USE OF A COMPUTER MAPPING PACKAGE IN DISPLAYING AREAL REPRESENTATIONS OF A SNOWCOVER

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In February, 1979, the snowcover distribution of the Elizabeth Lake Basin was studied in relation to topography and vegetation (Adams and Barr 1979, Adams and Roulet 1980). The basin is located in Labrador near the Arctic/Atlantic watershed divide, approximately 10km from the town of Schefferville, Quebec (latitude 54° 46'N, longitude 66° 54'W). The basin has an area of 50 ha, which consists of four main landscape types; tundra, open lichen woodland, close spruce forest and a lake surface.

In the planning stages of the project it was decided that a desireable standard error of the mean snow depth was 2.5cm. Based on data from past research on various landscape types (Findlay 1966), it was established that the lake surfaces in the area were consistently more variable than the other landscape types. The sample density was then calculated for the Elizabeth Lake surface to be 131. Extrapolating that to the complete basin, a 631 random sample pattern was designed to obtain depth of snow, water equivalent, and snow density.

With a sample size of this nature it was evident that a computer mapping package was needed to assist in reducing the data. The SYMAP (Synographic Mapping System) designed by the Laboratory for Computer Graphics and Spatial Analysis, Harvard University, updated and modified by Computing Services, Carleton University, was used (SYMAP, Users Reference Manual, 1976). Even though this system would be considered primitive (of first generation) in terms of mapping packages today, it has several advantages in this study.

The SYMAP package can be easily adapted as well as used at a satellite computing facility with limited hardware, such as Trent University. (This system is a satellite of the Carleton University, Xerox-Sigma 9 Computer). The only hardware required is a card reader (in the initial stages), a line printer (preferably with overprint capabilities), and an on-line timesharing terminal.

The SYMAP package is extremely simple to use if a limited amount of computing skill is known. A very basic understanding of FORTRAN and control languages is required.

The SYMAP package operates on a coordinate point identification system. Therefore a good base map and a knowledge of the line printer's pattern are required.

Finally, SYMAP offers a ranging of mapping processes from normal interpolation through to first to sixth order trend surface and residual mapping.

In this study, as in past studies (Adams and Brunger 1975, Prowse 1978, Roulet 1979), three particular maps were found to be very useful; normal interpolation, third order trend surface, and first order residuals.

Normal Interpolation

In the normal interpolation a process of simple contour fitting is used. Each sample point has the symbol of the depth class in which it falls and the interpolation proceeds from that point in all directions to the nearest datum point.

In the normal interpolation (see Adams and Barr 1979) the influence of the lake (low snow depth) and areas of woodland (high snow depth) could be seen. Also the rim of the basin, which consists of elevated wind swept ridges exhibited low snow depths as did the tundra at the very top of the basin.

Third Order Trend Surface

The third order trend surface is a more useful tool. Using trend surface analysis the normal technique of interpolation is not employed. Instead, the parameters for an equation representing a surface are estimated, using a least-squares criterion. This means, the surface is fitted to the data values in such a way that the sum of the squared deviations between the given values at data points and the height (value) of the computed surface at those data points is minimized.

The equation used to describe the trend can be linear at the first order through to the sixth order which contains many inflection points. In this study, third order trend surface analysis was used. This is a cubic surface, meaning the equation for the line has a linear, squared and cubic term giving two points of inflections. The higher the order, the lower the variation between computed and actual values. However, local trends may be lost. For this reason the third order surface was used, which gave a 60% explanation level in terms of the variation explained by the surface.

The third order trend surface (Figure 1) isolated two particular trends. One towards the large "hill" in the area of the close woodland and the other towards the "depression" related to the lake surface. There is also a marked trend of decreasing depth towards the tundra. These trends suggest the significance of the woodlands as snowtraps and the lakes and tundra as low accumulation and depositional areas. This surface explained 60% of the variation in the snow depths.

First Order Residual

The last map used in the display is the first order residual surface (Figure 2). Since the method of trend surface analysis is a process of data fitting, there will always be some variation between predicted and actual distributions, thus residuals are produced. These residuals are very useful in isolating local variations not predicted by the general trend surface represented by the fitted surface.

As in the normal interpolation, the lake and rims of the basin stand out as areas of low depth while the forested areas stand out as areas of higher depth.

Using SYMAP in large scale snow surveys for the purpose of spatial and areal analysis of snowcover seems to be adequate. While the quantitative values of the trend surface and residual surfaces may be questionable, their use in assisting in qualitative and descriptive spatial analysis is recognized.

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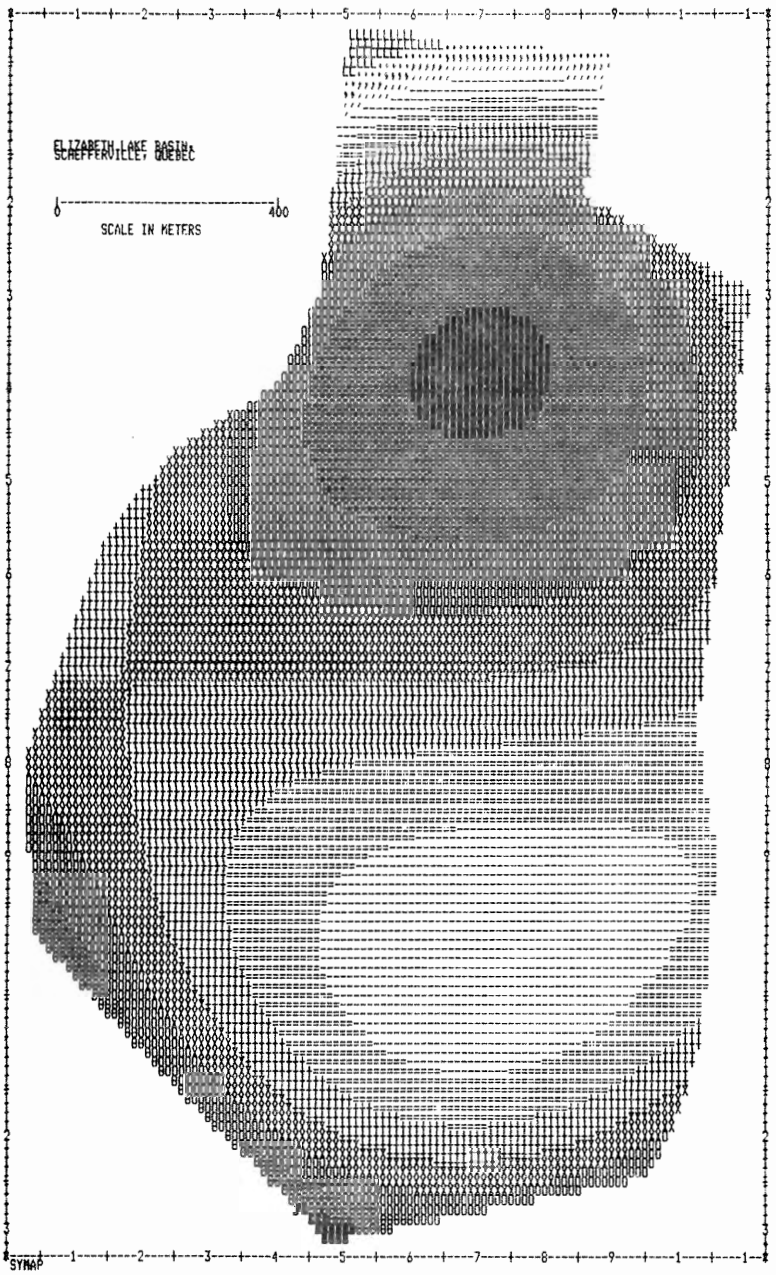

FIGURE 1 Third order trend surface of snow depth. The darker the area the greater the depth. The darker area is 160-180cm while the lighter area is 40-60cm.

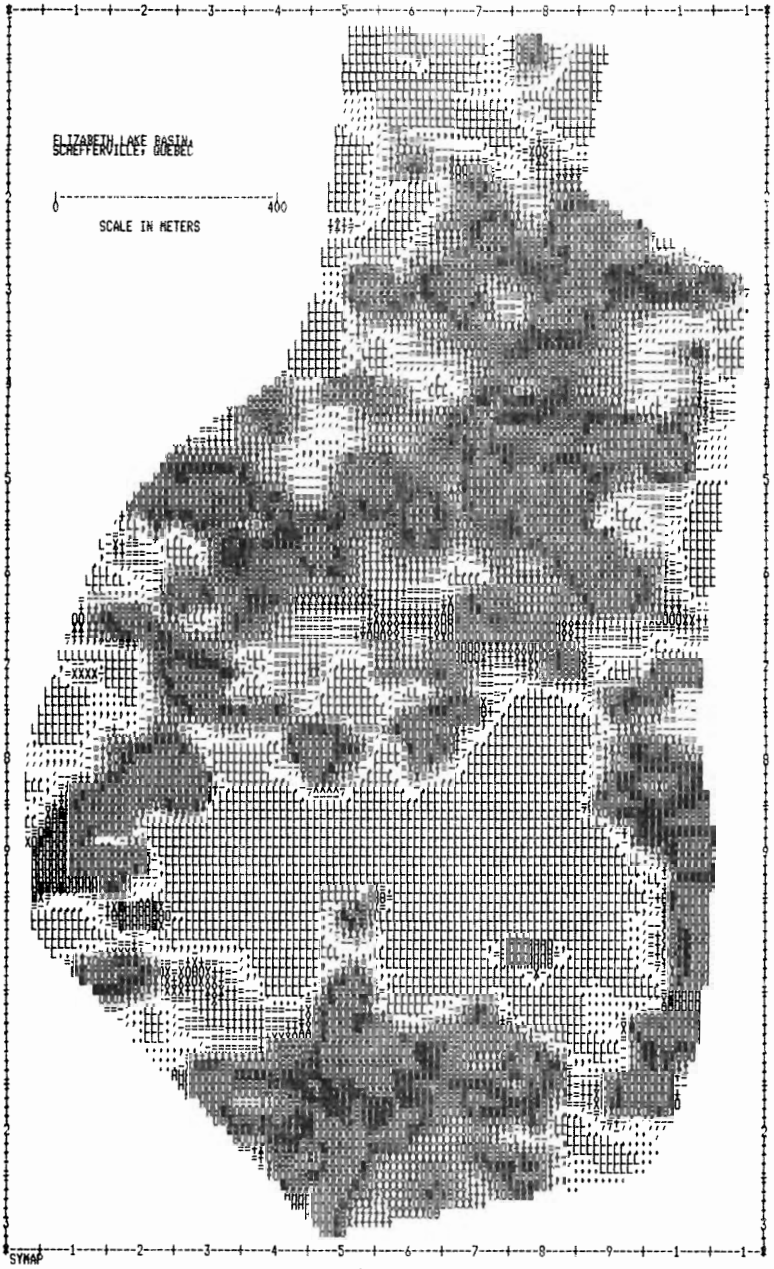

FIGURE 2 First order residual surface. The darkest areas represent those of high positive residual values while the lightest area represents high negative residual values.