MINISTRY OF NATIONAL INFRASTRUCTURES
GEOLOGICAL SURVEY OF ISRAEL

Test of the Accuracy of the DTM of Israel

John K. Hall, Rami Weinberger, Shmuel Marco and Gideon Steinitz

Report TR-GSI/1/99
Jerusalem, March 1999

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Introduction

The DTM of Israel (Hall and Cleave, 1988) is the first and only systematic high resolution DTM data set available for the entire country. The DTM consists of nearly 100 million land elevations, evenly spaced at 25 m intervals on a grid. It is based on the 10 and 20 m height contours of the local 1:50,000 scale topographic maps of Israel and adjacent areas. The height resolution is 0.1 m. Although it was produced by the Geological Survey of Israel, the DTM within Israel is the copyrighted property of the Survey of Israel.

Since its production this DTM has been widely used, over a wide spectrum of scientific and other applications. Among these are

- The DTM has been purchased under license from the Survey of Israel for NIS 125,000 by a number of commercial users. Its replacement, a photogrammetrically produced DTM on a 50 m grid, is as yet incomplete.
- The DTM is available from the Geological Survey of Israel, with the written permission of the GSI Director, for non-commercial scientific research purposes. It is also available, under the same conditions, on most of Israel's university GISs.
- Calculation of terrain corrections for gravity measurements (Ginzburg et al., 1993).
- Calculation of crustal response, rotations, and mean elevations (Wdowinsky and Zilberman, 1996; Wdowinsky, Zilberman, Matmon).
- Siting of television, radio, microwave, and cellular antennas to maximize exposure/coverage.
- Modeling of the relationship between GPS elevations (reference to the geoid), and actual topographic elevations (Papo and Sharni, 1997; 1998; Sharni et al., 1998).
- Calculation of times of sunrise and sunset (Keller and Hall, 2000).
- Visual continuity (fire and smoke signals) between historic settlements (Borowski et al., 1998).
- Rotem Botanical GIS Database at Hebrew University.
- GIS reference (Karnieli et al., 1999; Forrai et al., 1999).
- Road locations (Lavee et al., 1995).
- Visualization of topography (Lavee et al., 1995; Cleave and O'Neill, 1995; Rohr Productions, 1999; ten Brink et al., 1998; 1999; Electronic Arts-Janes, 1998; Skyline, 1999).
- Hypsometric calculations of the Dead Sea Depression (Hall, 1997a)
- Tectonic and drainage analysis (Krit-Man, 1998).
- Trafficability.

The wide use of this DTM in different applications has raised, in many instances, the question of its overall accuracy. Its relative accuracy, however, has already been shown via the two anecdotal cases described below.

Anecdotal Case 1:
When the DTM was used by the Geophysical Institute of Israel (GII) to provide the terrain corrections for the gravity measurements, they also tried testing the x,y,z coordinates of the sites surveyed for the micro-earthquake measurement stations. The agreement was quite good, except for several stations which showed differences of about 50 m. A check of these sites indicated that the reported x,y,z position were for the top of the transmitting antenna, which had been surveyed from distant control points. These erroneous seismometer heights were duly corrected (Ofer Siman-Tov, personal communication).

Anecdotal Case 2:
In 1999, the DTM was made available to the Hydrological Service for use in hydrologic modeling. Investigations of the *x,y,z* coordinates for some 7,000 water well sites showed generally good agreement, except for several tens of wells with differences of 50 or more meters. Inspection of these locations showed that the recorded elevations for the wells were in error (Y. Lifshitz, personal communication).

In order to better determine the accuracy of the DTM, a large scale test was carried out using the gravity database of the GII. This database contains more than 46,000 gravity measurements whose *x,y,z* coordinates were, for the greater part, determined independently from the maps which were the basis of the DTM. In describing this test, and the excellent results which were obtained, it is first necessary to describe the methods by which the DTM was obtained, and the assumed accuracies of the mapping on which it is based.

The Digital Terrain Model (DTM) of Israel

1. Description of the DTM - General

The DTM of Israel was prepared between 1987 and 1993 as a joint effort between the senior author, the Geological Survey of Israel (GSI), the Survey of Israel, and Historical Productions Ltd. (Hall, 1993). It consists of elevations (and depths) to 0.1 m resolution, on a 25 m grid locked into the local Israel Grid. The DTM is based upon the 10 m contours of the 1:50,000 scale topocadastral mapping of Israel, produced by the Survey of Israel. In certain flat areas (*viz.* the Jezreel Valley, the floor of the Dead Sea etc.) contours or form lines at intervals down to 1 m were used. On land, outside Israel, 10, 20, and sometimes 25 m contours were used from other mappings (such as the US Defense Mapping Agency [DMA] Series K737 for Jordan) primarily at 1:50,000 scale. In the marine areas, published and unpublished bathymetric survey data and charts were used to prepare a seamless DTM.

The DTM was made as a series of tiles, each representing a 20 by 20 km area, based upon the division of the 1:50,000 scale topocadastral maps for Israel. All told, some 240 tiles have been done for Israel and its adjacent territories.

2. The Methodology

The methodology for preparing the DTM is an intuitive and innovative one developed by the senior author. While the software is available from the GSI Documentation Center at nominal cost, the method has apparently not been used elsewhere. The method has been described in some detail in Hall et al. (1990), while some of the innovative and intuitive aspects are discussed at length in Hall (1995).

In brief, the method consists of scanning the original map sheets at 6 lines per 25 m, georeferencing them, using simple PC systems to interactively repair holes in contours, and then flooding the intervals between contours with colors appropriate to the value of the interval. Thus with 10 m contours, a 10 color palette is repeated for every 100 m of elevation change. Once this editing has been carried out, the computer can automatically and accurately determine the locations at which the contours cross the DTM grid. The positions are then used to fit splines in orthogonal directions, with elevations being determined by weighted averages of the two splines at each node.

3. Published accuracies of the topocadastral maps

The characteristics of the basic series of 1:50,000 scale topographic sheets of the Survey of Israel are as follows (Forrai et al., 1999):

a) Graphical (non-digital) data only: 88 map sheets completed over 20 years, up until the 1970s.

b) Horizontal accuracy: 20-40 m.

c: Vertical accuracy: 10-20 m.

d) Maps are non-uniform in terms of accuracy, as a result of the historic inhomogeniety of the horizontal and vertical geodetic control networks, and also in terms of the mapping methods used.

e) Only event-related or partial map revisions have been completed.

4. Estimated Accuracy of the DTM

Vertical Accuracy

The standard methods of producing DTMs from contours involve semi-automatic identification and digitization of contours. These methods generally undersample the contours, and risk incorrect identification of contour values. The method used to produce the DTM of Israel is different, in that the use of color fill between contours makes identification intuitive and almost foolproof, and the georeferencing provides the computer with all contour crossings on the DTM grid. Hence the number of contour crossings for a map tile ranged from 20,000 to over 600,000 depending upon topography, while a DTM made from a triangular irregular networks (TIN) might use only 5,000 points. In particular, if a grid node lines on a contour, it will have the contour value, while most interpolation schemes for random points will not exactly agree.

Since the DTM is based almost completely on the 10 m contours, the accuracy of the DTM will depend upon the accuracy of the original maps, and the ability of the cubic spline interpolation to fill in between the contours. Cubic splines have several unwanted properties. If there are abrupt changes in slope, such as over small buttes or steep sided local holes, then the splines will tend to greatly exaggerate the crests or troughs. This effect was minimized in the software by restricting the splines to excursions of no more than 5 m (a half contour interval) from a straight line joining adjacent contours. A more subtle artifact is the property of the spline wanting to hug its data points. Hence a splined profile tends to flatten out as it passes through its data points. If a histogram is taken of the DTM elevations, this results in local maxima at the contour interval (Hall, 1997a, Fig. 2-7; Guth, 1999).

Taking the above effects into account, the vertical accuracy of the DTMing process is estimated at ±5 m overall, with possible excursions up to 10 m within the interval, if for instance there is an appreciable distance between contours, and the ground remains level from one contour almost up to the other, and then abruptly steepens to the second contour. Near contours the accuracy should be within a few meters. Adding in the 10-20 m vertical accuracy of the mapping as noted by Forrai et al. (1999), the absolute accuracy of the DTM on land should be within 10-30 m.

Horizontal Accuracy

The absolute horizontal accuracy of the mapping as noted above is 20-40 m. The georeferencing process of the DTM assures that the location of the DTM grid should be very close to the original map coordinates. However, in the process of making the DTM, two sources of error were noted:

1) The stable bromide prints provided by the Survey of Israel from contact printing of the original film contour separations were scanned on a commercial prepress Hell scanner with 2200 lines per inch (lpi) optical resolution. The actual resolution of the scanning for the purposes of the DTM was about 304.8 dpi (12 lines per mm). None of the scans of the map tiles were found to be square. The usual skew was up to several pixels (1 pixel equals 4.16 m on the ground at 1:50,000 scale), while the maximum observed was 22 pixels (over 91 m).

2) The process of edge-matching the tiles showed that there was seldom an exact match of 1-2 pixels. In some cases the mismatch was such that in order to avoid a vertical or horizontal lineament in the DTM along this contact, a zone up to 15 pixels wide was erased along the boundary, and a smooth continuation of the contours was made manually. Hence the DTMing process is probably horizontally accurate to within 5-10 m for most of the area, with a few dislocations of 50-100 m.

Test of the Accuracy of the DTM of Israel

1. The Reference Elevation Data Set - The GII Free Air Gravity

In order to evaluate the accuracy of the DTM of Israel we compared it with a set of nearly 46,000 irregularly spaced Free Air gravity measurements carried out by the Geophysical Institute of Israel (GII). These measurements used three different methods of positioning (M. Rybakov, personal communication 1999). It is estimated that the bulk of the measurements (~90%) were made with a total station (Distomat) from trig or other surveyed control points, while perhaps 7% were made by reference to maps of 1:50,000, 1:25,000, or 1:10,000 scale, and about 3% were by kinematic GPS.

Figure 1 shows the location of the 45,947 gravity measurements against the background of the shaded relief map of Israel (Hall, 1994; 1997b). The measurements are plotted in red and yellow - the yellow dots indicating the 50 measurements with elevation differences of more than ±25 m. The locations are mostly concentrated on relatively level and accessible parts of the country.

2. Computation of DTM elevations at the reference locations

At each of the *x,y* locations of the 45,947 gravity stations, the elevation according to the DTM was computed. Although many schemes exist for interpolating within a regular grid (Jones, 1998; Doytsher and Hall, 1997), a very simple system was used. Given a point interior to a grid cell, its elevation is determined as follows:

a) An east-west line is constructed through the point, connecting the eastern and western sides of the grid cell at elevations proportional to the elevation change between the respective northern and southern corners.

b) For this east-west line, the elevation at the interior point is then calculated, and is proportional to its position between the end point elevations. This is elevation z_1.

c) A north-south line is now constructed through the point, connecting the northern and southern sides of the grid cell at elevations proportional to the elevation change between the respective eastern and western corners.

d) For this north-south line, the elevation at the interior point is then calculated, and is proportional to its position between the end point elevations. This is elevation z_2.

e) The elevation of the interior point is now the average of the two, or $z = ½(z_1+z_2)$. This type of calculation is necessary because it can happen that the four points define a saddle.

It is worthwhile noting that this simplification also provides an easy way to determine a surface normal at the point, simply by taking the vector cross product of the unit vectors defined by the east-west and north-south lines passing through the interior point. Such a calculation was used to determine the hill-shading used in the calculation of the shaded relief maps of Hall (1994a,b, 1997b, 1998a,b). Thus at each interpolated point this surface normal was used to compute the regional dip. In addition, the mnemonic of the map tile in which the point lies was also noted, as well as the difference between the DTM elevation and that of the gravity station.

3. Results

Figure 1 shows the regional distribution, over Israel, of the 45,947 control points. Figure 2 was derived by gridding (minimum curvature) the elevation differences over the map, and then plotting them out as a hypsometric map overlay of the differences. Note that there does not appear to be any particular clustering or linear trends - the difference in anomalies being dependent upon the data distribution.

The file of differences was then analyzed in order to determine the histogram of elevation differences (Figure 3). The results are appreciably better than anticipated in the above discussion of potential errors. Roughly 18% of the station elevations lie within ±1 m of the corresponding DTM elevations, while 80% are within ±5 m, and 95% within ±10 m. The skew in Figure 3 indicates that the DTM elevations tend to be slightly higher than those at the gravity measurement sites.

Another file was produced with those elevation differences greater than ±25 m. Table I in the Appendix lists all 50 measurements where the elevation differences were found to be more than ±25 m, sorted according to difference. An examination of the 1:50,000 scale topo sheets for the first (worst) six shows that for five of them, BO (Beerot Oded Sheet - Δ=473.1 m, Δ=36.9 m and Δ=34.9 m), RT (Ramat Tsofar - Δ=-

131.3 m), and MS (Mizpe Shalem - Δ=-85.1 m), the gravity elevations clearly disagree with the contours on the map, which accurately reflect the interpolated DTM values. The sixth, EI (Eilat - Δ=-77.6 m), is right next to a cliff, and the gravity station elevation is in agreement with the map, and the DTM elevation is clearly in error.

Under the assumption that vertical differences should be dependent upon local dips, because of the potential horizontal errors, the elevation differences were graphed against the regional dips. The datapoints near the zero height difference have been removed because the Golden Software Grapher™ program is limited to a maximum of less than 45,947 points, so these central points were removed from the plot. Interestingly, Figure 4 shows no discernible tendency for the elevation differences to increase with regional dip.

Discussion

The large and extensively distributed GII gravity station data set serves as an excellent control for testing the accuracy of the DTM. The results show that the DTM adequately describes the elevations obtained independently by measurements from discrete control points.

We therefore consider the DTM of Israel, extracted via innovative and intuitive methods from maps based upon stereo-photogrammetry, to be of sufficient accuracy and reliability to be used for various analytic tasks. such as terrain analysis applications like hypsometry, extraction of drainage networks, derivations of geomorphic features, slopes, aspects, gradients, etc.

Future investigations will cover further aspects of this calibration. These investigations might use the new 50 m DTM derived from the Survey of Israel's new semi-automatic digital stereo photogrammetry, or possibly the 10 and 30 m gridded datasets expected shortly from the NASA-NIMA STS-99 Shuttle Radar Topography Mission (SRTM), which will use interferometric C and X-band radar. Deeper insights will be sought as to the source of the observed deviations. The observed deviations are, theoretically, due to different reasons. Among these one can mention errors in the original contour maps, in the production of the DTM, in the geodetic measurement of the control points and in the process of computerizing the data.

Several caveats are recognized:

1. The gravity data are not evenly spaced. Their density is highly variable (Figures 1 and 2). It would therefore be desirable to explore the accuracy of the DTM for different regions as a function of the density of the gravity data.
2. Bias may arise due to differences in the terrain complexity. Thus, the issue of the dependence of the DTM accuracy on terrain complexity remains open.
3. The histograms are somewhat skewed (Figure 2) as the DTM elevations are typically higher than the ground truth.

Acknowledgements

We gratefully acknowledge the Survey of Israel (SOI) for providing the original copyrighted contour data, which served as the basis of the production of the DTM, and for their long term interest and cooperation in this field. The Geophysical Institute of Israel (GII) kindly provided the geodetic data set for their free air gravity

measurements. The DTM of Israel was produced via a joint effort of the GSI, the SOI, the senior author, and Historical Productions Inc., which financed the work. The 12,000 hours of computer analysis work were carried out by the senior author, Eric Schwartz, Bracha Moalem, Larissa Rybakov, and Miguel Calvente Chazanoff.

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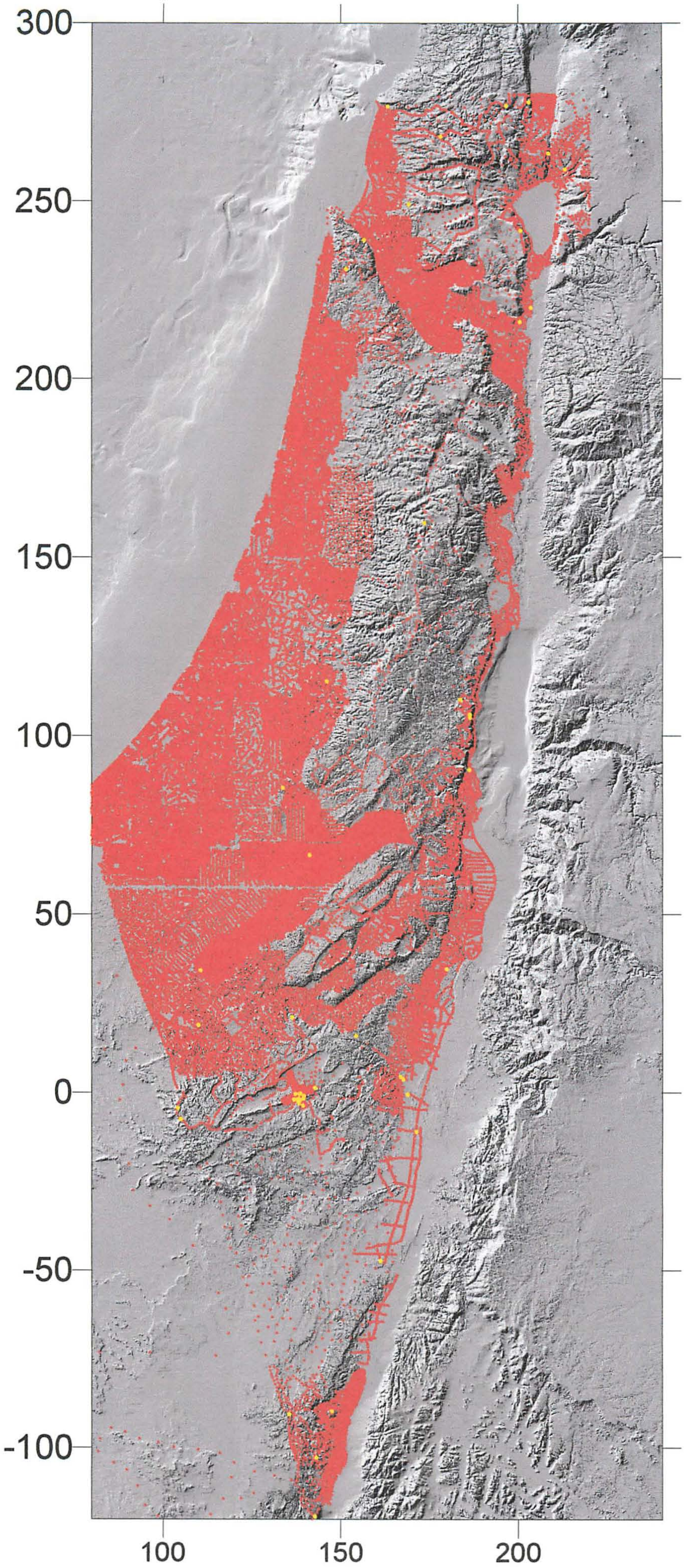

Figure 1: Location of 45,947 gravity stations

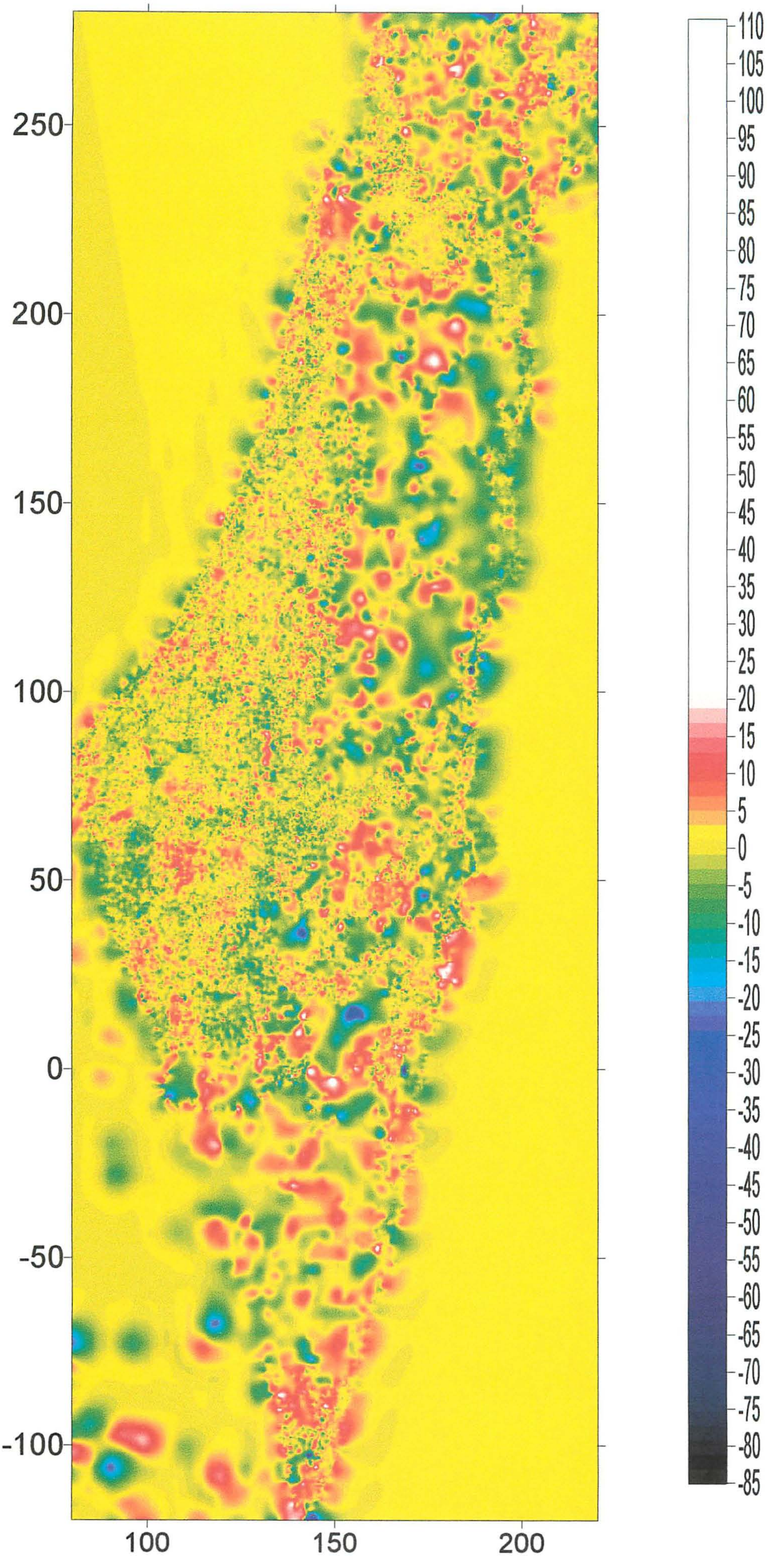

Figure 2: Elevation Differences (DTM-Grav)

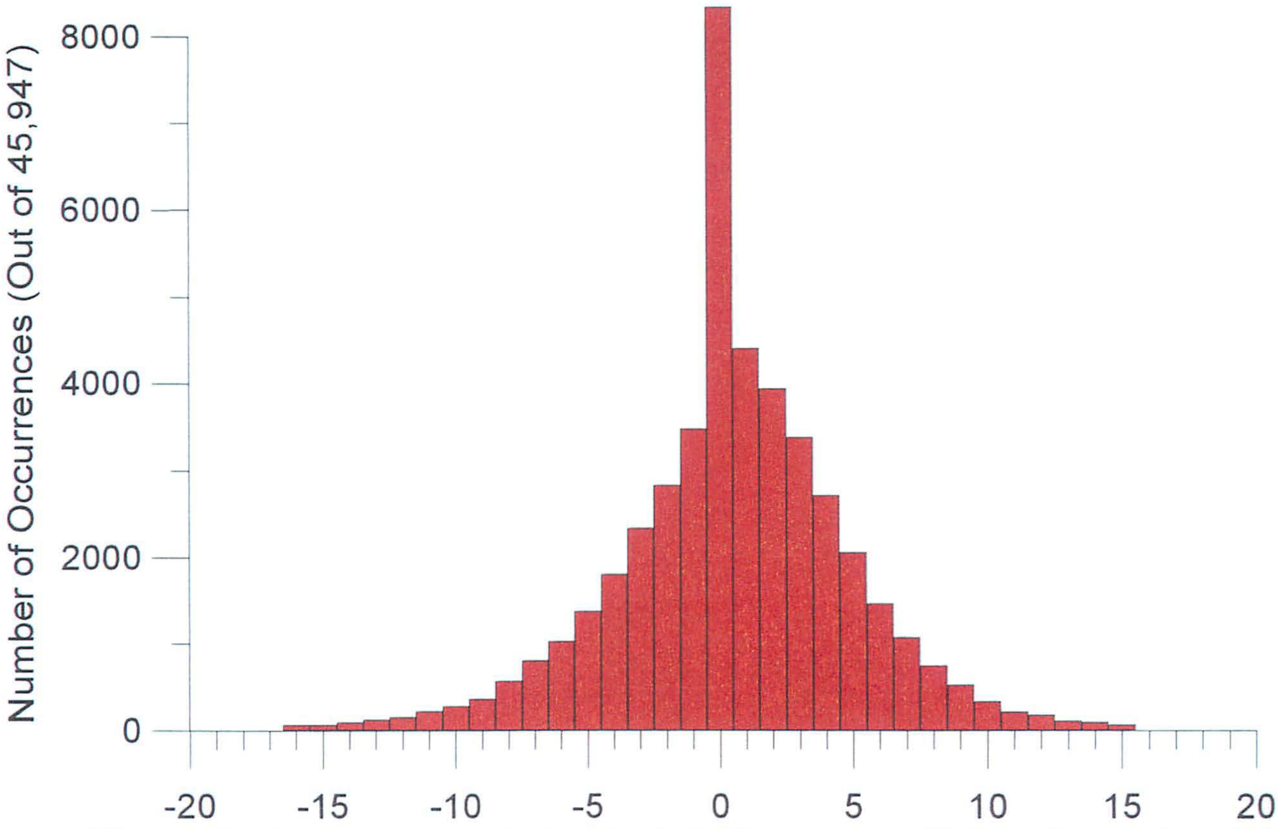

Figure 3: Histogram of Vertical Differences (Zdtm-Zgrav) in Meters

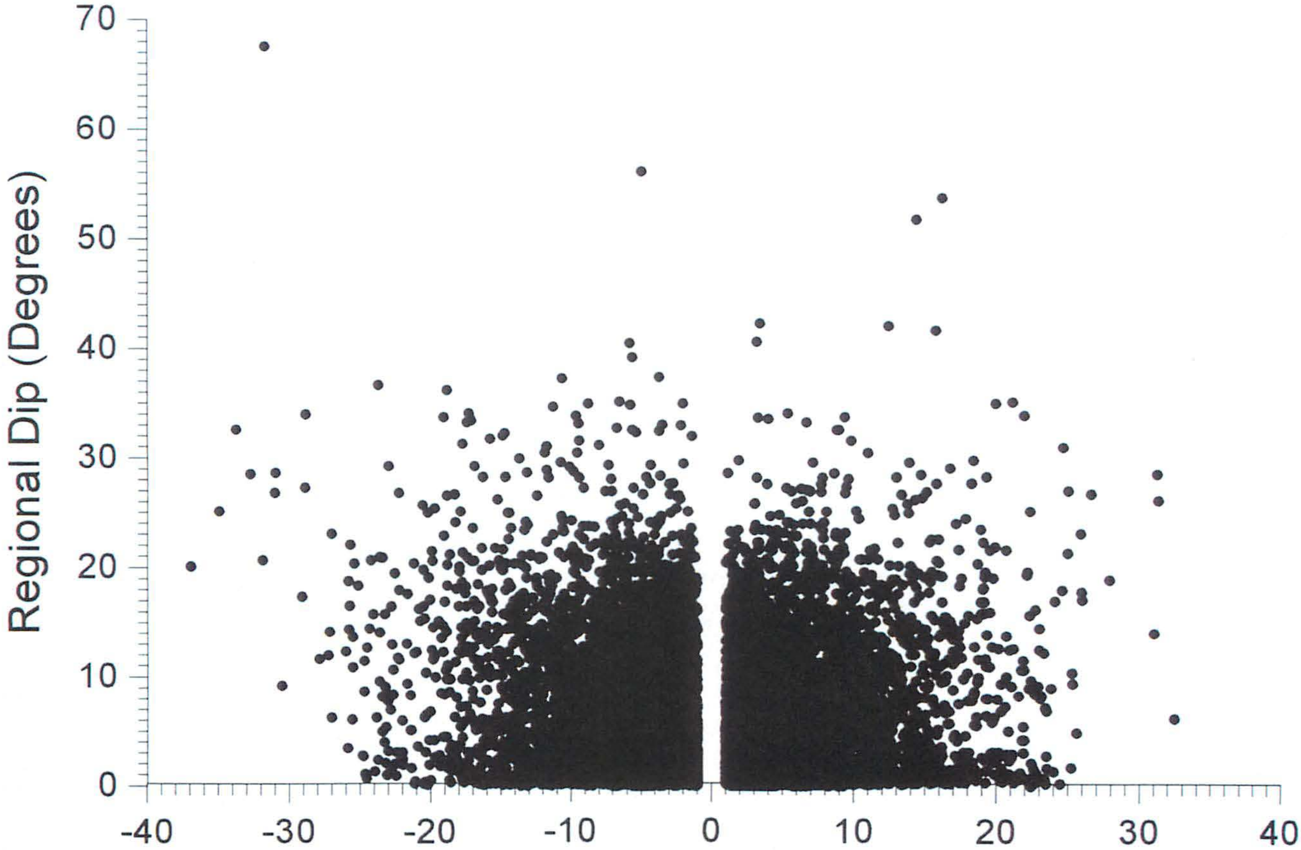

Figure 4: Height Difference (Zgrav-Zdtm) vs Regional Dip

APPENDIX I

Easting	Northing	Height	Z(DTM)	Diff	# in Bin	Quad	Dip	Strike
138.4821	-2.0870	48.89	521.98	473.09	1	BO	7.8	126.1
168.9330	-0.6500	92.99	-38.26	-131.25	1	RT	1.1	86.3
186.4561	105.9500	239.19	154.05	-85.14	1	MS	43.6	51.1
143.1140	-102.7660	616.40	538.84	-77.56	1	EI	1.7	303.3
138.3459	-0.3960	613.26	576.33	-36.93	1	BO	20.1	146.2
136.7100	-2.0490	693.00	658.09	-34.91	1	BO	25.1	149.7
212.9490	258.8610	4.00	-29.75	-33.75	1	TV	32.6	154.0
133.5900	85.2700	401.00	368.27	-32.73	1	MH	28.5	98.3
139.3220	-3.7630	541.39	509.51	-31.88	2	BO	20.7	108.2
186.4120	105.1340	257.80	226.10	-31.70	3	MS	67.6	90.0
138.5830	-0.2470	605.39	574.38	-31.01	1	BO	26.8	172.9
183.7750	110.2040	34.56	3.62	-30.94	2	MS	28.6	24.4
142.7000	-119.3000	0.00	-30.49	-30.49	1	EI	9.2	105.8
186.3101	90.4399	-318.10	-347.19	-29.09	1	EG	17.4	135.0
104.9000	-7.5400	933.82	904.97	-28.85	2	HL	27.3	196.3
109.9399	18.6970	520.24	491.43	-28.81	1	HM	34.0	91.3
141.1400	66.5601	398.45	370.59	-27.86	2	TM	11.7	138.8
138.2080	-3.0350	530.84	503.60	-27.24	5	BO	12.0	121.2
139.6390	-1.0030	554.68	527.53	-27.15	3	BO	14.2	53.5
138.1310	-1.7920	579.52	552.51	-27.01	4	BO	23.1	182.7
163.2300	276.3800	88.10	61.09	-27.01	1	NH	6.3	163.9
196.5800	276.5601	753.83	727.81	-26.02	1	SF	12.4	120.8
154.3700	15.7600	467.00	441.13	-25.87	7	HA	3.5	126.6
137.4170	-1.9980	588.10	562.28	-25.82	10	BO	18.8	138.5
173.7200	159.5000	810.00	784.25	-25.75	4	RA	14.4	74.4
136.3500	20.8600	636.49	610.78	-25.71	6	SB	16.6	154.4
142.7230	1.2000	447.35	421.67	-25.68	8	HA	22.1	27.6
200.3400	215.9800	-183.43	-208.99	-25.56	3	ET	6.1	86.1
104.1000	-4.4400	873.69	848.21	-25.48	11	HL	13.7	109.2
137.1510	-0.4070	590.82	565.34	-25.48	9	BO	10.9	120.9
156.7100	238.9399	54.68	29.28	-25.40	2	AT	20.4	51.2
208.3600	263.1600	77.65	52.50	-25.15	1	RP	18.4	77.5
110.5200	34.0000	335.12	310.00	-25.12	5	SV	0.0	270.0
161.3180	-47.3820	243.94	276.42	32.48	1	AR	6.1	148.3
200.5500	241.5800	92.08	123.48	31.40	2	TV	26.1	48.6
200.5500	241.5800	92.08	123.48	31.40	1	TV	26.1	48.6
151.4700	230.8300	147.77	179.05	31.28	3	AT	28.5	259.1
147.5790	-89.6310	248.02	279.10	31.08	4	BA	14.0	309.3
178.1400	267.8900	472.40	500.37	27.97	1	NH	18.9	243.8
135.5031	-90.5290	774.40	801.10	26.70	3	HS	26.7	101.4
203.5500	219.8600	-265.57	-239.51	26.06	1	ET	17.1	67.0
139.4041	-1.6890	516.35	542.39	26.04	2	BO	17.8	290.7
179.9500	34.4600	-274.23	-248.25	25.98	4	CT	23.1	63.7
169.2200	248.9500	85.00	110.64	25.64	2	SH	4.8	300.8
146.0900	115.2400	376.58	401.98	25.40	3	BG	9.3	351.0
171.3680	-11.1130	49.08	74.39	25.31	8	RT	10.3	116.6
171.3680	-11.1130	49.08	74.39	25.31	7	RT	10.3	116.6
167.6200	3.6700	-30.39	-5.13	25.26	6	EY	1.7	282.2
167.0000	4.3800	-12.22	12.90	25.12	5	EY	27.0	64.4
202.8900	277.5400	428.15	453.21	25.06	1	RP	21.3	312.3

Table 1: Sorted listing of the 50 measurements with differences of more than ±25 m.

APPENDIX II

Description of the DTM of Israel

1) Source of the DTM of Israel

The DTM of Israel is based upon the 10 m contours in the 88 sheets of the basic topographic map series of Israel at 1:50,000 scale. The characteristics of this series was (Forrai et al., 1999):

a) Graphical data only. 88 map sheets had been completed during 20 years, until the seventies.

b) Horizontal accuracy: 20-40 meters

c) Vertical accuracy: 10-20 meters

d) Non uniform maps in terms of accuracy, as a result of historic inhomogeneity of the horizontal and vertical geodetic control networks, and also in terms of the mapping methods used.

e) Only eventual and partial map revisions had been completed.

2) Method of Production of the DTM of Israel

The DTM of Israel was produced using an innovative graphical technique on the original 80286 PC-AT computer (Hall et al., 1990). In this method, each of the 20 km by 20 km map tiles was

a) scanned at 12 lines per mm (304.8 dpi) in bitmap, *i.e.* each pixel either white or black,

b) rotated, translated, and squared so that each map took up 4801 by 4801 pixels, and

c) broken up into a 14 row by 8 column matrix of 112 EGA (640 by 350 pixel IBM Enhanced Graphics Adapter) screens in the .PIC storage format of the HALO Graphics Library.

These screens were then graphically edited to

a) fill in all holes in contours, and to

b) fill in the intervals between contours with colors from a 16 color 'spectral' palette, such that each 100 m in height consisted of 10 colors, rising from purple at the bottom to red and rust and the top.

The editing was done with self-written programs in FORTRAN (IBM Professional FORTRAN - Ryan-McFarland Corporation), which used the FORTRAN binding of the HALO Graphics Library (Media Cybernetics Inc.). The program and the editing was controlled by intuitive and innovative use of a 16 button cursor on a 1000 lpi GTCO digitizing tablet.

Once the intervals between contours on all 112 screens were colored, the program was able to automatically determine the x,y,z coordinates of the intersections of the contours with a grid of 6 pixel spacing. For each row (y fixed), the center of a black contour could be determined to a half pixel (the x coordinate), with the colors bounding the contour determining the 10 m value of z coordinate. Since a 10 m contour interval is used, the intersections formed a profile whose hundreds and thousands values could be determined by just knowing the height of a map corner. The same procedure was carried out on the columns. For the maps of Israel, the number of *x,y,z* triads varied from 20,000 to over 600,000.

The DTM for each map was then determined by fitting bicubic splines to each of the 801 W-E profiles, and each of the 801 N-S profiles, and noting the height every 6 pixels, and the minimum distance to the nearest contour. Then the height at each grid node was determined by taking an inverse square distance weighted average of the two interpolated values at that node. The splining process was constrained by the requirement that the spline not deviate more than 5 m from a straight line between the two contours.

This resulted in some artifacts in flat areas of few contours, and a tendency of the splines to flatten out as they pass through the data points.

3) Format of the DTM of Israel

The DTM of Israel is made up of map tiles, each representing a 20 km by 20 km topographic sheet. Each sheet has a unique two letter mnemonic code (Fig. 1), which is usually related to the name of that topographic sheet (*i.e.* JM for Jerusalem, RP for Rosh Pina etc.). The digital file with the DTM heights has the form *nn*XXXX.SUM, where *nn* is the tile mnemonic (hence Jerusalem is JMXXXX.SUM).

Each map tile DTM consists of an 801 by 801 matrix of elevations. They are stored in a binary file as signed two byte integers (values from -32,768 to +32,767). The byte order is that of the Intel chip. Each two byte integer gives an elevation or depth in decimeters (*i.e.* 0.1 m or 10 cm). This resolution is possible since the elevations and depths in the area do not exceed ±3,276 m. Hence elevations may be obtained by dividing this value by 10.

The format of the file is such that the first value represents the upper left (northwest) corner of the map tile, and the first 801 elevations are those of the top row of the map. Then the next W-E row is stored, and the file continues row by row from top to bottom (north to south). This is the traditional IBM graphics and Scitex pixel format. Thus the file starts with 641,601 elevations in binary format (1,283,202 bytes).

The original construction of the binary files in FORTRAN called for the use of direct access sequential files. The record length was chosen as 1024 bytes (512 elevations). The .SUM file thus consisted of 1254 records, with the 1254th and last having 820 bytes free at the end. Into this free space was inserted the old Israel Grid coordinates of the upper left hand corner of the map (two byte integer(103) being the Northing and two byte integer(104) being the Easting), plus 800 bytes of plain language text giving a copyright notice, the map name, the graphic editor of the tile, and the completion date. This plain language 'footer' can be read with a file browser.