
The researches focus in a wide range of domains in updating information; starting with management of cadastral systems (Morneau, Roberge, 1999); continuing with the organization of topic, thematic and systematic mapping, such as updating flood inundation for the evacuation of population in emergencies, or for historical and geomorphological documentation (Jones, USGS, 1998).
The updated data received is transferred, propagated and analyzed automatically to parallel, or dependant collections of other less detailed data sets (Hojholt, 1999; Harrie & Hellstrom, 1999). The propagation – transformation from large scale and detailed database into smaller scale, involves the development of new generalization methods which will facilitate the updating procedures (Kilpelainen, 1994, 1995). The automatic implementation of this generalization- transformation was widely studied in multi-scale categorical databases (Jaakkola, 1998). The maintenance of these linked databases was discussed largely (Kilpelainen, 1998).
The requirement for maintaining up-to-date spatial data originates both from the end-user and from the information provider, since inability to do so may result in user reluctance to utilize the data. It involves the ability to optimize the integration of updated data into existing datasets, while upgrading it, preserving the uniform inner structure of the database (Croitoru, Doytsher, 2000).
Many subjects are discussed in professional publications dealing with maintenance and updating spatial data. For example:

a. Semi-automatic detection and enhancement of linear features to update transportation networks (Forghani, 2000);
b. Automatic extraction of geographical objects (roads and buildings) and their Integration into an existing Information System (Celikoyan & Altan, 2000);

c. Utilization of the image processing techniques for identification, interpretation, segmentation and matching among objects in known built areas (El-Kharki et. al., 2000; Niederost, 2000);
d. Automatic interpretation and extraction of visible, spatial topographic objects from imagery (Straub, Wiedemann & Heipke, 2000).

In the identification of different features, aerial photos and satellite imagery are used in the interpretation and automatic change detection (Freitas, 2000), Zhongchao & Ryosuke, 2000). It is used to 'patch' between an existing vector dataset and the raster data, and to optimize the integration between the two sets (Hardy & Wright, 1995; Maras & Altan, 2000). Moreover, the technology is able to integrate an existing database with data obtained from air-borne, high resolution, multi beam digital cameras (Hoffman, Van Der Vegt & Lehmann, 2000).

The 'ideal' mapping product is one that can be produced in real time, whenever it is necessary, directly from an updated GIS database. From this database, the consumer will choose the map region, the scale and the technical specifications needed to his mapping purposes. Consequently, it is preferable to focus on the continuous updating of the GIS database, with well-defined specifications, for the largest scale decided upon.

However, this task is labor intensive because of the detailed requirements, careful-examinations, field verification, etc.; hence, it is very time consuming.

The interim solution

A new or an updated national GIS database, may be obtained by completely re-mapping the required region, or by updating reduced areas according to users' demands. This task is long and time consuming because of the detailed technical specifications, quality control needed, verification of field surveying, photo interpretation etc. Therefore, for the short term, an interim solution is necessary for the updating of mapping products, produced in different scales (e.g. in the range of 1:25k- 1:100k).

The Solution Proposed

The solution proposed should be based on a more expedient method, as follows:

(1) Preparing the minimal technical specifications for updating each map series.
(2) Creating symbol libraries, for any desired scale, each one on its own platform.
(3) Producing the interface for the generalization, appropriate for the above-mentioned scales.
(4) Adapting computerized graphic tools in order to perform local/regional adjustments and to solve spatial conflicts.
(5) Generating a vector file based on the oldest map-sheet (because it is unacceptable to skip non-updated changes). This file will be the most detailed one (based on the specifications prepared for the largest map-scale). The file obtained will serve as the Master, from which files, suitable for each scale, will be derived each time it is necessary to update and print a map.

Utilizing the outlined process, the incoherence between updated map products in different scales could be prevented.

The Master file and its continuous updating, under minimal requirements, will make the production process of updating maps shorter, more efficient, more coherent and without major discrepancies.

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