Present and future role of FAO in soil information systems

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Introduction

Since 1968, the FAO Land and Water Development Division (AGL) has included in its programme of work, the development of a soil information system. Since 1974, this activity has been carried out in liaison with the Environmental Data Bank project of UNEP.

A first study of a soil information system was initiated by A.W. Moore (CSIRO, Queensland, Australia), for FAO in 1969.

His work provided the basis for a complete international Soil Data Bank. Even now, little needs to be changed in this report. Unfortunately the storage and retrieval system proposed was not adapted to the computer FAO had and international collaboration was arranged before further progress could be made.

A 'Report on the Soil Data Processing System in FAO' was produced in September 1971, outlining the role of FAO in this activity.

A questionnaire has been sent to different national organizations to ascertain their interest and their degree of participation in this bank. 59 organizations have recorded their support.

A Technical Officer was appointed as FAO officer to be in charge of the Soil Information System. He undertook a travel through the United States, France, Germany, Belgium and the Netherlands to collect documentation on all existing systems, especially the Soil Data System (SDS) of US Department of Agriculture, the ORSTOM and SOGREAH systems in France, and the systems for processing of raw data by multivariate analysis, multiple regression, numerical classification in Germany and Belgium.

A meeting on 'Land Productivity Evaluation' was held in Sofia in September 1971 to consider the subject. The meeting studied methods of interpreting soil data, evaluating soil productivity, predicting yield, etc. These methods make frequently use of the computer for calculations, and these application programmes influence the choice of input data, the data files, the data retrieval system and, in general, the structure of the data bank.

An *ad hoc* Consultation on 'Computerized Soil Data Interpretation for Development Purposes' was held in Rome in April 1972. Many ideas were exchanged between 22 participants. The main recommendations resulting from the meeting were: 1) each interested institution was invited, although using its own methods of data collection, to participate in a World Data Bank; 2) FAO and other international agencies (Unesco, International Society of Soil Science) should take up the responsibility for organizing a Soil Data Processing System.

Many papers on soil data processing have been presented by FAO in different meetings from 1971 to 1974. Examples are: 'Soil

Data Processing as an Aid to Regional Land Use Planning', Land and Water Resources Evaluation, Mexico 1971, 'Approach of FAO in the Field of Soil Data Processing' in a session of the Working Party on rice soils, water and fertilizer practices, Bangkok, November 1972, and 'The Production of Soil Maps for the FAO by Automatic Methods' in an Expert Consultation on Soil Degradation held in Rome, June 1974.

FAO has also participated in the meetings: Colloque international 'Informatique et Environment', Arlon, May 1974, meetings of the 'Groupe Pédologique de l'Association Internationale Informatique et Biosphère', Nîmes and Grenoble, 1973.

During this period FAO began to develop a system for processing by computer of results from fertilizer trials.

Present role of FAO

The preceding statements show that FAO has been active in this field during the period from 1969 to the present, but before explaining achievements, let me place the project in perspective.

Almost all soil information systems in the world are at an experimental stage and progress quickly with the progress of computers. FAO cannot adopt a system without experiments. The system must also be compatible with existing systems in different countries. This explains that FAO has been playing a waiting game during recent years. It now seems the moment for FAO to coordinate all activities and to obtain international agreement, firstly on the soil data to be registered, on their codification and perhaps on the bank structure, to elaborate a common retrieval system. The 'Catalogue on Soil Information Systems', an initiative of ISSS, and the meeting of the ISSS Working Group will facilitate the comparison and the bringing together of the different systems.

The difficulties are very real: the number and the cost of personnel necessary to create a soil information service, the data collection by persons who often do not see the purpose of such collection, the difficulty of going beyond an experimental study to a routine situation, the amount of data necessary to characterize the environment or to calculate soil productivity. FAO has not yet overcome these difficulties.

Achievements

Soil Data File

The general structure of this file was established in 1971. A second revised draft of items definitions has now been prepared.

Data entry has been the object of much thought and discussion, giving particular consideration to the constraints of data capture (which should be as simple as possible) and the constraints of data interchange between data banks (which should allow each data bank to handle the data according to its own storage and processing system). For data interchange, the proposed solution is a standard card image on tape, each entry bearing an initial identification number. This common communication format for the exchange of data between international users, has been discussed with Interorganization Board of International Computer Centre of UN in Geneva, and the FAO Computer Systems Branch in FAO.

Compatibility between different soil data systems have been studied simultaneously with the establishment of the soil data file.

A 'Guideline to Codifying Soil Data' has been prepared but not yet published. It will appear before the end of 1975 in provisional form and will be widely distributed for comment. Our aim is to obtain the consensus of as many experts as possible on this system, which is intended to become international.

The publication will list the items and variables to describe a soil profile, together with physical and chemical data and environmental characteristics. Many other soil information systems already adopted by other institutions, organizations or countries have been compiled in the listing and we have chosen the common soil properties currently collected throughout the world with the exception of properties particular to an ecological zone, or for special use. Such cases can be handled in the regional, national or local banks; an example is the permafrost horizon description. The objective has been to codify and standardize the entry format of items common to the majority of banks. The selection of items has been governed by using those required for soil classification or for land evaluation and soil productivity.

Cross references with the climatic bank of WMO, with the FAO land use and geographic data file and with the FAO farm management, are foreseen in the input cards.

Hayatsu of the FAO Computer Branch has recently proposed an appropriate storage, retrieval and updating system, which is adapted to the FAO computer, IBM 370.

Geographic Data File and Automated Cartography

The data on soil, environment and land use, are grouped and linked to a mapping unit of the FAO/Unesco Soil Map of the World. Later they will be linked to an agro-ecological map.

This programme has been carried out under contract with the Experimental Cartography Unit (ECU) at the Royal College of Art in London. It is as yet experimental, but shows promise. It will probably be used to automatically draft a land degradation map, from the World Soil Map.

The South America sheet of the Soil Map of the World has been digitized, and data on climate, physiography, geology, vegetation, land use, land management (two to eight punched cards for each mapping unit) are recorded by soil units, i.e. the soil association comprising the mapping unit. Retrieval of 1-20 single or associated land characteristics can be achieved by the computer and the areas with these characteristics can be displayed on a cathode ray tube and photographed, or drafted on a plotting table on completion of editing. Changes of map scale and changes of projection are possible.

Computerized contour maps can also be drafted from data points by a computer programme of ECU. FAO has used this programme to produce a contour map of equal climatic aggressivity related to erosion, from climatic stations for each of which an aggressivity index was calculated. This experimental work will be very useful, in future, to formulate a land degradation map.

The cartographic file and automated cartography are very important for all FAO work on environment.

Data recording, in these activities, is unfortunately laborious both for the land characteristics and digitization of the area boundaries (numerous errors of

digitizing must be corrected). Additionally these programmes are costly, particularly in the experimental stage.

Fertilization File and Bank
The FAO Fertilizer Programme puts out, each year, a large amount of data on field fertilizer demonstration and trials results. Fertilizer response curves and the optimum economic rate of application can be obtained from this data. A sophisticated set of computer programmes for these calculations (by Colwell) have recently been published by FAO. A programme, using the orthogonal polynomial method, permits the calculation of economic rate, not only with the interaction of other fertilizers but also of other productivity factors such as climate, soil, percentage nutrients, soil texture, etc. This programme requires special trial arrangements.

FAO now routinely uses a simplified programme determining the optimum economic rate of fertilizers. Interactions between fertilizers are taken in account in the trials but not in the mathematical equation. A great advantage of this particular computer programme is that it permits stratification of results according to climate, soil type or some physical or chemical soil properties, divided in classes. Amounts of fertilizers can be recommended as a function of these different criteria. The results are recorded on magnetic tape and can be retrieved by country, soil, climate, and updated. This is the basis of the FAO Fertilization Bank.

Land-Use File
This activity is still in the project stage. Ultimately it will obviously have to be perfectly correlated with the Soil Data File and with the farm management data collection, analysis, storage and retrieval system of the FAO Agriculture Division. This farm management system records yield, crop, soil, climate, limiting factors, land tenure, agricultural practices and management by parcel of land or by farm.

Let me stress the fact that it is a land-use file and not a soil-use file. The use of soil is already recorded in the Soil Data File. The Land-Use File is the nearest to a geographic data file, because it concerns areas.

Miscellaneous Computer Programmes
For some particular purposes, FAO uses general packages of IBM or programmes especially written for the particular purpose. Attempted correlation of fertilizer response with soil analysis, by a multiple regression programme written by an FAO programmer, is an example.

The calculation of soil productivity from plant, soil and climate data is another example. This is in an experimental stage and employs a computer programme PARME (parametric method) written by Culot and me. This activity is a good example of application programmes, which use soil data, and climatic data, and will use plant physiological data, extracted from the corresponding banks.

Linear programming has also been used for an FAO project in Korea to optimize peasant incomes, by crops best suited to various soil types.

Future role of FAO

FAO is less interested in theoretical research programmes on a particular point than in large application programmes having a practical aim.

Many computer programmes have not a sufficiently large application to cover world problems. Such programmes require special data which are not 'normally' available and must be specially collected.

However FAO has to collect these programmes for use in its field projects. The ISSS catalogue is a good basis which must be widened to particular agricultural problems: plant physiology, hydrology, plant-climate relationship, water balance in soils, erosion in watersheds, etc. For its own staff FAO needs programmes of worldwide use, taking their data from worlwide banks or regional banks having the same soil information system.

The present FAO objectives on this matter are as follows:
- To promote local or regional banks on soil, land use, geographical data;
- To publish a list of items, a standard codification, a storage and retrieval system able to adapt itself to different situations and constituting a common basis to local banks. A choice of files must be previously effected. Exchange between banks will be reduced to magnetic tape exchanges.
- To coordinate the soil information system with other banks, such as climatic, and plant physiology, by cross reference, in collaboration with UNEP.
- To create an international soil bank gathering the data of local or regional banks. It appears that the international bank should not only be a bank of references to local or regional banks, but should additionally record all the data.
- To develop the application programmes, which must justify the bank's existence.

The following points and difficulties are pertinent to this programme of activities:
1. It is difficult to gain acceptance of a soil information system in countries that have already developed their own system, perhaps better adapted to local conditions and needs. In consequence we think that it is necessary to act quickly to avoid the multiplication of different systems.
2. The choice of a soil information system implies the use of a field record form to be completed by experts in the field. It is difficult to write a practical model, suitable for different conditions.
3. Cross-references between different files save time and money, provided the other files can be interrogated for each question. It is proposed that each cross-reference can provide total information but that usually each file will contain sufficient data for the immediate objective.
4. Until now computer programmes in FAO, mainly in experimental stage, have been costly and time-consuming. We hope that it will not be the same in the future. A budget for the creation of a specialized service has yet to be made.
5. A soil data bank becomes useful when sufficient data are recorded. To collect data, we are dependent on the good will of soil specialists. To process the data, for instance statistically, we must have a sufficiently large collection of data on a given attribute.

It is necessary however to establish a code for the future and FAO will submit, very soon, an international bank project for the comments of experts. The discussion at this meeting will very much help in finalizing the text for this project.