TRAINING COURSE

ON

SOFTWARE FOR GROUNDWATER DATA MANAGEMENT

UNDER

WORLD BANK FUNDED HYDROLOGY PROJECT

LECTURE NOTES
ON

GENERAL PURPOSE SOFTWARE
(UNIT - 2)

BY

VIJAY KUMAR

ORGANISED BY

NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE - 247 667
INDIA

SURFER

1.0 INTRODUCTION

Hydrological maps are commonly used to represent large amount of information about the water regime of the surface and near surface of the earth. Contour maps display the information in its spatial relationship and in relationship to the configuration of land itself. This type of data presentation can convey a rapid impression on the areal variability of a parameter. If carefully prepared, these maps can provide a large amount of information in a small space.

SURFER is one such software which is used to draw 2 and 3-dimensional plots. 2-dimensional plots are also known as contour maps. The software is menu driven and so very simple to operate. This software is prepared by Golden Software Inc. This software is widely used in Civil Engineering application. In Groundwater, many types of contour maps are required and can be drawn with this software. For Example, Topographical maps, Groundwater Level contour maps, Groundwater Depth contour maps are frequently used in all most all studies of groundwater.

2.0 HOW TO RUN SURFER

SURFER program can be run both from hard disk drive and from floppy drive. If one wants to run the SURFER from hard disk, first copy the software to the hard disk. To do this, make a directory of SURFER name and copy all the files from the floppy having the SURFER software. To do this, proceed as follow.

C:>MD SURFER<ENTER>

C:>CD SURFER<ENTER>

C:\SURFER\COPY A:*.*<ENTER>

Now the SURFER software is loaded in the hard disk of the computer. To work in SURFER, enter the following

C:>CD SURFER<ENTER>

C:\SURFER\SURFER<ENTER>

With this command, the main menu of the SURFER (as shown in Fig.1) will appear. The first two lines of the menu on the screen is called topic menu. Arrow keys may be used to move the highlighted pointer to different options. As different options are highlighted, a brief explanation of the current option will be displayed on the second row of the screen. The desired option can be selected by positioning the pointer to the desired option and pressing <ENTER>. If <ESC> is pressed while in a topic menu, the previous menu will be displayed.

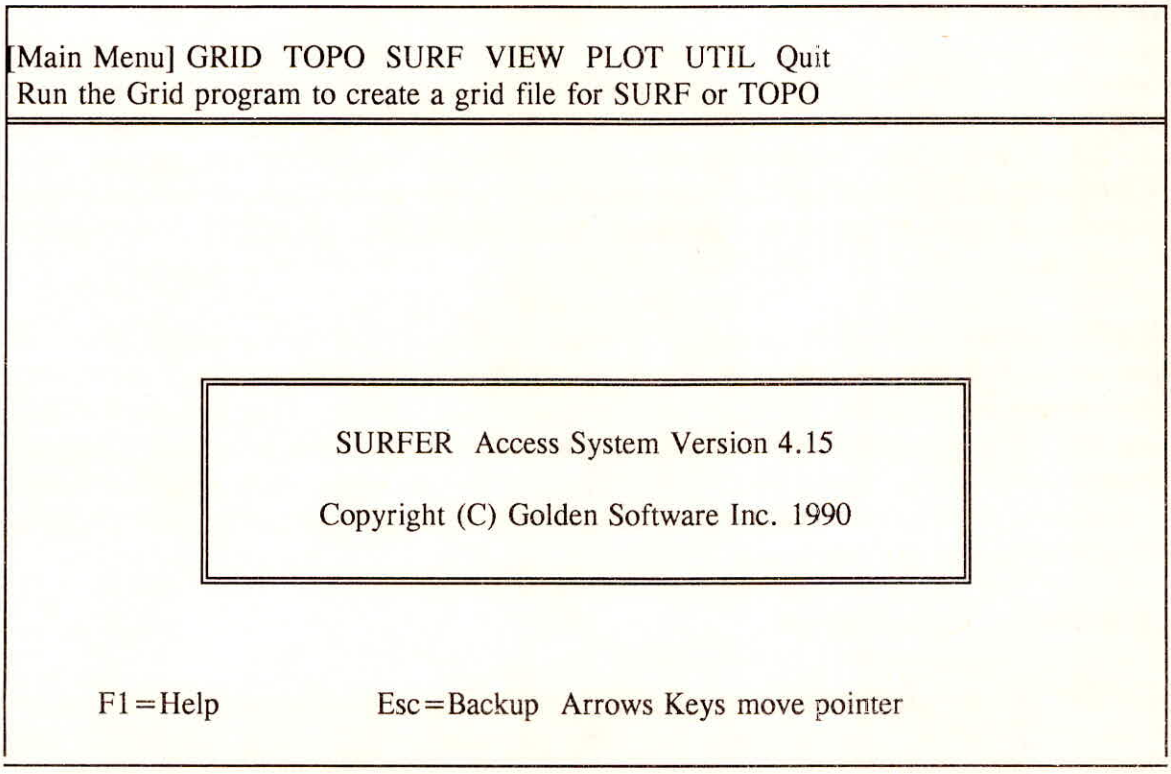


Fig. 1. Main Menu of SURFER

The main menu of the SURFER software contains the following six options.

GRID Creates a regularly spaced grid of data from irregularly spaced data or a user specified function.

TOPO Creates contour maps from a grid created with GRID.

SURF Creates surface plots from a grid created with GRID.

VIEW Views a plot created with TOPO or SURF on the screen. Plots may be panned and zoomed.

PLOT Sends a plot created with TOPO or SURF to a hardcopy device. TO install a new device enter /I at the filespec prompt.

UTIL Computes volumes, slices, etc. from grided data

QUIT To quit the SURFER

3.0 GRID

GRID creates and manipulates files of regularly spaced data points called grid files. SURF and TOPO use these files to create 3 dimensional surface plots and contour maps. By pressing the <ENTER> after selecting the GRID from main menu, the Grid Menu (Fig.2) will appear.

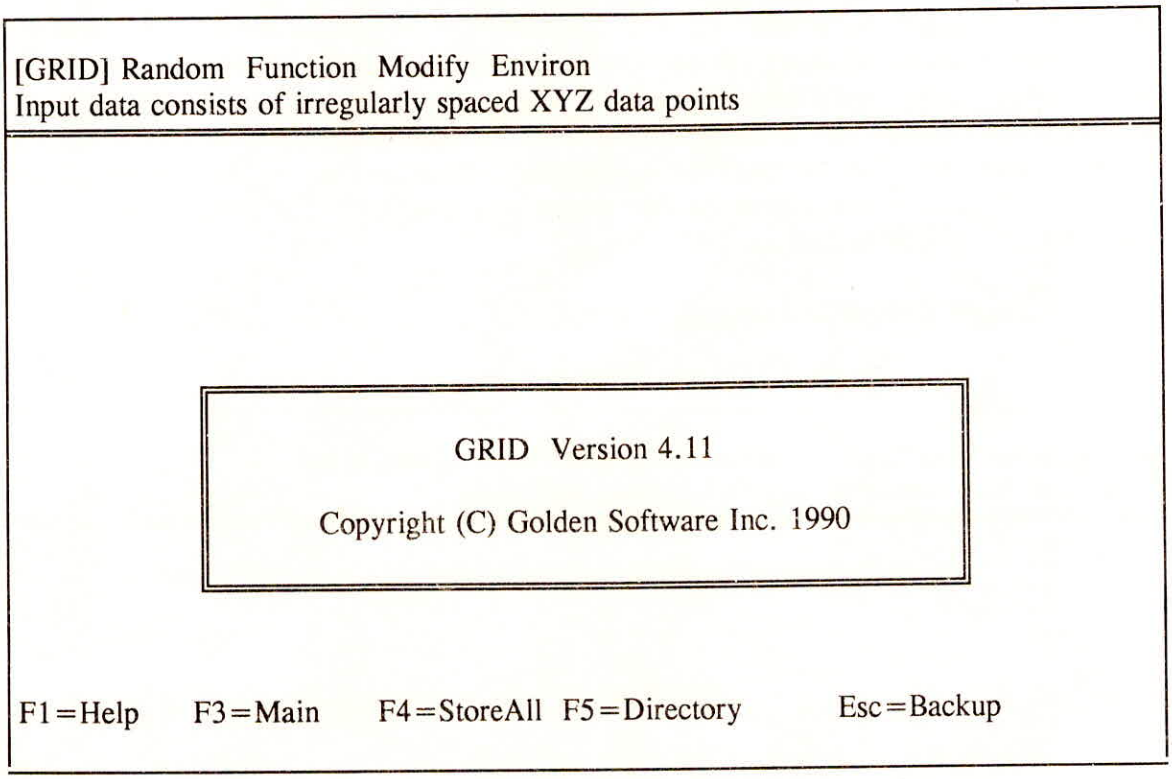


Fig. 2. GRID Menu of SURFER

From the GRID Menu, select

Random to create a grid file from irregularly spaced data.

Function to create a grid file from a function of 2 variables.

Modify to smooth, blank, or modify an existing grid.

Environ to specify the hardware configuration

3.1 Random Menu

The Random menu (Fig. 3.) contains all options related to creating a grid from random or irregularly spaced XYZ data. Each data point consists of 3 values: an X,Y, and Z coordinate.

INPUT option will accept data from the keyboard or from several different types of data files. Edit will place you directly into GRID's worksheet (Fig. 4.) where all XYZ data are stored. Xternal will input data from an existing ASCII or Lotus 123 file into the worksheet. Insert, Delete, Copy, and Move will perform operations on an entire group of data in the worksheet from a single cell to an entire range of cells. Format will allow the user to change the way a numeric value is printed in the worksheet. Transform will apply a user specified equation to the data in one or more columns to calculate a new column. The Save option will save the current worksheet as an ASCII file.

OUTPUT assigns a name to the output grid file.

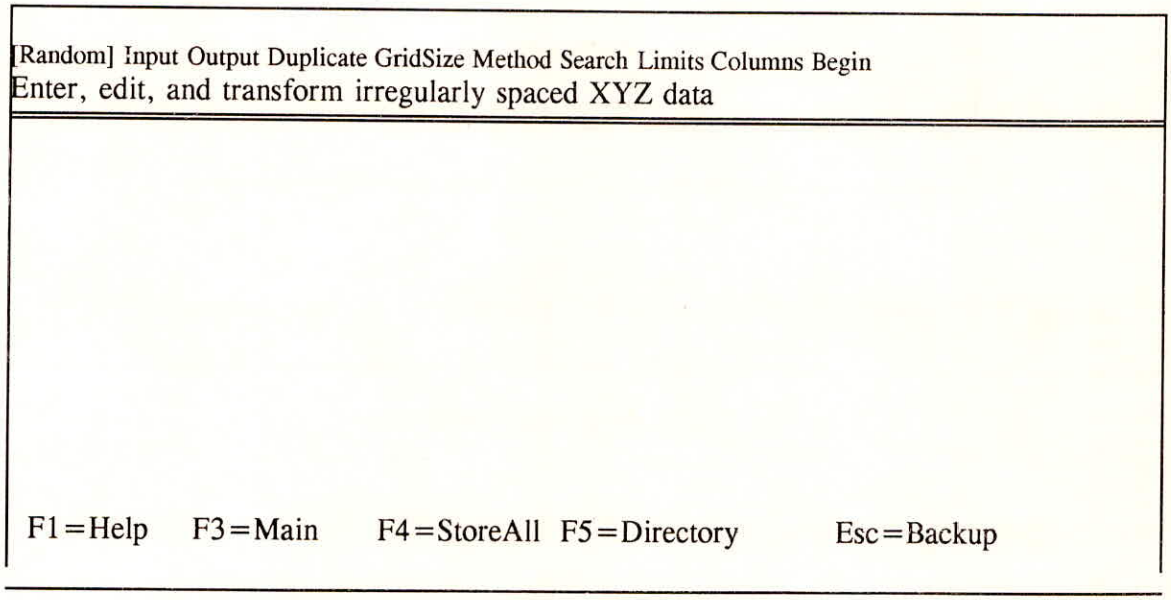


Fig. 3. Random Menu of GRID

SEARCH will set the parameters used to search for data points during the griding process. A search is performed by GRID to determine which XYZ data points to use in the calculation of the current grid node. A Normal search will use the N nearest data points around the current grid node that are also within the specified search radius. Quadrant and Octant searches are similar to Normal searches except that the number of nearest points and search radius are applied to each quadrant or octant respectively. The 'All' option will disable searching and use all of the input data points to calculate each grid node.

LIMITS specifies the coordinates of the edge of the grid. GRID will use the limits of the original XYZ data as default values for the grid limits.

COLUMNS specifies the X, Y, and Z columns for griding. For example, the X column may be the 2nd in the data file, the Y column may be the 5th, and the Z column may be the 9th.

BEGIN is used to begin creating the grid after all the above parameters have been set to their desired values.

3.2 Function Menu

The Function menu is used to create a grid from a user specified function of 2 variables. These variables must be named X,Y, and Z, and correspond to the X,Y and Z coordinates of a point to be calculated. The function is evaluated at discrete points corresponding to the grid nodes. The coordinates of these points and the grid density are calculated from the minimum, maximum, and increment values input by the user.

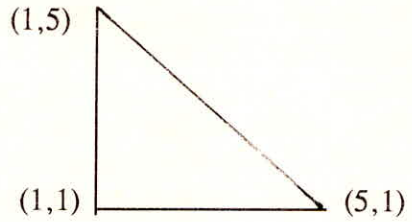
3.3 Modify Menu

The Modify menu allows the user to change a previously created grid file.

SMOOTH option will smooth a grid to eliminate irregularities in the surface and produce a more aesthetic plot. There are currently two different smoothing methods available in GRID. Spline smoothing will fit a cubic spline to the input grid and interpolate additional values for the output grid. This results in a denser grid with the original data points preserved. Matrix smoothing passes a user defined smoothing matrix over the input grid. Data under the smoothing matrix is weighted and averaged to produce the output grid.

BLANK will read in an existing file with coordinates of a region to be blanked. This region will be marked with special values in the grid file to eliminate contour and surface lines in the final plot. Blanked regions are specified by a sequence of X,Y coordinates defining a closed polygon. Polygon sides must not cross. A blanking file is used to specify the region to blank. The first line is a header consisting of the number of points to follow and the side flag. If the side flag is 0, grid elements outside the polygon are blanked. If the side flag is 1, the grid elements inside the polygon are blanked. For Example, to blank the area outside the following triangle, a blank file must contain the data as follow:

```
4 0
1     1
5     1
1     5
1     1
```



MATH is used to perform mathematical operations between two existing grid files of the same size. An equation is specified to define the mathematical operation. An equation is used to specify how to combine the two input grids. The equation is a function of 2 variables named A and B. These variables correspond to the two input grids. Any of GRID's built-in functions may be used in the equations.

4.0 TOPO

TOPO is a menu-driven contouring program. The contour plot may be viewed on the screen, output to a plot file, and/or sent to a hardcopy device. Contour and plot parameters may be default values or fully specified by the user. Gridded data, in the format used by the GRID program, is input from a data file in either ASCII or binary format. The Topo Menu is shown in Fig.5. and are explained below.

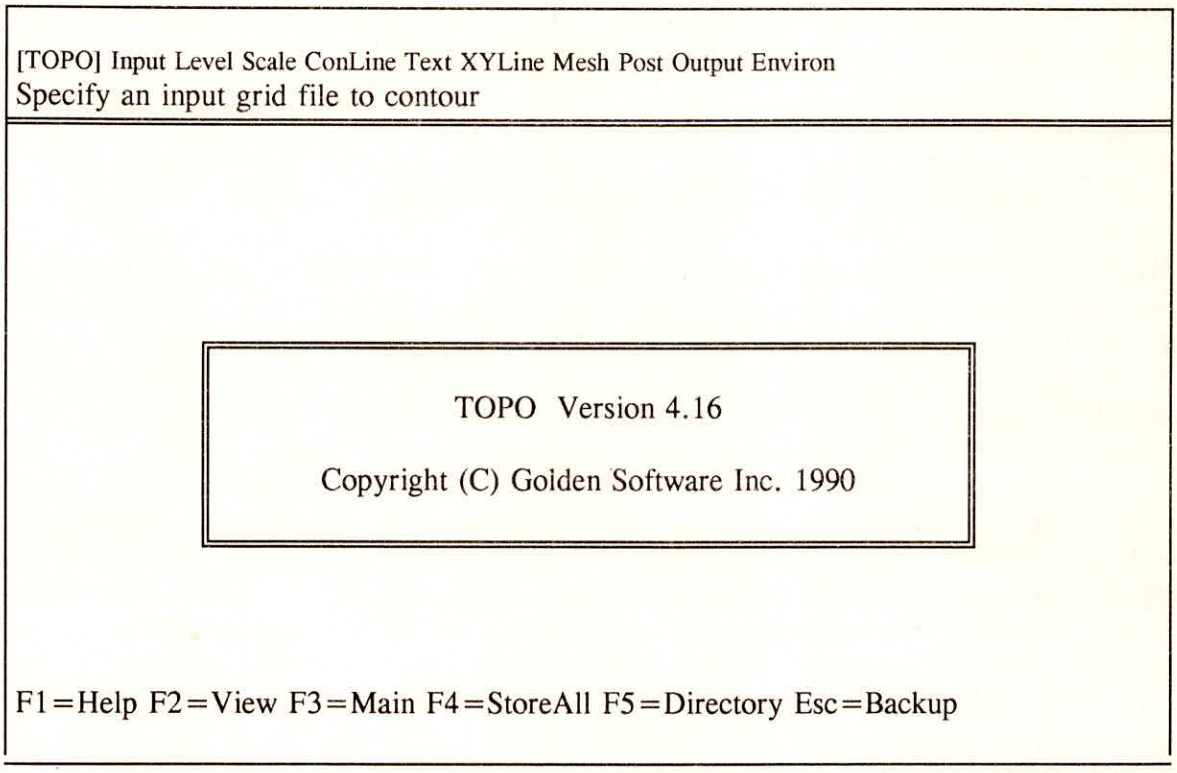


Fig. 5. TOPO Menu of SURFER

4.1 Input

You may specify the name of the input grid file and whether to input the entire file or a part of the file corresponding to a subgrid.

4.2 Level

The values of the contour lines may be changed by specifying the minimum, maximum, and interval values, or by specifying a data file containing the contour levels desired. The level file is an ASCII data file with one contour level per line. There is a maximum of 200 levels if a level file is used. The levels do not need to be in any order, and do not need to be evenly spaced.

4.3 Scale

The user may specify the physical size of the plot by entering either of two parameters; the length in inches of the longest side of the plot, or the number of data units per inch.

4.4 ConLine (Contour Lines)

This menu allows the user to specify the contour line and in-line label parameters. Labelled option provides labelled contour line frequency and the colour, dash length, line thickness and hachure length of labelled contour lines. Unlabelled option provides same as above of unlabelled contour lines. Conlab option provides properties of in-line contour labels, including the numeric format, colour, height, and symbol set. The distance between labels, the distance from labels to edges, and the label curve tolerance may also be specified. Smooth option provides whether to smooth contour lines, and how much. ZonesOfColor option provides a file which defines colour zones. Each contour lying within a colour zone will use the colour specified within this file.

4.5 Text

This menu allows the user to specify textual information for the plot like Map Title, Border Title and Legend. It also allows to Edit Text and Retrieve Text.

4.6 Border

This menu allows the user to specify whether to plot a border box around the contour map. It also allows to tic the border.

4.7 XYLine

The boundary file is an ASCII file used for drawing line segments on the plot. The file may contain one or more series of connected lines. Each line is described by a set of vertices in the boundary file. The first row of the file has at least one value. This value is the number of points, N, specifying the line. The next N rows of the file contain the coordinates of

[Random Input] Edit Xternal Insert Delete Copy Move Format Transform Save
Edit values in worksheet

Rows=11019	A	B	C	D	E
1	226.18	97.17	187.62	2.30	
2	217.78	94.15	188.31	2.56	
3	215.62	92.10	186.76	1.85	
4	220.96	92.76	188.73	3.03	
5	209.35	124.78	183.92	8.26	
6	221.65	87.54	187.52	8.80	
7	190.26	116.45	178.76	15.50	
8	183.50	100.49	178.08	5.66	
9	188.18	100.82	178.35	10.05	
10	209.56	81.37	182.22	14.20	
11					
12					

Fig. 4. Random Input in GRID

DUPLICATE tells GRID how to handle points with identical XY coordinates. If the Average option is selected, all points with identical XY coordinates will have their Z coordinates averaged. Delete will remove the duplicate points before the griding process. The Ignore option is included for users who are sure their data does not contain duplicate data points. The duplicate check is bypassed and griding proceeds immediately.

GRIDSIZE specifies the size or density of the final grid. Grid density may be specified by either the 'Number of grid lines' along each side of the grid (X or Y) or the 'Distance between grid lines' in X or Y data units along each side of the grid.

METHOD allows the user to specify the griding method to use. There are currently three different griding methods available;
Inverse distance, Kriging, and Minimum curvature. Inverse distance uses a weighted averaging technique to interpolate grid nodes from the XYZ data. The weights are inversely proportional to the distance to the grid node. Inverse distance squared is the most common weighting power. Kriging uses geostatistical techniques to calculate the autocorrelation between data points and produce a minimum variance unbiased estimate. In theory, no other griding method can produce more accurate estimates than Kriging. Minimum curvature first examines all data and sets the nearest grid node to that data value (or average of data values), thus honouring the data. Then, the values at the other grid nodes are computed so as to give a gridded surface of minimum curvature through the set grid nodes. This method should not be used for extrapolation into large regions without data, as results are unpredictable, and it should only be used with caution if the data are quite noisy.

these points, each row containing two values, an X and Y coordinate in data units.

4.8 Mesh

A mesh is a set of vertical and horizontal lines drawn across the plot as an aid in determining position.

4.9 Post

This menu allows the user to specify posting information for the plot. For example, user may like to plot the position of observation points on the contour map.

4.10 Output

Create a plot file of the current contour map. Optionally, send output to a printer or plotter via the PLOT program. One important option in this is 'File write mode'. Overwrite will cause the plot to be written over any old information in the file (hence destroying it). Append will write the current plot at the end of the specified plot file. Fig. 6 shows the one output contour map.

4.11 On-Screen Contour Line Editing

Select special function key F2 to plot the current contour map. Press any key except ESC to begin on screen digitization and editing. Move the crosshairs with the arrow keys. To edit the grid, select G. Use the direction keys to move the crosshairs. Note that the cursor is locked to grid element locations. Enter a new value to change the Z value at the current grid element. To save the new grid, use Alt-S. The old grid will be overwritten. Press ESC when done editing.

To move the title, use the crosshairs and Alt-T. Move the legend in the same way as the title, but use Alt-L in place of Alt-T.

5.0 SURF

SURF is an interactive, menu-driven graphics program that produces three dimensional surface representations for output to the screen, printer, or plotter. Gridded data, in the format used by the GRID program, is input from a data file in either ASCII or binary format. The Surf Menu is shown in Fig. 7 and is explained below.

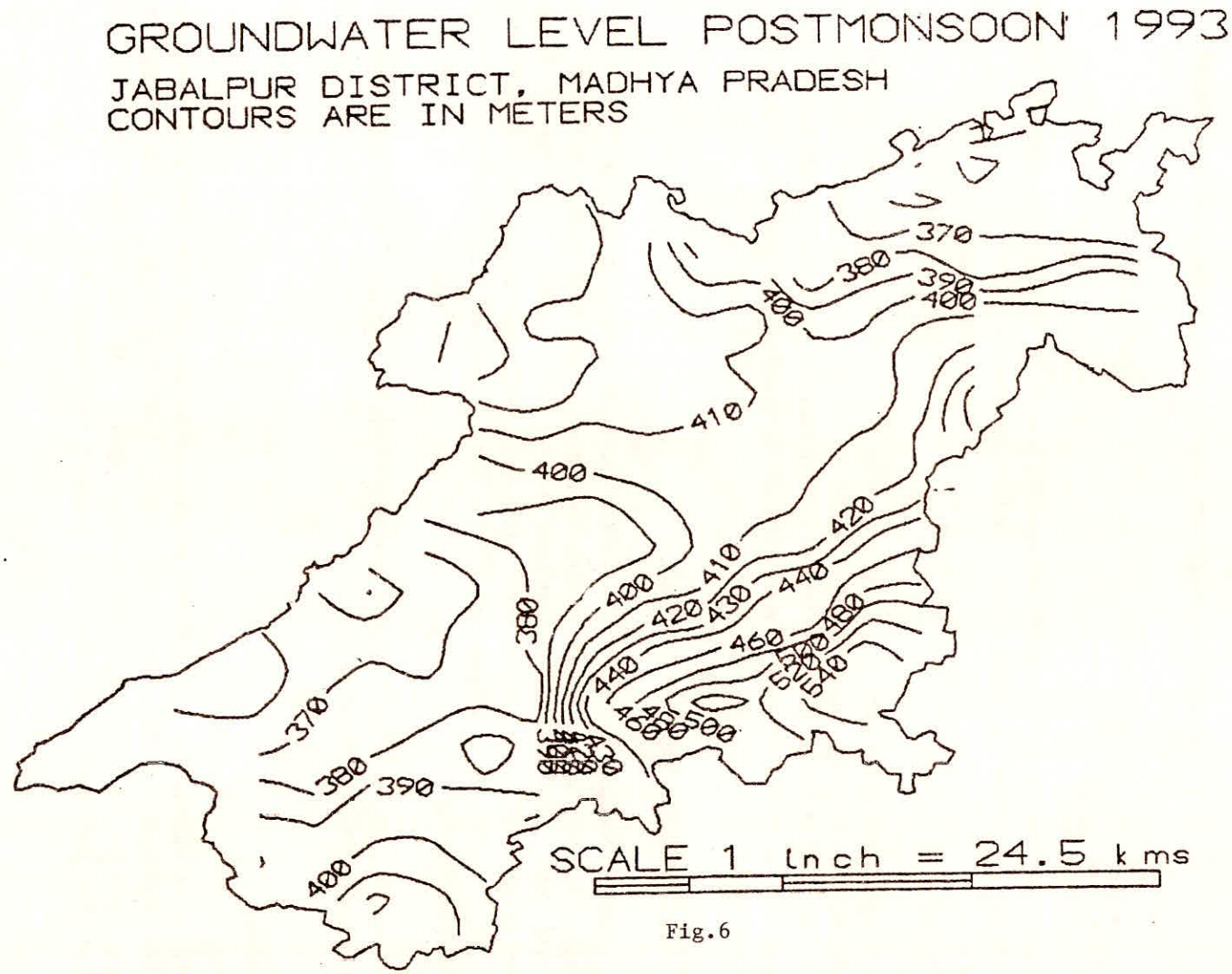

GROUNDWATER LEVEL POSTMONSOON 1993
JABALPUR DISTRICT, MADHYA PRADESH
CONTOURS ARE IN METERS
370
380
390
400
410
420
430
440
460
480
500
540
SCALE 1 inch = 24.5 kms

Fig.6

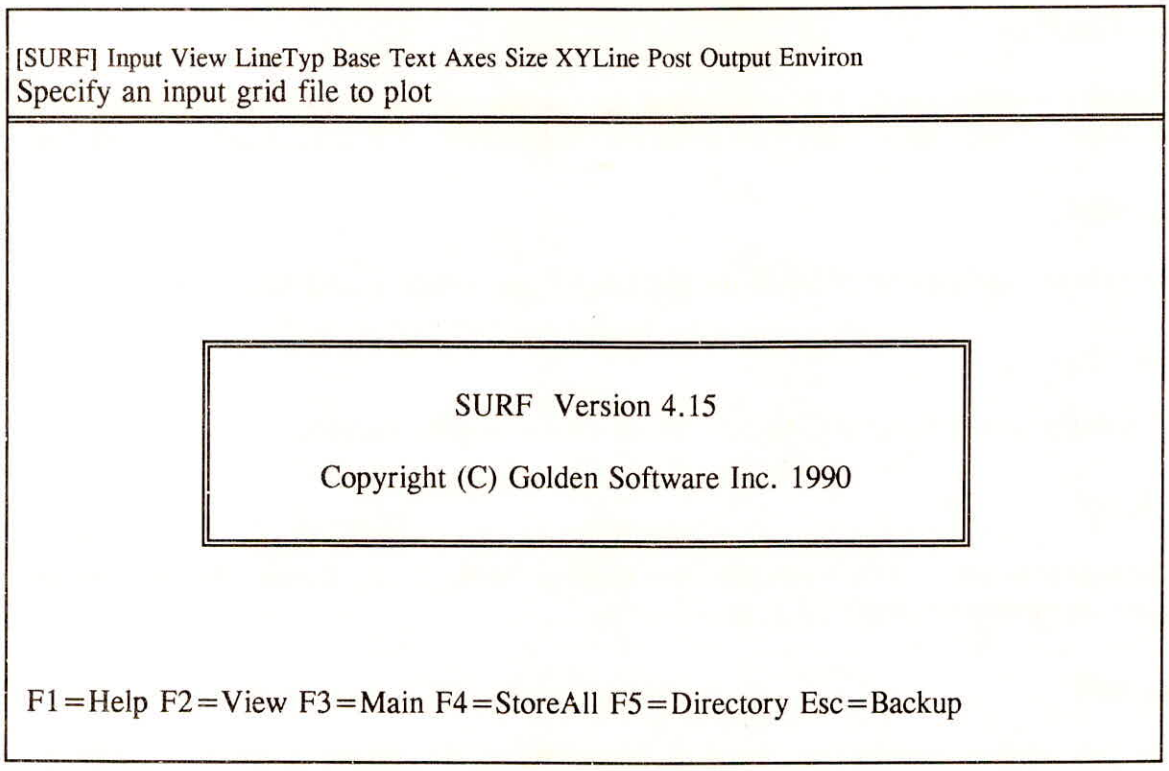


Fig. 7. SURF Menu of SURFER

5.1 Input

This option is same as in case of TOPO.

5.2 View

This option is to see the image on screen. Three are two type of projection i.e. Orthographic and Perspective projection. Orthographic projection is better when measurements are to be taken off the surface. Parallel lines will remain parallel. The perspective projection creates a visual effect similar to that of the human eye. Parallel lines appear to converge at a distance similar to railroad tracks at the horizon. Other options in this are Rotation, Tilt, surface-eye distance(for Perspective projections only) and visible surface. Rotation is the number of degrees from the positive X axis. The surface appears to rotate clockwise. Tilt specifies the angle, above or below the X-Y plane, from which the surface is to be viewed. Surface-Eye Distance is the distance of the viewer's eye to the centre of the surface. Visible surface option provides to plot lines only on the top of the surface, only the lower surface and both the upper and lower surfaces. All these options have default values but one can change it.

5.3 LineTyp

To plot lines of constant X,Y, and Z enter any combination (X,Y,Z) of the 3 letters X,Y,or Z. Lines of constant Z will create a stacked contour plot. XY lines create a fishnet plot.

5.4 Base

An opaque base may be added to the plot to give the surface a solid block effect.

5.5 Text

This menu allows the user to specify textual information for the plot.

5.6 Axes

The user may select to draw and label any or all of the X, Y, and Z axes. The axes and axis titles are plotted in the XY, XZ, or YZ plane.

5.7 Size

The plot may be sized in two directions: Horizontally: The length of the plot base (X,Y), in inches, may be specified. Vertically: The plot may be exaggerated vertically by specifying the 'Z scale factor'. With Automatic, the Z scale factor is chosen to create a surface half as tall as the length of the diagonal across the XY plane.

5.8 XYLine

Same as in TOPO

5.9 Post

This menu allows the user to specify posting information for the plot same as in TOPO.

5.10 Output

Create a plot file of the current surface plot. Optionally, send output to a printer or plotter via the PLOT program. Fig. 8 shows a output of SURF.

6.0 UTIL

UTIL is a utility program which performs several functions on grid files, such as produced by the GRID program. Fig.8 shows the Util Menu.

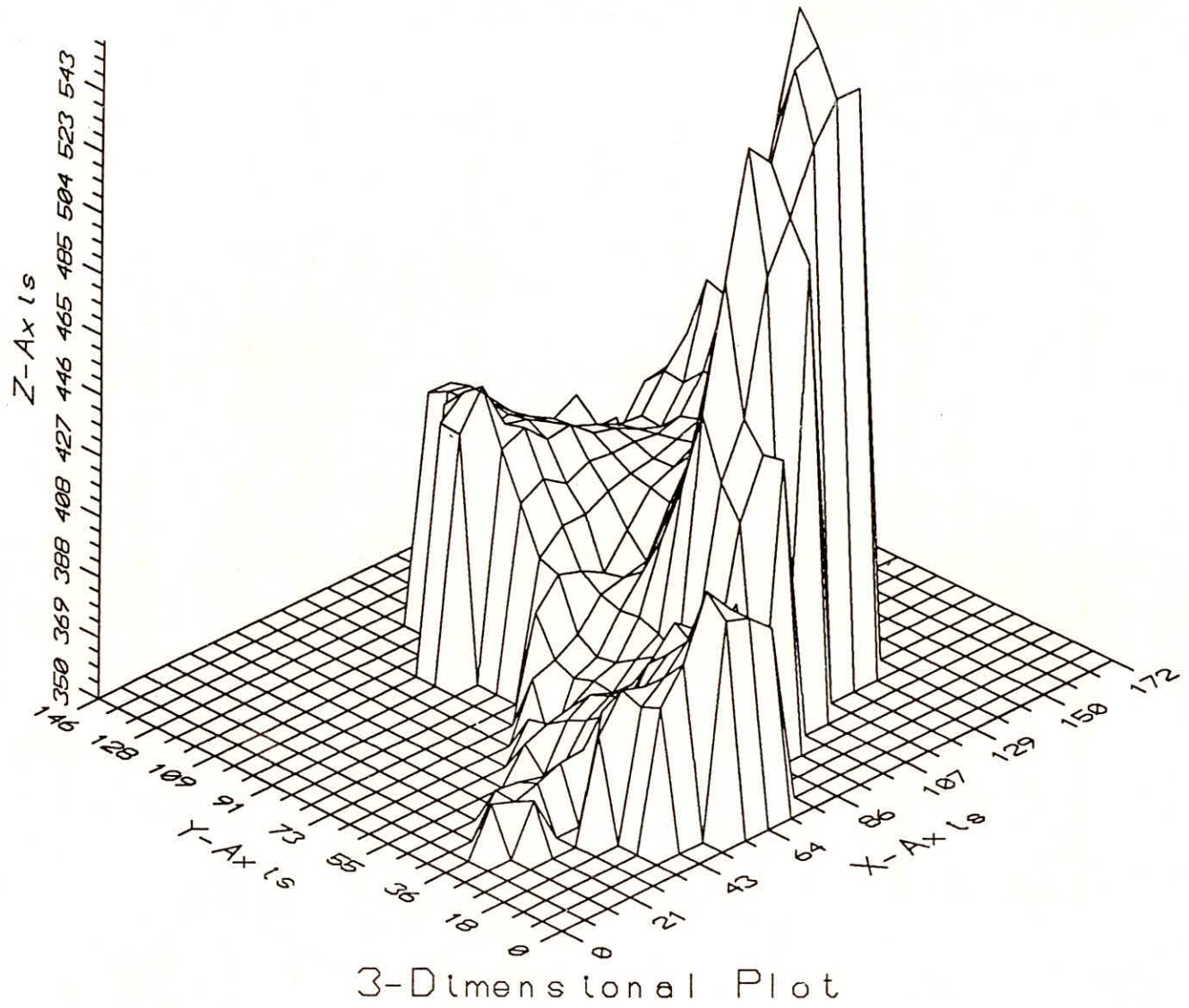

Z-Axis
350 369 388 408 427 446 465 485 504 523 543
Y-Axis
146 128 109 91 73 55 36 18 0
X-Axis
0 21 43 64 86 107 129 150 172
3-Dimensional Plot

Fig.8

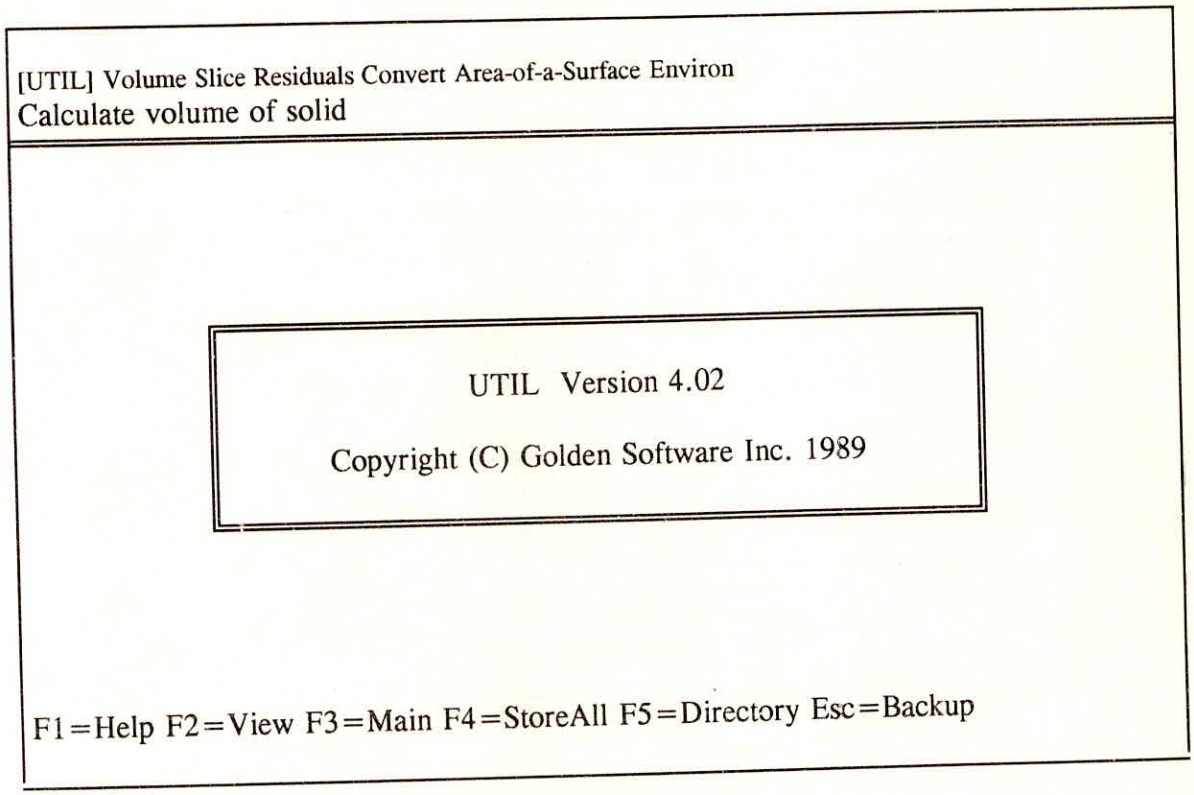


Fig. 9. UTIL Menu of SURFER

From the UTIL Menu, select

Volume to calculate volumes of solids defined by gridded surfaces.

Slice to create cross-sections of a gridded surface, for either a boundary file for SURFER or a data file for GRAPHER.

Residuals to calculate the residuals of a set of data from a gridded surface.

Convert to convert a grid file to a data file, or between grid formats.

Area-of-a-Surface to calculate the surface area of a gridded surface.

Environ to specify the hardware configuration.

6.1 Volume

The Volume menu contains all options related to computing volumes of solids between gridded surfaces (.GRD files as created by GRID). Volume computes the net volume between the surfaces. Cuts&Fills also computes net volume, but in addition, computes separately positive volume (Cuts) and negative volume (Fills). Three methods are used to compute net volume: Trapezoidal Rule, Simpson's Rule, and Simpson's 3/8 Rule. First, specify the Upper surface, which is usually a grid file (.GRD file created by GRID). The LOWER surface is usually a constant (the default is Z=0).

6.2 Slice

Slice will, if given a file in the Boundary Line Format containing lines through the region specified by a grid file (.GRD file as produced by GRID), produce either or both of: a new boundary line file (.BLN file) with points inserted for every grid line crossing. This may be used, for example, with SURF, to plot roads, rivers, or other line features on three-dimensional surfaces. The file contains the X,Y,Z data to plot these lines; a data file (.DAT file) which contains X,Y,Z data in columns 1,2,3 and horizontally traversed distance in column 4. Column 5 contains an integer which specifies from which original line the data was computed.

6.3 Residuals

Residuals will, if given a gridded surface (as specified by a .GRD file as produced by GRID) and a data file (which need not be the file used to produce the gridded surface), optionally produce a new data file of residuals from the surface, and will give the mean and standard deviation of these residuals. The residuals (X,Y,Z data points) are only computed for input data points which are found within the grid region and over non-blanked areas.

6.4 Convert

Convert can be used to convert a grid file (.GRD, as produced by the GRID program) to an X,Y,Z data file or to convert a grid file to a different format (binary to ASCII or ASCII to binary)

6.5 Area-of-a-Surface

This option can be used to compute the approximate Surface Area of a gridded surface. To obtain the entire Surface Area of the gridded surface, either enter a Constant Level which is below (or above) the entire surface. Then the result will be the Surface Area of the entire surface. To obtain the Surface Area of that part of the surface which lies above (below) a specified z-value, set Constant Level to that value. The result will also include that part of the surface AT the Constant Level, in the case of "above".

7.0 SPECIAL KEYS

The following keys have special purposes:

F1	Help
F3	Return to UTIL Menu
F4	Save all current settings in a specified command file
Shift F4	Store highlighted setting in command file UTIL.CMD
F5	Directory
Esc	Back up 1 level (Exits UTIL at UTIL Menu)
Enter	Select current option; begin processing if on bottom