The 1998 Israeli Regulations for Surveying and Mapping: Standardization and Regulation of Spatial Information

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Abstract. The government of Israel, through the Survey of Israel, periodically publishes regulations for surveying and mapping. All surveying activities should be performed according to these regulations. The latest version of the regulations was published in June 1998. The regulations are concerned with several aspects of mapping activities. The core three chapters cover geodetic control, topographic mapping and cadastral surveying. All three are related to the state-of-the-art of instrumentation and technology. In addition, basic definitions for modern mapping terms are presented. This paper deals mainly with the topographic mapping aspect, with respect to its impact on spatial information management in Israel.

The chapter that deals with topographic information covers several new aspects of modern digital mapping. These are mainly aimed at standardizing the use of modern instrumentation, the working methods and the digital mapping products. Equipment for data acquisition, especially photogrammetric instrumentation, is categorized into levels of accuracy and resolution. Digital Elevation Models are classified into accuracy levels and are linked to scale. An orthophoto is recognized, for the first time, as a mapping product and is graded according to the sources of information and production methods. Finally, the use of digital mapping and its link to the Geographical Information Systems environment are specified.

1. Introduction

The Survey of Israel (SOI) is the governmental agency responsible for geodesy, topographic and cadastral mapping and the National Geographic Information System, as well as for licensing and instructing the geodetic and mapping professionals in Israel. These responsibilities were basically determined by the Survey Ordnance, published in 1929 during the British mandate in Palestine, and were applied to the surveying activities by the Survey of Palestine, the agency that preceded SOI. This document still serves as a valid law in the State of Israel.

Based on the mandatory ordnance, the Israeli Government, through SOI, periodically publishes surveying and mapping regulations. The latest version, confirmed by the minister of construction and housing (as required by the law), was published in June 1998. These regulations are in fact a law, and all surveying and mapping activities should be performed according to them.

As a result of the fast technological changes during the past decades, the regulations have been going through an updating procedure approximately every ten years. The rapid progress, and the continuous transition from graphical maps to digital information is clearly demonstrated by a long list of the professional issues, which have been regulated in 1998 but had not even been mentioned in the previous version, published in 1987.

In the past decade, with the developments of GPS technology, a fundamental change has been performed with respect to the national geodetic frame. The New Israeli Grid, which is based on a new datum, a new projection and a new coordinate system has been adopted by the mapping community. This grid is considerably more accurate and consistent than the previous one and enables significantly better handling of a nationwide spatial data.

Photogrammetry in general and digital photogrammetry in particular have been recognized as a major source of topographic and cadastral information. Standards regarding accuracy and quality levels of instrumentation and products were included in the regulations. Basic requirements for digital spatial data handling have been set, emphasizing accuracy, completeness and topology. These requirements, in fact, differentiate between a “digital map” (set as a CAD information) and structured geographical information (set as a GIS).

In order to avoid a large gap between the regulations and state-of-the-art future technology, detailed operational guidelines were published in conjunction with the regulations. Naturally, these guidelines follow the regulations. However, they may be modified by the Director General of SOI, in particularly when new technology comes in. Such a modification will enable quick response to new technology without a need to change the regulations themselves frequently.

The regulations contain five chapters. The core three of them deal with geodesy, topographic mapping and cadastre. This paper deals mainly with the topographic mapping aspect, with respect to its impact on spatial information handling in Israel.

2. Transition toward Modern Mapping

Mapping is gradually passing from the domain of graphics to the domain of digital information. This transition is divided into three generations:

- Conventional (graphical) mapping.
- Computerized (digital) mapping.
- Database (topological) mapping under spatial information systems.

In the far past, mapping was based completely on field surveying and analogue photogrammetric systems, with the output being ordinary paper maps. The transition to what is called today computerized mapping (or automated cartography) began during the 60's and 70's. Analytical photogrammetry was introduced, and the maps were drawn from digital data, using computers and peripheral equipment (e.g., plotters and digitizers). It should be emphasized that the final product of mapping processes was and still is the plotted map. During the second generation the data was characterized only by its graphical nature, although being stored digitally. Structured capabilities to retrieve and merge a combination of separate layers of relevant or required information were almost impossible.

In the past decade there have been a clear trend toward the third generation of mapping, which emphasizes the use of structured spatial information. Here the main purpose of mapping is building geographical databases in digital formats, and not drawing paper maps. Paper maps are produced from these digital data ad-hoc. Therefore a special attention is given both to the geometrical accuracy and for collecting and maintaining topological relations, as well as to descriptive alphanumerical information.

Two simultaneous processes characterize the modern high-tech mapping domain:

- Massive expansion of the need for digital products by users from different professions and human activities (engineers, planners, managers, marketing executives, etc.).

- Standardization of products, modern equipment and new methods, such as digital photogrammetric 3D workstations, accurate photogrammetric scanners, orthophotos, Digital Elevation Models (DEMs) and others.

Apparently, the transition toward digital mapping procedures facilitates simple access to and processing of data, leading to the risk of non-professional production of low quality products. The mapping community must maintain the high standards that have been set along the past decades. These standards are maintained by up-to-date regulations and guidelines.

3. Regulations for Topographic Data Acquisition

The new regulations (and especially the topographic chapter within the regulations) through their professional dictionary of terms, definition of standards, and level classifications of the different products, form the basis for a common and fruitful dialog between the different members of the mapping community. The topographic mapping chapter of the regulations consists of three major aspects:

1. Content and scale values, standards for the accuracy of the details and relief information stored in the database, and surveying methods.
2. Data acquisition equipment to be used, classified by accuracy properties.
3. Intermediate and final products, classified by their quality.

Since most topographic mapping is performed nowadays by photogrammetric means (aerial and satellite), a clear trend in this direction is reflected in the regulations. This is a major change compared to the previous version of the regulations, where photogrammetry did not play a major role. Furthermore, digital photogrammetry and spatial information, which are common in the surveying arena, are noticeable along the entire chapter.

3.1 Type of Information, Accuracy Standards and Surveying Methods

Topographic mapping consists of details and relief (ground shape). Details can be classified into two types:

(a) Details that are part of the ground surface, such as cliffs, quarries and water bodies; and

(b) Man-made objects, such as buildings, roads and electric poles.

The amount of details depends on scale, i.e., in smaller scales a generalization is made. This notion is similar to what is known from previous generations of map making. The main reason is that scale-less spatial databases are still beyond the scope of current technology. Relief is usually represented by contour lines, with vertical interval depending on the scale.

The regulations set a standard for information as a function of scales, spanning from 1:100 to 1:10,000. While in early versions different sets of map scales were dictated for topographic and cadastral mapping, the two sets were unified, allowing overlays between these two types of maps without a need to change the scale. Moreover, by having topographic and cadastral information in the same scale, a link between these two types of information is easily made, thus enabling the establishment of an integrated spatial database. It should be noted that since accuracy in the cadastral environment is critical, a special consideration was given in order to handle different accuracy levels.

Topographic information can be obtained by field or aerial surveying. All topographic maps should be connected to the national horizontal and vertical coordinate frames. Additional control points should be surveyed where necessary, in order to facilitate the surveying procedure. Control points for aerial surveying can be marked in the field a-priori, or identified in the photographs and measured in the field a-posteriori.

The accuracy of both locations and elevations of map features is defined. Standards are expressed as the difference between coordinate values of a point obtained from the topographic map and the values measured independently for quality control.

3.2 Classification of Equipment for Topographic Data Acquisition

Photogrammetric mapping should be based only on photographs that were obtained by a *metric photogrammetric camera*. Cameras are characterized into three classes based on their properties and performances, and must be certified a-priori. Proper calibration is required every five years or less.

Classification of *stereoplotters* has been modified to include digital photogrammetric workstations. In general, analogue, analytical and digital stereoplotters are classified into four quality levels. This classification is dominated by two factors that specify the upper bounds for the flying height based on the vertical interval of contour lines, and the flying height based on the scale of the map. Similar to photogrammetric cameras, stereoplotters must be certified, and periodically calibrated.

Scanners are considered in the regulations for the first time. They are classified into three levels:

(a) Scanners with minimum resolution of 1600 dpi and accuracy better than 4 ìm, to be used for scanning photographs for digital photogrammetric mapping;

(b) Scanners with minimum resolution of 1000 dpi and accuracy better than 20 ìm, to be used for scanning photographs for orthophoto generation; and

(c) Scanners with minimum resolution of 250 dpi and accuracy better than 100 ìm, to be used for all other mapping purposes.

Scanners should also be certified, and calibrated every six months according to manufacturer’s instructions.

3.3 Classification of Intermediate and Final Products

A *topographic map* is classified into one of the following types:

(a) A map for which all the details, including their line of intersection with the ground and their external perimeters were surveyed in the field or were surveyed by photogrammetry and completed by field surveying; or

(b) A map that was surveyed by photogrammetry only (without any complementary field surveying).

In light of the trend toward digital mapping, a *digital elevation model* (DEM) is considered as a major source for the relief part of topographic information. DEMs are classified into two quality levels. The lower level contains only elevation points. The higher level contains, in addition to the elevation points, topographic discontinuity lines such as breaklines and formlines. Another characterization classifies DEMs into three accuracy levels, with maximum distances between elevation points of 10, 25 and 50 m, and maximum error values (for all checked points) of 0.5, 3 and 10 m, respectively. For all three levels, the error values for 90% of the checked points should not exceed half of the maximum error values. The regulations distinguish between two types of DEMs: elevation points on an evenly spaced grid, and scattered elevation points in arbitrary locations, which properly define the terrain. Both types should agree with the quality and accuracy standards mentioned above. The regulations also set direct relations between the density of the DEM and the scale of the map (or orthophoto) derived from it. These relations range from 4 m maximum spacing (minimum 62,500 points per square km) for 1:100 scale, to 50 m maximum spacing (minimum 400 points per square km) for a 1:10,000 scale.

Orthophotos are recognized and standardized as a map product for the first time, terminating the previous status in which orthophotos were often generated inappropriately. Specific enlargement factors between the scale of a photograph and the scale of a hardcopy orthophoto produced by digital means have been set. These are ranged from a factor of 10 for orthophoto scale of 1:500, with maximum ground pixel size of 7.5 cm, to a factor of 4 for orthophoto scale of 1:10,000, with ground pixel size of 100 cm.

An orthophoto is classified into one of four levels. These levels are based on the information utilized for producing the orthophoto:

One. A properly spaced DEM, with all topographic discontinuity lines (breaklines, formlines etc.) and additional spot heights. Selected details from the digital mapping, apparently man-made objects, are also considered.

Two. A properly spaced DEM, with all topographic discontinuity lines and additional spot heights.

Three. A properly spaced DEM.

Four. Selected spot heights, which must include points near the corners of the orthophoto.

4. Summary

The mapping profession has been on the transition from the analogue, man-made mapmaking, through limited digital environment toward digital databases and automated mapmaking processes. Standards and regulations must take such changes into consideration. The 1998 Israeli surveying and mapping regulations were prepared in light of this tremendous transition.

Although spatial data seem easy to obtain and manipulate, the mapping community must maintain the high standards that have been set for years in order to collect high quality spatial information, and to generate high quality products. The regulations impose the high level standards that were widely accepted for conventional mapping on the new equipment, methods and products.

The importance of updating the regulations is obvious when observing the rapid technological changes. A quick review of the changes, which are not covered in the regulations and already need attention, include (among others) the use of GPS technology related to permanent GPS stations, metadata standards for GIS, use of high resolution satellite imagery, and incorporating analytical cadastre. Therefore, although the impact of these regulations on spatial digital data is significant and effectively contributes to a high quality digital mapmaking in Israel, preliminary steps for continuing the regulation updating process are already taken.