REPORT

on

NATIONAL SOIL CONSERVATION PROGRAM

SOIL SURVEY UPGRADE COMPONENT

1990-1993

Prepared by: K. Bruce MacDonald
Ontario Land Resource Unit
Agriculture Canada
70 Fountain St.
Guelph, Ontario
N1H 3N6

EXECUTIVE SUMMARY

The purpose of the National Soil Conservation Program (NSCP) Soil Survey component was to promote a standard compilation of information on the quality, extent and location of agricultural lands in Ontario to provide standard reference data for policy, planning and extension initiatives. The soil survey upgrade sub-program was given a budget of $ 200,000 over the three year duration of the program.

Activities in this sub-program were started by Dr. C. J. Acton who established the general guidelines and managed the activities from 1990 until the fall of 1991 when he left to participate in a CIDA project. Subsequently, the activities were coordinated and managed by K. B. MacDonald. Throughout this time there was ongoing consultation with associated personnel in the university, provincial and private sector clients.

There were three areas of activity under this sub-program. The first was the development of an overall approach to soil survey information in the province. This included critical assessment of the requirements for the information and guidelines for upgrading surveys which were inadequate. This activity was carried out in-house with a great deal of consultation with associated agencies. The second activity consisted of a several small projects conducted in-house to speed up the development of a generalized provincial level soil survey map for broad scale planning at regional, provincial and national levels. This activity also included a completion of data compilation for a detailed soil re-survey map and report. The third activity dealt with the need to upgrade substantial areas of the province for which the current soil survey information is inadequate. The requirements for additional information to bring the survey up to modern requirements were defined and developed into "statements of Work" which formed part of requests for proposals. Three proposals were funded for a total cost of $125,000. The remainder of the funds were used to support in-house projects to prepare generalized detailed maps and reports.

The following pages present a short summary of the activities carried out under this sub-program. The first section outlines the work done to develop a clear coordinated program and subsequent sections provide a precis of the statements of work along with an executive summary of the project activities and conclusions. The detailed reports are maintained separately.

Respectfully

K. Bruce MacDonald
Ontario Land Resource Unit

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SOIL SURVEY SUB-PROGRAM OF THE NATIONAL SOIL CONSERVATION PROGRAM

BACKGROUND

The Canada-Ontario Agreement on Soil Conservation provided for $11.1 million from both Canada and Ontario in matching funds over a three year period ending March 31, 1993. The soil survey upgrade sub-component had a budget of $200,000 and was administered by the head of the federal soil survey unit in Guelph.

The soil survey upgrade component dealt principally with the development and implementation of a process to provide standard reference data for policy, planning and extension initiatives to provincial, federal and private sector personnel. The development activity involved extensive consultation with partners and clients to develop a statement of requirements and the implementation is achieved through a standard compilation of information on the quality, extent and location of land resources in Ontario. At the outset of this activity it was clear that the traditional procedures for collection of land resource information by comprehensive re-survey were too costly and time consuming. A major component of this activity consisted of evaluating feasibility of upgrading existing surveys using new technology and procedures.

Projects were carried out by Agriculture Canada, University of Guelph, Upper Thames River Conservation Authority, and Gregory Geoscience.

<u>Development of Soil Survey Upgrade Requirements and Procedures</u>
(developed in-house with consultation)

The soil resource data base for Southern Ontario has mainly been compiled on a county, regional or municipality basis over many years. This represents the archive of soil resource information from which most agricultural based resource decisions are now and will continue to be made. Due to changes and improvements over time in survey methods, sampling procedures, classification standards, etc. the soil information for Southern Ontario (published and/or available in digital form) varies significantly on a county or regional municipality basis. In many cases, the information is deficient in either topographic (slope) information, analytical site specific data or both. In addition, on a provincial basis the available information is inconsistent in its accuracy, reliability, and conformity to established standards. It also contains major discrepancies in available interpretive information, in particular the soil capability (CLI) interpretations. The development and proliferation of GIS technology in both the private and public sector has led to increasing demands for soil data in digital format. With computerized procedures for manipulating the data the inconsistencies in data quality and content across administrative boundaries is causing increasing problem and concern.

In the course of land use and land management planning across the province, it is frequently necessary to revise and update the information in existing surveys or to prepare updated interpretations in response to specific requirements. These requests usually involve expert soil surveyor and often require additional field work and site checking. In many cases, the results of these specific projects meet the immediate planning needs but do not contribute to the overall body of soil inventory information. The intent of the soil survey upgrade activity is, that whenever it is necessary to collect additional soil inventory information the upgrade procedures would be used to collect a consistent minimum amount of data. In this way, the overall provincial data would be upgraded gradually as individual specific projects are carried out and the additional cost to each project would be marginal. The soil inventory data for the province would eventually build up to a single clearly defined minimal standard. (There may be circumstances where the information needs are so specific or the study area is so small that collection of the upgrade information will not be warranted). In addition, there may be requirements for upgrade projects in specific areas of high priority.

The objective of this project is to identify the kinds and level of information required for planning at the County, township or watershed level, or for broad targeting of soil-related agricultural programs. It will allow resource managers to extrapolate research findings, transfer management practices to similar soil types, target soil conservation efforts and help address other soil related issues.

Specifically, this involves the development of consistent soil inventory information for the province of Ontario at a nominal scale of 1:50,000 for regional and county use. The minimum requirement for this level of soil survey information will be to carry out interpretations for CLI agricultural capability and for requirements for the provincial level official plan.

Proposed information content of a Streamlined 1:50,000 scale upgraded soil survey.

The streamlined upgrade would include a standardized legend and, in particular, standardization of the criteria by which polygons are delineated.

Features of the database:

The basic spatial unit is the map polygon and each Polygon a is defined in terms of:

- soil (code + modifier), % of the polygon occupied and associated slope and stoniness class
- up to three soils can be defined within a polygon

- inclusions may comprise up to 20 % of each delineation.

A soil name record defining the general properties of the soil is linked to each soil (code + modifier)

At least one soil layer record and up to 9 is linked to the soil (code + modifier) for a land use which is either agricultural or non-agricultural.

Linked to each soil (code + modifier) is a typical example (specific site location) of the soil in question.

> Note: this link is suggested because it is clearly not feasible to store all possible kinds of information about each individual soil in the soil survey (map) database. When additional information is required, it may be associated with the site description or at least the typical site provides a location where the user can go and sample to obtain further analytical information. The specific sites potentially offer good locations for additional studies.

Generic Legend development: Work with the soil map legends in South Western Ontario and also in Lanark and RMOC, the important and common elements (diagnostic?) of the legend should include:

Surface texture
Parent materials
Topographic Classes
Drainage class
Soil Phases
Polygon (mapunit) proportions
Soil Series/type/name

It may well be appropriate to add information on:

Quality/reliability
Representative site identified/described (Y/N)
Additional data available (Y/N)
Pointers/linkages.

Scale, Survey Intensity Level (SIL) and standards: The upgrade scale for Ontario is basically fixed at 1:50,000 (a recommendation of "A study of the use of soil survey information in Ontario" OIP publication 86-1). It is clearly relevant to review the information associated with a streamlined 1:50,000 soil survey upgrade critically and identify the kinds of uses and interpretations which would be appropriate and also, just as importantly, to clearly identify uses and interpretations which would not be appropriate with the 1:50,000 data without additional information or field checking. The streamlined 1:50,000 upgraded soil survey must have sufficient data for CLI interpretations and provincial level official plan requirements.

Any streamlined 1:50,000 upgraded soil survey should adhere to established provincial and federal standards. To be acceptable as a provincial data set the soil inventory map must meet the requirements of the Canadian System of Soil Classification, the CanSIS or OIP field manual for describing soils and the survey intensity level specifications outlined in the "Soil Mapping System for Canada". It may be that the minimum map resolution represents a map of topography, materials, texture and mode of deposition. The SIL may be closer to 4-5 than to 2-3 so that it may not be possible to identify individual soil components within the polygons but it may still provide acceptable accuracy for the proposed uses of provincial level official plan and CLI agricultural capability. The delineation of wetland areas are an important component of an upgraded soil survey. The definition of wetland areas should, of course, correspond to the accepted (OMNR?) or CSSC definition.

One aspect that the upgraded survey must deal with is the expectations of the user of digital data in working with a legend versus the expectations of a user of conventional maps.

Data linkages - A streamlined 1:50,000 upgraded soil survey will serve only a limited subset of the applications of land resource data. Data from other sources, collected at different scales, will be required for the myriad of other needs. The ways of identifying when other data are available, the kinds of linkages and pointers and the possible structures for nested data bases will be very important components of the data associated with an upgraded soil survey.

Application of Geographic Information Systems (GIS) for Soil Survey Upgrading in Ontario

(Contract No. 01950-1-0190/01-XSE)
Contractor - University of Guelph

Statement of Work:

The traditional approach to upgrading soil data base information would most likely focus on field data collection and remapping of areas, which is extremely time consuming. However, digital data bases and Geographic Information Systems Technology offer the possibility of upgrading the soil resource information in a more timely and efficient fashion by integrating existing soil data with existing topographic and geologic information. In addition, the science of remote sensing and image analysis offers another rapidly available source of data to assist with upgrading the existing soil data base.

Objectives:

1. To develop a methodology for integrating digital land resource data using GIS technology and remote sensing to upgrade older soil surveys in Ontario at a scale of 1:50,000.
2. To test the methodology in a small pilot study area in Southwestern Ontario and evaluate its applicability in other soil landscapes in Southwestern Ontario.

Introduction

The currently existing soil data base for Ontario varies significantly in its accuracy, reliability and conformity to established standards. Existing maps are either on a county or regional basis and are at varying scales. This variation exists because of changes that have been made to soil survey methods, sampling and data collection and classification procedures. The existing soil information in many cases is extremely general with only very general soil classes being identified with little or no topographic information and only very general definitions of texture and drainage classes. Specific data indicating slope, texture and drainage information is extremely important for determination of soil capabilities for agricultural production and land use planning and for calculation of potential soil erosion which is vital for use in soil conservation programs. The soil data base for Ontario needs to be upgraded to include this vital information and to bring the data base to a consistent level of accuracy and reliability.

The traditional approach to upgrading soil data base information would most likely focus on field data collection and remapping of areas. This is extremely time consuming. However digital data bases and Geographic Information Systems Technology offer the possibility of upgrading the soil resource information in a more timely and efficient fashion by integrating existing soil data with existing topographic and geologic information.

Specific Objectives

1. To examine the potential of using the Terrasoft Geographic Information System as an aid in the soil survey upgrade process.
2. To test this potential using a small pilot study area in Southwestern Ontario.
3. To use the Terrasoft DTM to calculate slopes for the study area and test the accuracy of the resultant calculations through field verification.

Conclusions

This investigation has shown that the Terrasoft GIS is capable of producing a reasonable estimate of slopes. The maps produced could be of use as a basic input for soil survey upgrades. The surveyor could estimate slope categories for existing soil polygons from these maps. Also it is possible that areal estimates of slope categories within a polygon could be determined using the software. Although this was not attempted for this particular project.

If this methodology is to be pursued further for application in soil survey upgrading, the Terrasoft version 10 DTM needs to be applied to the study area to see if it offers improved accuracy of slope modelling. Also the methodology should be tested on a much larger study area to identify technical issues which may be associated with larger file sizes, processing time and computer memory as a result of working with a much larger study area. Also, the issue of areal estimates of slope categories should be investigated for its use and practicality. In addition, a good test of the model would be to use the predicted slopes in conjunction with existing soil polygons to produce an interpretive map of soil capability for agriculture. If a sufficiently accurate interpretive map can be produced, then it can be concluded that the GIS system is an excellent tool to assist in soil survey upgrades.

In summary, it can be said that this methodology appears to hold promise for use in soil survey upgrading but further testing, particularly in the areas suggested above is necessary before any final conclusions are reached.

Development, Evaluation and Demonstration of Soil Survey Upgrade

Phase 1: Evaluate GIS and digital elevation technology compared to conventional air photo interpretation to assign slope classes and proportions to existing soil polygons in the Oxford County pilot study area.

Phase 2: Preparation of a multi-county digital soil map for Oxford and adjacent counties.

Contract No. 01950-2-0592/01-XSE
with Upper Thames River Conservation Authority

Statement of Work

Phase 1: The contractor shall provide technical support services in analyzing and assessing available digital elevation and soil inventory data to improve and standardize old soil survey maps. The contractor shall also provide professional soil survey services and consultation to develop and test procedures. The work shall include:

1. Use the existing Digital Elevation Data for the Study area to:
    - Calculate slope aspect and define slope extents based on breaks in aspect.
    - Calculate average slope lengths.
    - Prepare a digital physiographic map for the study area and intersect with the digital elevation data to create a map of slope class/landform units.
    - Compare the units created by combinations of slope class and landform with the existing soil polygons (recognizing that, in many cases, soil polygons will consist of major and minor soil components each with a different slope class and landform).

2. Based on Aerial Photography of the study area:
    - Carry out a conventional stereographic analysis of the area to upgrade the existing soil survey with slope information. This will result in an assessment of the validity of the existing soil polygon boundaries; and for each polygon the designation of one or more slope classes contained along with an assessment of the proportion of the polygon occupied by each slope class.
    - Carry out a conventional stereographic analysis to estimate the slope in percent on a regular grid spacing of 300 x 300 m.
    - Meet with the Ontario Centre for Soil Resource Evaluation to review the requirements of soil upgrade procedures for Ontario and to establish appropriate techniques to meet the objectives.

3. Combine digital data and data compiled form air photo interpretation to:
   - Compare slopes estimated by air photo interpretation to slopes estimated by DEM based on the sample grid established for photo interpretation (all samples and also stratified by slope classes)
   - Compare the slope classes, proportions and polygon boundaries established by digital techniques to those derived from conventional photo interpretation and assess the usefulness of these digital techniques for slope upgrade for soil survey data at scales of 1:63,360 and 1:50,000.

Phase 2: to provide technical support services to combine and integrate available digital soil inventory data for counties adjacent to Oxford (Middlesex and Elgin), to define the diagnostic criteria to be used to delineate soil areas and develop a basic legend structure for the regional digital soil layer, to analyze and document the differences in map legend content between the old (Oxford) soil inventory information and the recent (Middlesex and Elgin) and, where possible, to upgrade the Oxford data to modern standards and complete the edge match between Oxford, Middlesex and Elgin counties. The work will include:

1. Digital soil inventory map and attribute data for Middlesex and Elgin Counties will be edge-matched and combined to produce a single contiguous digital coverage for the two county area. Any problems or inconsistencies along the map boundaries will be resolved with the authors. A copy of the combined data (lines and attribute data) will be provided in Terra Soft format to the Guelph Unit office.

2. Create a digital data layer containing the location of the sample site data for the counties of Middlesex and Elgin and integrate these data with the digital soil map layer to identify where representative sites are located for all soils on the maps.

3. Carry out legend analysis and development for Oxford and surrounding counties to define the diagnostic criteria to be used to delineate soil areas for a regional digital soil layer and to develop a basic legend structure.

4. Edge-match the digital soil inventory map for Oxford County with the adjacent boundaries in Middlesex and Elgin Counties. Conduct a detailed analysis of the shared boundary to summarize (i) the adjacent attribute information and (ii) the adjacent map legend information.

5. Review the edge-match between Oxford, Middlesex and Elgin counties to upgrade the Oxford data to modern standards where possible and identify the nature of the inconsistencies which must be resolved through field work.

Phase 1:

In Ontario, soils information varies greatly across the province in terms accuracy and the extent of information available. This is due to the fact that soil survey in Ontario was carried out county by county over a relatively long period of time ranging from the early 1930's to the late 1960's. Inconsistencies in the soil database exist due to the changes both in survey methods and the types and amount information available to surveyors over this period of time.

Soil survey information can play an important role in activities such as soil conservation, regional planning and environmental assessment and therefore should be as up to date and reliable as possible. In recognition of this fact efforts to upgrade the soils database for Ontario have been and are being made. Recently upgraded surveys include Waterloo, Peterborough, Niagara, Haldimand-Norfolk, Brant, Ottawa-Carleton, Elgin and Middlesex counties with Kent county currently under way.

Upgrades have been accomplished through remapping of areas at a larger scale (increased to 1:50000), more intensive collection of field data, stereographic interpretation and revision of map legends.

Such upgrade methods can be very time consuming. Geographic Information Systems technology offers a means by which information important in conducting soil survey can be quickly and efficiently made available to surveyors. New survey methods that make use of currently available digital databases and GIS need to be investigated. Efforts are currently under way to incorporate LANDSAT data in soil survey upgrade. This study, however, focused on integrating GIS technology and Digital Terrain Models (DTM's) into the process of soil survey upgrade.

Study Objectives

The objectives of this study were:

1) To generate a DEM, slope and aspect maps for the study area using Terrasoft GIS software.
2) To evaluate the usefulness of these and other available digital products for survey upgrade and determination of slope length.
3) To test the accuracy of the digital products developed.

Conclusions

The Ontario soils database varies considerably with respect to detail and accuracy of the data. To satisfy the needs of today's resource managers many of the existing surveys require upgrading. Conventional methods of soil survey upgrade can be time consuming; GIS technology offers some possible means of expediting the process which require investigation. This study evaluated the use of GIS and Digital Terrain Modelling in the soil survey upgrade process.

This study found that the reliability of the slope and aspect generated by Terrasoft is questionable; some problems can be attributed to the software itself, but some problems arise because the detail and nature of the base topographic data utilized. It should be noted that the software might perform better if the base topographic data could be enhanced i.e. additional contour info could be added (if any exists). The software also offers the option of using a coverage of spot elevations instead of digitized contours to generate a DEM. Using this approach may provide a better digital product from which to work.

Although the accuracy of the techniques employed were questionable, the nature of the products created show promise as basis for beginning a soil survey upgrade. Using a combination of slope, aspect and elevation maps surveyors may establish areas of differing drainage. In combination with the existing survey information, it should be possible to quickly establish a generalized soil map with polygons representing areas of homogeneous slopes, drainage and surface texture. This map could be refined with more conventional methods such as field sampling, but would hopefully reduce the amount of such activity required.

Phase 2: Objectives

The specific objectives for this study were as follows:

1) To combine digital soil maps for Middlesex, Elgin and Oxford counties in a single digital coverage using Terrasoft GIS software.
2) To assess the capabilities of the software when dealing with very large volumes of this type of data.
3) To investigate the possibility of using this data in upgrading soils data in Oxford county along the along the Oxford- Elgin/Middlesex border.
4) To investigate the requirements for producing a map legend suitable for the entire area.

Study Data

The data utilized in this study consisted of digital soil coverages for Oxford, Elgin and Middlesex counties. Both Elgin and Middlesex coverages are products of recent resurveys while the Oxford is based on the original survey of the county conducted in the early 1950's. The location of these counties in Southwestern Ontario and their relation to one another are illustrated in figures 1 and 2.

The Middlesex county resurvey was completed in 1992, the resurvey improved the map scale from 1:126,720 to 1:50000, significantly improving the detail and precision of the soils data. There was also a much more in depth physical and chemical characterization of soils. The county was divided into 3 different map sheets along township boundaries. Soil polygon symbols consist of a soil association code, drainage and phase modifier for a dominant and subdominant that exists in the polygon. Under this is a letter code for slope classification

The Elgin county survey is very similar to Middlesex, again it is the product of a recent resurvey conducted at a 1:50000 scale. For the published maps the county was also divided into 3 maps sheets. Map symbology differs somewhat for the Middlesex map however, instead of code for soil association and drainage modifier, these elements were combined to form various soil series within each association.

The Oxford county soils coverage is based on the original survey which was completed in the early 1950's. The scale of the survey is 1:63360 (1 inch to 1 mile). The level of precision in differentiating criteria is much coarser then that of the previous surveys described, and the accuracy is not comparable to the re-surveys.

CANSIS digital database files containing in depth characterization of soils described in each survey should be available for each county. While this is true for Oxford, the files have not yet been completed for Elgin and Middlesex since these surveys have only been completed recently.

Overview of Technical Procedures

The technical procedures involved several main steps as follows: 1) Merging digital linework from the various coverages (seven in all, 3 for both Middlesex and Elgin counties and 1 for Oxford) into a single map universe 2) Editing and edgematching linework along mapsheet and county boundaries 3) Processing new topology and linking of the separate databases.

After each individual coverage had been imported into Terrasoft format, they had to be merged into a single coverage. During merging it is possible to offset the coordinates of the coverage being merged in, this makes it possible to optimize the positioning of each mapsheet relative to one another for edgematching. Within Middlesex county no alterations were made between mapsheets and they were merged into a single Middlesex county coverage as is. In Elgin county, however, there was a considerable gap between the second and third mapsheets which was minimized with the use of the offset function plus the rubbersheeting function. After the individual mapsheets were merged for each Middlesex and Elgin counties the resulting coverages were then merged. In order to get the best fit it was also necessary to use the offset and rubbersheeting function on the Middlesex coverage when it was merged in with the Elgin coverage.

Since each individual coverage was more or less digitized as a separate entity, the linework along joining edges never match perfectly. Terrasoft does not have a specialized edgematching feature, so reconciling these differences required quite a bit of manual editing of linework. This involved both deleting redundant linework, and manipulating points of the remaining coverage so that matching polygon boundaries were fitted together cleanly. Following this, the Oxford coverage was merged in with the Middlesex/Elgin coverage, no offsets were made. When the three mapsheets were merged, the necessary editing of linework took place. There were some significant edgematching problems in Middlesex/Elgin that were resolved with the aid of the survey authors. It should be pointed out that editing of polygon boundaries will alter the extents of many soil types.

The next step was processing the polygon topology for the entire coverage. The main concern at this point was if the software could handle this much data efficiently, which it did fairly well; processing time was fairly lengthy (approx. 2 hr), but not unreasonable.

Once polygon topology had been developed linking the new coverage to attribute database tables of the original coverage was necessary. To achieve this it was necessary to develop polygon labels in the original coverage that would be unique in the combined coverage. These labels were merged into the combined coverage and allowed a new attribute table to be created that incorporated all the data from the original coverages.

The steps described here may seem simple, but required the bulk of the contract period to complete because of the amount of experimentation that was involved.

The software seems deal with this amount of data satisfactorily. Performing simple queries on the coverages worked quite well. Using the dynamic labelling function however, was extremely slow. Since the software is running on a lower end machine (25 MHz 386) it is conceivable that performance could be significantly improved through hardware upgrade.

To complete the coverage an operation to dissolve the boundaries between polygons that cross map sheet or county boundaries should be undertaken. This operation requires that there be an identical attribute between the two polygons so that the dissolve may occur. The most logical attribute to use is the map symbol, which will work well within counties. It should be possible to carry out a dissolve between Elgin and Middlesex counties since the soils types have been correlated, but the map symbol conventions are different which for the time being make this operation impossible. Involving the Oxford portion of the coverage in this operation would also prove extremely difficult. The difference in scale and level of precision between Oxford and Elgin/Middlesex means that edgematching possibilities for soil polygon boundaries are almost non-existent.

Oxford Upgrade Possibilities

Bringing together these three surveys raises the question of whether or not it may be possible to somehow extend boundary lines from Elgin/Middlesex into the adjacent area of Oxford county, thus upgrading the information in these areas of Oxford. Using only the soil polygon boundary lines this would not be possible, but with the additional layers of information such as surficial geology data or topographic data generated from digital terrain modelling, such an operation may be feasible.

Time constraints prevented a full investigation of this portion of the study and should possibly be pursued further in the future.

Legend Development

With the creation of the new coverage it was necessary to determine whether or a not a legend suitable for the entire coverage could be developed. The existing legends for Elgin and Middlesex are fairly closely related in format and the soils described have been correlated between counties. The Oxford legend on the other hand, differs substantially from the previous two in form and content.

The best approach seemed to be to use a selected group of soil physical and chemical properties which exist for each soil within the CANSIS files, however, since the Elgin and Middlesex surveys have only been recently completed, the CANSIS files have not been completed for either county. Oxford county does possess completed CANSIS files but since many of the attributes are really only estimates, especially those in the layer file, the reliability may come into question.

The suggested list of soil properties is as follows:

SOIL_CODE
MODIFIER
Map
Mode of deposition 1
Depth
Mode of deposition 2
Surface texture
Parent material texture
Drainage class
Depth of control section
Surface organic matter content
Surface ph class

Conclusions

In this study, three adjacent digital soil survey coverages, Oxford, Elgin and Middlesex counties, were combined using Terrasoft GIS software in order to investigate the feasibility and usefulness of such a digital product.

This investigation showed that the hardware and software used seems to have the capacity to handle this volume of data reasonably well. From a practical stand point, this type of product may only be useful in digital form since it would require 9 E-sized sheets to plot the coverage at 1:50000 scale and still 4 E-sized sheets at the 1:100000 scale.

In addition, this study was very useful for discovering and correcting previously undetected discrepancies between mapsheets and between counties.

Two aspects of this study, map legend development and survey upgrade opportunities, were not fully investigated due to time constraints and availability of data, and should be more thoroughly investigated in the future.

Unsolicited Proposal: Research and Development of a Methodology for Soil Survey Upgrade and an Information System

Contract No. 01950-2-1711/01-XSE
Gregory Geoscience Limited

Objectives

The overall objective of this research project is to develop and test a new methodology for a soil survey upgrade that will lead to a consistent and continuous soils database for Eastern Ontario and possibly all of Ontario. To this end, the following specific objectives are defined for the project.

1. From all the soil surveys of Eastern Ontario, develop a common legend that defines the soils in Eastern Ontario relative to one another. The legend for Ottawa-Carleton may be used as a foundation on which to build the new legend.

2. To develop and test a survey upgrade methodology using air photo analysis and field sample techniques. The methodology must be quick, cost-effective and produce data that will fit into the common legend to be developed in this study. The methodology will edge match county boundaries to produce a seamless database.

3. To investigate other possible sources of soils information and evaluate their potential for incorporation into the soil survey database.

4. To define a database structure that will provide a uniform level of soil information for Eastern Ontario, and yet be open to expansion and provide linkages to other more detailed soil information.

5. To define the type of application for which the general level soils survey data is suited and those applications for which more detailed information must be added.

6. To define an operational soil survey upgrade program for Eastern Ontario.

Recommended Operational Soil Survey Upgrade

The research carried out in this project in itself cannot be used as a model for operational soil survey due to the unacceptable schedule of tasks and the lack of a final product evaluation. However, the work does suggest a sequence of tasks that, if carried out, would lead to an upgrade of the soil surveys in Eastern Ontario and possible the rest of the province. The goal of such an upgrading process is to provide a consistent seamless soils database that is built on one common legend.

It is recommended that before this method is accepted for operational work it should be tested proto-operationally for the remainder of Lanark County of part thereof. This should be done for several reasons.

1. The tasks should be carried out in the proper prescribed sequence.

2. Both time and financial requirements for operational programs can be more accurately determined.

3. To test database structure and integration.

4. To suggest minor modifications to the methodology that may be required for an operational program.

Method

The proposed methodology for an operational soil survey upgrade is presented in the following tasks.

Pre-Mapping Phase:

Task 1. Assemble and review existing soil survey maps, physiographic, surficial geology and other information, become familiar with soil types, their morphology, association and parent material groupings.

Task 2. Enlarge the existing soils maps to 1:50,000 or 1:20,000 scale. Most of the existing county soil surveys are available in digital form.

Task 3. Select the appropriate base and prepare copies on a stable base for a township or county. The recent Ontario Base Maps (OBM) at 1:10,000 reduced to 1:20,000 are appropriate. Alternatively, the 1:50,000 scale NTS can be utilized. Research needs to be done on the cost effectiveness of utilizing orthophoto mosaics or enlarged satellite imagery as a plotting base.

Task 4. Acquire existing aerial photography suitable for the upgrade if available or have new photography flown for the upgrade area. It is desirable to have a consistent scale and imagery that is taken in the spring season after the snow has gone but before the leaves on the deciduous trees have emerged. The spring photography is more suitable for the assessment of microtopographic features and for soil drainage and wetness conditions. Also, areas that are subject to inundations are more readily identified when the natural ground vegetation or crops are low or suppressed.

At the end of this pre-mapping phase all reference, base maps, air photos and digital data will have been gathered. These materials will form the foundation of the soil survey upgrading process.

Mapping Phase

Task 5. Carry out a reconnaissance investigation of the soil survey area to gain familiarity with the landscape features and physiographic components to develop a photo-interpretative legend.

Task 6. Undertake a systematic stereoscopic examination of the aerial photographs identifying, delineating and classifying the main landform-soils-terrain features. This establishes the polygons or basic map unit that reflects a sameness or homogeneity, or exhibits a consistent heterogeneity. This exercise should be done without referral to the existing soils map. The basic elements of landform-soils-terrain mapping is the landform itself. Within the landform framework the soil materials are interpreted or estimated. Also interpreted is the soil drainage condition. The slope or topographic conditions within the polygon is interpreted in terms of degree of slope or topographic feature.

Task 7. Based on the photo-interpretative landform-soil-terrain analysis, plan a field survey to confirm the landform-soil-terrain interpretation and to collect in-depth data on the soil morphology and drainage characteristics. At each site selected, a comprehensive data sheet should be completed and the location of the site marked on the aerial photograph. As a guideline, a minimum of 1 sample site per 250 hectares is considered sufficient. However, if the landform-soils of the upgrade area are complex, more sample sites may be required. The actual location of field sample sites is determined during the airphoto interpretation. The data from these sites will be used to validate and make adjustments to polygons as they are mapped form the air photos. The data will also be used to extend the attribute database information recorded for each soil type.

Task 8. Based on the field work, some adjustments to the interpretation may be required and the polygons and the classification adjusted. The interpretation is then finalized.

Post-Mapping Phase

Task 9. Transfer the interpreted information and the sample point locations on the aerial photographs to the cronaflex copy of the base map or ortho-photo. The OBM mapping has numerous reference features which can assist in the plotting. It is important to plot the data as accurately as possible to avoid distortion or exaggeration of the polygon.

Task 10. To ensure that all polygons close and have been classified, carry out a colour check of the polygons to assure all areas have been completed. Some further field checking may be required.

Task 11. The finalized field map is digitized for GIS entry. Each polygon is given a unique number to permit linkage with the attribute table. The digital files are processed in a GIS to produce the raw soil polygon map which will be used as a base on which to build the upgraded soil survey map. The map will be developed using a UTM base that is now the accepted Federal and Provincial base.

Task 12. The digital soil attribute file will be produced for the study area. The unique soil polygon number will be listed in the attribute file as a link to the map. It is possible that this attribute file could be developed during the field sample program and modified after map finalization. This could save some project time.

The attribute files will be added to the GIS database. They will be used to reclassify the soil polygon map and prepare new soil attribute maps.

Task 13. Based on the results of Tasks 7, 10, and 12, a set of soil representative sites will be defined. These sites will be visited in the field where a soil pit will be dug and comprehensive soil attributes recorded. Sample soil profiles will be extracted and removed for preservation and laboratory analysis. As part of the collection of the representative site record, the exact position of the site location will be recorded so that it may be revisited in the future to add information on the oil or monitor changes in the soil. This may be done by large scale plotting of the geographic position (air photo) or with a GPS system.

Task 14. The soil attribute maps will be combined in the GIS to produce a landform class coil map that is defined using the common legend developed in the research phase of methodology development.

The attribute maps will also be used to develop a CLI map using land capability matrices that are based on the landform CLI assignment table.

Task 15. Final products will be produced for the study area. (Report, paper map, digital files for soil polygons, soil attributes, field sample sites and soil representative sites.)