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Computer Mapping: An Introduction to the Use of Electronic Computers In the Storage, Compilation and Assessment of Natural and Economic Data for the Evaluation of Marginal Lands

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AN INTRODUCTION TO THE USE OF ELECTRONIC COMPUTERS IN THE STORAGE, COMPILATION AND ASSESSMENT OF NATURAL AND ECONOMIC DATA FOR THE EVALUATION OF MARGINAL LANDS.

by

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The assessment and evaluation of marginal agricultural lands depends directly on full consideration of all the data that can be assembled regarding those lands.

The types of data presently available for consideration are many and varied, and the form of their presentation is equally varied. The particular combinations of data types actually existing in any part of the country are similarly varied and possibly entirely different in separate areas of the same size. The purposes for which the assessment must be made are also varied.

Clearly the major tasks in the evaluation of the marginal lands are the accumulation and handling of data; the compilation of it so that all factors regarding a specific area may be considered together; and finally the accurate weighing or comparison of it so that sound judgements can be made.

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The electronic computer has in recent years increasingly demonstrated its ability to store, compile and assess statistical data. The staff of Spartan Air Services Limited with many years' experience in all phases of survey and mapping, and the personnel of International Business Machines Company Limited with their extensive facilities for computer research and development, have initiated studies regarding the application of computers to the storage, compilation and assessment of map data as well as statistical data, and to the production of accurate and specific correlations between the two types of data. These very preliminary investigations definitely indicate the feasibility of the use of computers in this field.

Basically, the types of data available for computer input are maps or tables. Maps will be considered first. They may represent any type of data from soil survey to land use capability survey. With the exception of topographic maps, however, they essentially represent the plotting of characterised areas, each area defined by a boundary. They are at various scales, though each commonly has a system of geographical or arbitrary co-ordinates at the margins. They are usually plotted on paper, which is liable to minor distortions. They can be in either printed or manuscript form.

The problem is to describe these maps in computer form and store the data from each one in a manner that will allow it to be retrieved and compared with similar data from the next map, or next group

of maps, or with statistical data.

Experience with high precision photogrammetric plotters led to the suggestion that a read-in device could be produced which would allow any map sheet to be placed on the plotting table and its data traced directly into the computer's memory. This would be done by aligning the map co-ordinates with the edges of the tracing table so that each movement of the plotting pointer would be related to geographical co-ordinates. As the pointer was moved around a type boundary it would pass through co-ordinates, and each change would be automatically recorded in the computer. On the photogrammetric plotters, a movement of .01 mm represents a one unit change in a co-ordinate, so it can be seen that an area could be very accurately described by this method. As the area was plotted, so the character of the area could be put into the computer's memory by a key punch method.

The problem of minor distortion in any map sheet could be resolved by placing the pointer on the corner co-ordinates at the beginning of the plot-in. This would allow the computer to record the known co-ordinate for a physical position of the pointer. Subsequent movements of the pointer would then be related to the known co-ordinate positions rather than to the edges of the plotting table, and thus the information would be described by its true co-ordinate position, and could later be compared with other data similarly described. The plotting by co-ordinate also resolves the problem of scale, as the storage, comparison and retrieval

can be done entirely - and most efficiently - from the co-ordinate specification, and the output of data can naturally be plotted at any scale.

As only one copy of any map is required for programming the computer with the data that it represents, the valuable manuscript maps can also be plotted without further drafting or production work being completed on them.

Statistical data can be inserted into exactly the same system as the map data. If the boundaries of a statistical unit can be accurately described with geographical co-ordinates, or if the corners of a regularly shaped statistical unit such as a prairie township can be located by latitude and longitude or Universal Transverse Mercator co-ordinates, or if the political boundary appears on any map, (and one or more of these possibilities applies to every known statistical unit in Canada) then equally its description can be put into the computer memory. Furthermore, once a political area has been described in this way for one set of statistics, it need be described no more, as all further data can be related to the original area description in the computer.

In this manner all data regarding any particular area can be stored in the computer, in a form that will allow easy retrieval and comparison of different data types.

Given the computer programmed in this fashion, there are an infinite number of tasks that can be done. These would naturally depend on the requirements of the assessment, and the type of information that was available in the area concerned.

Perhaps the most straightforward task is the statistical assessment of all data, in any given area of any size.

If it were required to assess the natural factors within a statistical unit such as a township, it would be possible to read out the actual area of each of the factors or classification units within the township. These could also be expressed as a percentage of the total area of the township. If more than one factor were present, the ratio between the various areas, or percentages, or values of the factors, could be expressed. If the ratio were the basis of a classification system, the unit area (i.e. the township) could be classified as a whole. This total assessment might then be directly compared with statistical data also relating to the whole township, and a combined rating given.

As was stated before, the comparisons that can be made are simple and numerous, and would be directly allied to the requirements of any particular area.

Just as one township can be assessed, so can the results of the various township ratings be assessed, allowing groups of townships with certain values to be recognized. In this way it would be possible to evaluate significantly large areas.

A second type of compilation that can be done is the division of any area into type classes based on any classification criteria related to the data programmed in the computer. This function is somewhat different from the township study described above as the area chosen could be either smaller or larger than a township, and the type boundaries would

be plotted in their true position as indicated from the assessment of all the available data, rather than in the form of rectangular township units. It can , however, be seen that the operation of scanning and comparing the existing data would be essentially the same.

A third, and slightly different function, is the direct isolation of areas with specific characteristics. Thus, if land of a particular type needed to be located in a certain area and the criteria for the land type could be decided from the available data, then the computer could compare the required criteria with the complete compilation of data it had stored, and read out the result in the form of the boundary of the area required. A small refinement of this approach would allow the computer to assess the "degree of fit" of the criteria. This means that if there were areas that almost, but not quite, met the specifications, they could also be indicated and the part of the criteria which they were missing could be indicated. A further extension of this method would allow 'contours of fit' to be drawn, showing areas which perfectly met the critera as the highest value, with decreasing values out to areas which were completely opposite to the criteria.

These examples of possible computer capability may or may not be immediately needed for the study and assessment of marginal lands, but they do illustrate the manner in which data may be handled, and the facility with which comparisons and assessments may be made.

Output from the computer system could come in the same

forms as the input data, i.e. as maps or tables, or both. If plot-out was required in map form, a plotting table would be used. This would operate in much the same way as the read-in device but in reverse. The computer would supply co-ordinates and a servo-operated point would be guided through them with a high speed mechanism. The required map would thus be drawn alongside the computer either on plain paper with co-ordinates plotted by the computer or on an existing base map on stable material, with its co-ordinates aligned to the edge of the plotting table. A similar system could be designed using a high speed printer to indicate the desired boundaries in much the same manner as meteorological charts are now drawn by computers. At any time statistical data could be transcribed in the form of type-written sheets either related to already mapped statistical areas, or related to boundaries being plotted on the output table.

It is apparent that the output data and assessments rely directly on the type and accuracy of the data programmed into the computer. This will probably vary across Canada. While the form of the output can be as nearly standardized as possible, and while the computer system will give a method of rating the overall reliability of its final output, it must be clearly stated that the computer can never improve the original data, and its output can never be more reliable than the original data. It can, however, maintain with absolute certainty the accuracy of any data it is supplied with, and can compile and assess all the available data regardless of scale or form.

Further, if at any time one particular facet of the original data is changed, the change can easily be made in the computer storage unit, and the output programme quickly re-run to assess the effect of the change - quantitatively - on the original evaluation. As many factors, particularly those of economics, are not static, this facility may prove of considerable value. Even natural factors, such as a change in vegetation by burning or other agencies, can be considered in the same manner, and the effect on the original assessment shown. If there was the requirement, a projected change in any factor could be inserted and the effect on the whole similarly judged.

It can be appreciated from the foregoing that computers have a definite capability that may be applied to the immediate tasks of the Agricultural Rehabilitation and Development Administration. It is proposed that this capability should be thoroughly investigated in relation to the specific data available for the study concerned and with direct application to the assessments that have to be made. This investigation would be based on research and trial of the concepts described above to the point where the practical application of computer analysis to the A. R. D. A. programme can be thoroughly evaluated and the decision made whether to incorporate the approach in the overall programme.

The initial studies made by Spartan and I. B. M. certainly indicate the high probability that a practical system can be developed. This opinion has been confirmed by discussion with a considerable number of

Government authorities in mapping and computing. It is considered that while the final application of computer mapping to the A. R. D. A. programme must rely on the proposed investigation, the possible benefit of the system and the applications that can be envisaged warrant a reasonable expenditure to determine the extent to which computer mapping is applicable to the problems of the Agricultural Rehabilitation and Development Administration.