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EXPERT GROUP MEETING ON THE DEVELOPMENT OF A GLOBAL LAND/SOIL MONITORING SYSTEM

KIEV, USSR, October, 1982

REPORT AND PROCEEDINGS

Draft Report
compiled and edited by Jean Thie, Director Lands Directorate, Environment Canada, Chair of the Expert Group Meeting in Kiev; typing by M. Poulin, Lands drectorate

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EXPERT GROUP MEETING ON THE DEVELOPMENT OF A GLOBAL LAND/SOIL MONITORING SYSTEM

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REPORT OF THE MEETING

1. EXECUTIVE SUMMARY

The World Soils Policy recognizes that soil is a finite resource on which continuously increasing demands are placed by a growing world population. Only sound principles of resource management will maintain soil productivity, prevent soil erosion and degradation and reduce unnecessary loss of farmland to non-farm purposes.

In response to the World Soils Policy, the Medium Term Plan of the United Nations Environment Program calls for a Global Environmental Monitoring System (GEMS). The UNEP soil program proposes, as part of GEMS, to keep global land and soil resources, their productivity and status under constant surveillance and elaborate and promote guidelines for integrated management of soil resources.

An expert group meeting was held in October, 1982, in Kiev, USSR, to discuss the criteria which should form the basis for implementing a Global Land/Soil Monitoring System. The experts, in response to a consultants report prepared for UNEP, discussed information requirements, data handling capabilities and system implementation considerations.

The expert meeting strongly supports the initiatives taken by the UNEP and concluded that a Global Land/Soil Monitoring system is technically and operationally feasible and urgently needed.

The expert panel recommends that UNEP undertake the preparation of a formal project proposal during 1983 as a first phase in the ultimate implementation of the system. A large number of recommendations were made related to specific technical and implementation issues. These are elaborated in detail in the main body of this report in Chapters 8 and 9.

2. OPENING OF MEETING

The meeting was opened at 11:00 hours on Monday, Oct. 4, 1982, in Kiev, USSR. Prof. Dr. I.O. Garbouchev, Chairman of the Soil and Water Task Force, Environmental Management Service/UNEP welcomed the participants and addressed the meeting (Appendix A 1). Other opening addresses were presented by Mrs. B.I. Protsenko, the Chairperson of the Ukranian SSR

State Committee for Environmental Protection and formal host of this meeting; Mr. Z.O. Kalensky, representing FAO, Dr. R. Arnold representing the ISSS (Appendices A 2, 3, and 4, respectively). All speakers emphasized the importance of the task at hand and the support for this effort in their respective organizations.

3. ELECTION OF OFFICERS

The following invited experts were elected as officers of the meeting:

Mr. J. Thie, Chairman
Dr. K.G. Tejwani, Deputy Chairman
Dr. B.S. Nosko, Deputy Chairman
Mr. Z.D. Kalensky, Rapporteur.

4. PARTICIPATION

Eighteen invited experts participated in the meeting. In addition 20 observers representing a range of USSR science organizations contributed to the meeting. Names and affiliation of experts and observers are provided in Appendix C. The continued presence of the Chairperson, Ukranian SSR State Committee for Environmental Protection reflected the strong interest of the host organization to make the meeting a success.

5. AGENDA

The agenda proposed by the organizing committee was implemented as follows:

Day 1 (Oct. 4) Morning Session

- Conference opening: address by UNEP representative, chairperson of Ukrania SSR State Committee for Environments; representatives of ISSS, FAO.
- election of officers

Afternoon Session

- Presentation, of Consultants report: Project Criteria/Software-Hardware for Global Land/Soil Monitoring System prepared by Drs. S. Bie and J. Lamb
  Presentation by S. Bie
- Overview of soil protection, conservation and improvement in the Ukraine background paper presented by Dr. Gogslanov.

Day 2 (Oct. 5) Morning Session

- Presentation of background papers by Dr. Nosko (Scientific Fundamental for the System of Fertility Control and Monitoring of Ukranian Soils - Appendix B 1) and Dr. Novakowski (Land Evaluation and Land Productivity in the Ukranian SSR - Appendix B 2).
- Further Elaboration on Consultant report, and discussions.

Afternoon Session

- Formal comments by expert group members on consultants report (Rozhov, Areola, Venkataratram, Zonn, Arnold, Tejwani, Kalensky, Thie, Pachepsky).

Night Session

- Organizing workshops, establishing terms of reference and questions by conference leaders and consultants.

Day 3 (Oct. 6) Morning Session

- Introduction to workshop sessions, terms of reference. Questions to be answered by workshop on
  1 - Minimum Data Sets
  2 - Data Handling System
  3 - Implementation of System
- Workshop Discussions led by Dr. Arnold (1) Dr. Sadovski (2) and Dr. Tejwani (3) respectively.

Afternoon Session

- Continued workshop sessions

Night Session

- Finalization of workshop results by chairpersons and rapporteur.

Day 4 (Oct. 7) Morning Session

- Reporting and discussion of workshop results and recommendations
- sightseeing excursion

Afternoon Session

- Presentations by Drs. Kalensky, Venkataratram, Andronikov and Thie relating to remote sensing, and geographic information system use.

Day 5 (Oct. 8) Morning Session

- Final discussion and modification of recommendations
- approval of recommendation
- closing of meeting.

6. BACKGROUND DOCUMENTATION

6.1 World Soils Policy

The World Soils Policy recognizes that soil is a finite resource on which continuously increasing demands are placed by a growing world

population. Only sound principles of resource management will enhance soil productivity, prevent soil erosion and degradation and reduce unnecessary loss of farmland to non-farm purposes.

In response to the World Soils Policy, the UNEP's Medium Term Plan (1982-83 UNEP/GC.916. March 1981) calls for a Global Environmental Monitoring System.

Within the objectives of the UNEP soil program; the medium term plan calls for the development of a system to keep global land and soil resources, their productivity and status under constant surveillance, and elaborate and promote guidelines for integrated management of land and soil resources.

6.2 Consultants Report: CRITERIA/SOFT-HARDWARE FOR GLOBAL LAND/SOIL MONITORING

In the context of the world soils policy and the medium term plan of UNEP a specific request was made for "criteria for a global computerized soil monitoring system". (Elements of a world soils policy - UNEP/WG.56/2/Rev.1, April 1981, S56 p.15).

In November 1981 the Consultants Dr. S. Bie and J. Lamp submitted a 83 page report to UNEP. This report was distributed in advance to the experts participating in the Kiev meeting. During the various sessions in Kiev, the approach, methodology conclusions and recommendations were elaborated on by Dr. Bie and discussed. The size of the original document does not allow it to be included in the body of the proceedings of the meeting. The following summary gives in a very condensed manner, the essence of the report. To provide an overview of the breath of material treated by this important report, the table of contents is added as Appendix 6.

Summary of Consultants Report:

The consultants propose and specify an inventory and monitoring service for soil and land data within a Global Environmental Monitoring System. GEMS, particularly related to land use, land productivity, soil degradation and desertification aspects.

A methodology is outlined based on overlays of cell maps of individual attributes with data obtained from probability samples, existing surveys supported by uncertainty estimates, and the decomposition of existing soil classification into component attribute-values. Remote sensing will become a valuable information source when the new high-resolution land resource satellites are launched in 1982-84.

The use is recommended of internationally accepted methods for land use, land productivity, soil degradation and desertification assessment.

The consultants specify a computer hardware-software system for Soil/

Land-GEMS consisting of 13 main modules implemented on a mini-computer, and recommended it to be installed at UNEP, Nairobi as part of GEMS/PAC.

Total investment costs are estimates at US $440,000 with annual running costs of US $50,000.

Soil/Land-GEMS will rely on outside organizations cooperating with data collection. Operation of the system in UNEP will require 2 computer-minded earth scientists plus 1 earth science - minded computer scientist.

The system is designed to suit a wide range of other GEMS activities, without major modifications.

6.3 Special Presentations

Three papers were presented describing land evaluation, monitoring and management of soils in the Ukraine. The first report was given during the afternoon session of the first day by Dr. Bogdanov president of the VASHNIL Presidium, Southern Department. He described the land protection measures undertaken in the Ukranian SSR. He stressed the need to include data relevant to soil protection and conservation of land resources in the Global Monitoring System. The second paper entitled "Scientific Fundamentals for the System of Fertility Control and Monitoring of Ukranian Soils", was presented by Dr. Nosko. The third paper by Dr. Novakowski dealt with land evaluation and productivity in the Ukraine. Summaries of the three background papers are provided in Appendix B. Furthermore a number of short presentations were made by Dr. Andronikov (remote sensing in the USSR) Mr. Kalensky (Feasibility of Using Remote Sensing for Monitoring, FAO perspective), Dr. Venkakaratham (Remote Sensing Applications in India) and Mr. J. Thie (The Application of the Canada Land Data Systems to Resource Management and Environmental Monitoring, see summary Appendix B).

7. DISCUSSION OF CONSULTANTS REPORT AND BACKGROUND PAPERS

7.1 General

The record of the discussions after the special background papers is provided following the respective summaries in the Appendices. The record of the discussion related to the consultants report is given in the following section. The discussion spanned a number of days and for clarity sake, the record of discussion is presented in the order of the agenda.

7.2 Elaboration on Report by Consultant

Day 1 Afternoon Session: The consultant presented an overview of the first four chapters of the report covering:

Terms of Reference
General Aspects of Inventories and Monitoring

Analysis of Data Input
Analysis of Procedures and Models.

In the discussion Mr. Kalensky of FAO, referred to the proposed system flowchart. Fig. 1 on page 4 of the Report. He asked for the following clarification:

a) will the coordination role for the future Global Environment Monitoring System be exercised by the UNEP/GEMS?

b) will the responsibility for establishing and maintaining the component subsystems provide input data to the Global Environmental Monitoring System be entrusted to UN Agencies responsible for the particular discipline/field of application, in cooperation with the UNEP/GEMS? Will, for example, the FAO have a leading role in providing inputs on the terrestrial renewable resources; Who on climate, Who on health etc.?

This concept was confirmed by the UNEP consultant Mr. Bie. The second comment was by Mr. Venkataraham of the National Remote Sensing Agency of India. He referred to Fig. 1.2 on page 3 of the Report and proposed to include natural disasters as inputs for assessments of the land productivity. In particular he listed cyclones/floods, saline water intrusion, sand casting, droughts and changes of water courses as important limited factors of land productivity in countries like India, Pakistan, Bangladesh, Indonesia and probably in some African countries.

Day 2 Morning Session: The Consultant elaborated further on the last 3 chapters of the report:

Proposed Data Handling Systems
Links to other GEMS activities
Conclusions and Proposals for Implementation.

During the discussion a number of questions of clarification were raised. Comments of the participating experts are reflected in the following section.

7.3 Initial comments by Participants on Consultants report

7.3.1 Comments by Dr. Kalensky, FAO

Referring to consultants' views on the execution of the proposed project as expressed in section 5.2, these statements should be modified when finalizing the project documents taking in account the mandate, expertise and activities of UN Agencies such as FAO, WMO, UNESCO and others.

Referring to the Fig. 5.1 "Systems Overview" it provides a good basis but has to be further elaborated, in

particular with reference to suggested remote sensing data inputs.

Mr. Kalensky raised the question of referencing the Global Land/Soil Monitoring System to the natural land divisions rather than to the regular grid of cells. In particular during the data gathering and analysis, the natural land divisions such as geomorphologic land formations, watersheds, major land-use types would facilitate execution of this task. A geographic reference grid of cells of selected size can be overlayed onto the data sets of land/soil attributes at a later stage. In this context the FAO/UNESCO World Soil Map of the scale 1:5M should be used as one of the data sources for establishment of the baseline land/soil data bank to which the changes will be references.

Furthermore, there is a question of resolution at which the input data, that is the soil and land attributes should be collected. The proposed level consisting of 10m x 10m cells is unrealistic for implementation of global scale, because of the cost of collecting the soil/land use attributes to be compatible with this scale as well as the practical problems of geometric identification of cells of this size in developing countries. At the same time, the system should be sufficiently flexible to allow this precision of data collection and change monitoring for selected, high priority areas. Use of large cells such as 10km x 10km as proposed for level 4 cannot account for local differences in land/soil attributes within individual cells. Thus their usefulness for environmental monitoring and management is reduced. In particular at this level the natural land/soil boundaries would be preferable at the data gathering and analysis stage.

It is proposed that a pilot project is conducted for testing and further development of the proposed methodology. A working group should be formed to prepare a project document for such a task.

7.3.2 Comments by Dr. Sadovski

Since four levels of input data collection are proposed, the system should be hierarchical. This hierarchy affects the ways of data collection, the volume of data bases, the algorithms for decision-making and other problems.

Level 1 with a cell size 10m x 10m is applicable by way of exception to intensive land use in some areas and small countries such as the Netherlands (40,000 km^2).

Level 2 with a cell size 100 m x 100 m is suitable for countries that are not large, e.g. Bulgaria (110,000 km^2).

Level 3 with a cell size of 1 km x 1 km is suitable for some big countries or regions, e.g. Algeria (2.2 mln km^2) or Canada (9.9 mln km^2).

Level 4 with a cell size 10 x 10 km can be used by UNEP for the total land surface of the earth (134 mln km^2).

At the lower levels a considerable part of the data will be supplied from different large-scale mapping and surveys and a smaller portion will come from remote-sensing studies. On the contrary, at the higher levels remote sensing will yield the greater part of the data while small-scale surveys will supply the lesser part. Therefore, the available data from soil and other surveys should be most thoroughly utilized and in the future satellite data will be increasingly used, especially at level 4.

We consider it worthwhile to give some figures concerning the volume of data bases at different levels. It follows from the consultants' proposals that the data base should contain at least the following 5 files:

(1) Climatic data;
(2) Soil data;
(3) Biological data (vegetation);
(4) Land use and agrotechnical data;
(5) Socio-economic data.

Some preliminary considerations which harmonize with the CR have yielded the following numbers of the characteristics (attributes) in these files;

Level	Climatic	Soil	Biological	Agrotechnical	Socio-economic
1	20-30	30-50	15-25	15-25	20-30
2	20-30	30-30	15-25	15-25	20-30
3	20-30	20-30	15-25	10-15	20-30
4	10-15	10-15	10-15	10-15	10-15

In table 1 some results are given for the number of records in the separate files and for the required capacity of magnetic-disc memory. This table can be used when determining the type and configuration of the computer system for data processing.

The Consultant report discusses the problem of mathematical modelling but not thoroughly. The efficient use of land and soil depends above all on the level of the knowledge about the relationships between the

mechanisms forming plant production and the factors participating on the process. It is impossible to embrace their complex interaction without using mathematical modelling especially in intensive agriculture where some mancontrolable factors may, on the one hand, increase the yield for a certain period of time but on the other hand they may considerably change the status of the agroecosystems in an unfavourable direction. A very promising application of models is the description of the link "soil/land - productivity" and the prediction of changes (degradation/improvement) in soil and land. For this purpose different analytical (empirical, semiempirical or functional) and simulation models can be constructed. In this field the USSR, the Netherlands (Wageningen) and Bulgaria (the N. Poushkarov Institute of Soil Science) have achieved significant results.

As far as computer hardware and staff requirements are concerned, the Consultant report is somewhat optimistic. Table 1 indicates that the minimal configuration of the computer system should include:

3-200 M bytes disc memory
2-800/1600 bpi magnetic tape drives
1-600 lpm printer
2 key to tape data preparation units.

It should also have system software including: virtual storage operating system, data base management system, compilers for FORTRAN, PL-1, COBOL and BASIC languages.

The staff required for the normal functioning of the computer system should include:

1 earth-science-minded scientists
2 computer-minded earth scientists
1 system software programmer
1 application software programmer
1 computer hardware service person
1 computer operator
2 data preparation operators.

This staff will be in a position to perform some routine calculations for other GEMS activities.

Addendum:

Finally, we submit for consideration to the Expert Group Meeting the following opinion:

(1) We accept in principle the basic theses of the Consultants report.
(2) We propose to UNEP to take steps to establish the

system at level 4.

(3) We recommend that working groups of UNEP be set up to handle the following issues:

(a) mathematical modelling for determining the link "soil/land productivity" and for prediction of changes in land and soil;
(b) software - algorithms and programs for input, data handling data analysis and decision-making;
(c) working out recommendations on land use and technologies for increasing laird productivity and preventing soil degradation.

(4) We propose that support should be provided for development of three pilot projects for the three hierarchical levels (2,3 and 4) in two countries and the UNEP.

TABLE 1

COUNTRY	CLIMATIC	SOIL	BIOLO-GICAL	AGRO-TECHN.	SOCIO-ECON.	TOTAL	UNIT
ETHERLANDS	$4,0.10^4$	$4,0.10^8$	$4,0.70^6$	$4,0.10^6$	$4,0.10^2$	$4,1.10^8$ $8,1.10^{10}$	rec byte
ULGARIA	$1,1.10^5$	$1,1.10^7$	$1,1.10^7$	$1,1.10^3$	$1,1.10^3$	$3,3.10^{10}_9$ $4,4.10^9$	rec byte
LGERIA	$2,2.10^4$	$2,2.10^6$	$2,2.10^6$	$2,2.10^6$	$2,2.10^4$	$6,6.10^6_8$ $6,2.10^8$	rec byte
NEP	$1,3.10^6$	$1,3.10^6$	$1,3.10^6$	$1,3.10^6$	$1,3.10^6$	$6,7.10^{10}_8$ $4,0.10^8$	rec byte

$100,000\ km^2$ = Bulgaria

At a later stage of the meeting Dr. Sadovski made some further comments which are useful to include with his original comments.

Question 1: What is the "monitoring"? Opinion: It is a process which includes observation, prediction and control.

Question 2: What type of system has to be decentralized or centralized with a very big computer centre? Opinion: The system should be hierarchical and distributed with medium size computer facilities in UNEP.

Question 3: Whether the soil pollution should be considered together with soil degradation and other points? Opinion: Yes. It has to be included for monitoring.

Addendum: In addition to the topics on page 7B of the Consultant report we want to put the following:

7.7.11 Models of "land/soil-productivity", US $ 200 000 (over 4 years)

7.7.12 Models for prediction of changes in land and soil. US $ 150 000 (over 3 years)

On page 83 with the list of organizations - sources of high-quality software don't forget: Rothamstead Experimental Station, Harpenden, England; Academy of Sciences of USSR - Novosibirsk; North Carolina State University, USA.

Purpose: The global land/soil monitoring system (GLSMS) has the purpose to establish an international information system for prediction and control of:

a) The critical environmental problems related to agriculture and land use.
b) the response of terrestrial ecosystems to anthropogenic pressures.

It is intended to fulfill the following tasks:
1. Collection of data for land and soil.
2. Data handling and data analysis.
3. Use of those data by UN institutions and preparing recommendations to the governments for decision-making about land use, land productivity, soil degradation and dessertification.

7.3.3 Comments by Dr. V. Rozhokov

The project under consideration deals with an important aspect of monitoring. The implementation of the set objectives to a considerable extent determines the solution realization of its main problems. However, strictly speaking, the document cannot be considered a project in technical sense but rather as a program and a basis for making the project.

In this case, it is advisable to retain the term "soil and land monitoring" in the title of the project. We agree with suggestions which have been already made by our colleagues.

Suggestions to the Project

1. It is necessary to provide a general structure of monitoring objectives and to suggest a detailed structure (model) of data.

Obviously, the structure of data should be a network one. The unified system of classification and coding of attributes and methods should be used as a language of communication between different countries. It should include both general input formats and information exchange formats.

The FAO system may be used as a basis to be enlarged and updated in accordance with similar systems in Canada and especially in the USSR since they have the greatest variety of soils and weather conditions.

2. The concept of data should be specified. They should be distinguished in accordance with the purpose and level of the reliability and type as: raw, reference and standard to meet the CODATA requirements where the International Society of Soil Scientists has its section. Finally, there is a necessity to agree upon the scales of attributes through which these data will be presented. It is advisable to use only nominal and ordinal scales, more rarely - the ratio scale. The ration scale should express also all changes registered by monitoring. It will permit to exclude the problems of compatibility of measuring scales as well as a number of problems associated with classified information.

3. The ideology of the required information system is the ideology and structure of distributed and integrated data bases in a hierarchical system. All this should find its reflection in the project.

4. With regard to program packages and database control systems we should discuss them with experts with special emphasis on the objectives required rather than on the programs. At present we submit two proposals: (i) to change the point of view presented in the project under discussion and instead orientation on one software source to announce a competition for the development of such packages or better for individual modules; (ii) to improve module system structure in accordance with suggestions presented by Messrs Kalenski, Sadovski and our suggestions we are going to present.

5. The project should include recommendations on the principles of observations; they can be:

statistical (in general case they can be stochastic for monitoring) but often determinated ones. Statistics are a sampling method and when we can use a uniform or

randomized sampling we should give at least a rough type of sampling stratification etc.

In the case of a determinated approach an expert analysis is required; and certain methods should be recommended as well as a clear-cut definition of the set of indications having an absolute character and not requiring analysis.

The project concentrates much on the main factors of degradation. A further precise definition of a number of aspects is necessary and we have to do it tomorrow.

In conclusion it should be remembered that the first version of the program of soil/land monitoring was suggested in 1978 by Prof. V.A. Kovda.

Soviet scientists have vast experience in the problems discussed and UNEP can make use of it in the future. Soviet scientific research institutes can be used as a base for solving a wide range of problems.

7.3.4 Comments by Dr. O. Areola (Nigeria)

Having gone through the Consultants Report on the Global Land/Soil Monitoring System, I think there are three questions one might ask in appraising the report. First, is the proposed system feasible? Second, is it useful, will it serve any useful purpose? Third, is the system workable?

With regard to the first question, the Consultants have shown clearly that the system is technically and scientifically feasible. They have identified the various dimensions of the project and made a specific proposals for dealing with the technical and conceptual problems involved.

Is the system useful? There is no doubt that the proposed system would serve some useful purpose. The usefulness may not be very obvious to developed countries with well-established data gathering systems. Coming from a developing country, I know that the proposed monitoring system could have very positive effects in encouraging many countries to develop their environmental data gathering systems. However, to ensure that the desired effects are realized, it is important to give specific roles or tasks to individual countries or national institutions. Unless this is done, there is a distinct possibility that some countries, especially the poorer ones, would simply shelve activities at the local level and depend solely on the Global Land/Soil Monitoring System. That would be an undesirable effect of the system. Thus, it is

necessary to apportion specific responsibilities to individual countries either in terms of the supply of inputs to the system and/or in terms of follow-up activities.

Is the proposed system workable? We do not know yet; and I believe that the main purpose of this expert group meeting is to draw up a strategy for testing the workability of the system. There is clearly a need to have a pilot project to test the practicability of the system. The ingredients for carrying out such a pilot project are already in the Consultants' Report. Chapter 3 of the report lists possible attributes and systems of classification and evaluations for the various items to be included in the monitoring system. These were obtained from studies carried out by the FAO and other UN agencies and they provide a useful starting point for testing the monitoring system. The pilot project should cover at least two "test sites", on in the developed industrialized world and one in the less-developed part where the data gathering systems are not quite as developed.

In arriving at the list of attributes and objectives of the monitoring system, it may be necessary to subdivide the world into zones as the major environmental issues and problems differ from one part of the world to another. Also, different agencies may be needed to examine these issues and problems in different parts of the world. I do not think that a single agency can cope with the work. In any case, there is a tendency for these international agencies to specialize in specific areas of the world.

7.3.5 Dr. L. Venkataratnam (India)

It appears to me that this report is a comprehensive collection of data available mostly in the countries best known to the consultants and from libraries of UNEP.

I would like to comment regarding the analysis of data input. I feel that the peculiarities of the tropical countries one to be taken into consideration. There should be a comprehensive land use classification which should be acceptable to various countries irrespective of their socio-economic conditions.

Regarding the climatic factor, monsoonal climate has to be given much consideration. The limitation of monsoon is that it is very difficult to get good data during main agricultural season for monitoring purposes.

Soil monitoring is of considerable importance to a developing country like India where one region or the other is always affected by droughts, floods, cyclones etc. It may be pertinent to add here that India is covered by more than 200 Landsat scenes and is going to have its own remote sensing satellite in the orbit by 1986.

I would like to stress the importance of practical application of whole monitoring system which has to be perfected before its implementation in various countries. For instance, ground (field) data collection methodology has to be developed as the field data forms as input for GEMS Exchanger. This would be in addition to the possible use of satellite imagery which forms the only data base in several under-developed countries.

Regarding the statistics module, time series is important for monitoring purpose. For example, in the case of satellite data, the reflectance values of the same land cover or soil class change with the season.

It is also essential that some of the organizations in various countries have to be identified and added to the lists given by the consultants in pages 82 and 83 (Appendix 4 and 5). For instance, my own organization (NRSA) is at presently capable of collection of ground, airborne and satellite (Landsat, Metsat) data, Analysis facilities (visual and computer), storage (data bank), retrieval and distribution in addition to scientific personnel (Applications and software).

7.3.6 Comments by Dr. R. Arnold, USA

Identify issues arising from the report.

I am not a computer expert but I am impressed with the logic of the information system proposed. It appears to be flexible enough to satisfy most needs of data storage, data manipulation and presentation of results. For global overview the fourth level (10km x 10km) reasonable to me because it can provide generalized information without compromising specific details used for state or level planning.

Disaggregated data at larger scales is the domain of local jurisdiction and seems not to need such detail for global overviews.

I am much more concerned with the data that we feel should be measured, generalized and stored to assist in providing information about the loss, misuse, or reclamation of soil and land.

If we can agree that an information system similar to the one discussed is reasonably appropriate to handle data, then we come quickly to the need to standardize the criteria and procedures for obtaining acceptable observations.

As a representative of world pedologists I think we want to discuss more among ourselves and much other disciplines the properties that are being used or have been proposed.

A number of soil attributes are quite expensive to obtain even after we reach a specific location, and often are efficient to generalize to the level and cells.

We need to search for a minimum data set to achieve our objectives. For some purposes we may be collecting more information than required for a global view. Most of us work with smaller areas and are trying to solve our own questions - this information is nice to have but not always required for a global overview.

I believe that soil scientists must more rapidly offer additional recommendations on methods of standardizing field data collection. For example, my staff in the USA believe that we cannot easily obtain soil information about desertification as proposed by FAC and currently we have decided not to test that proposal further until, or unless we modify the criteria that have been proposed.

There is a lot of work yet to be done in agreeing on data to collect. We must more rapidly if we want to offer suggestions to international agencies.

7.3.7 S.V. Zonn, Institute of Geography, USSR

The report presented by Dr. Bie on the draft project of criteria of soft/hardware for global land/soil monitoring system is an important one having great significance for the global inventory, monitoring, conservation, protection of land/soils and desertification. However, I would like to make the following constructive comments and suggestions:

(i) All the time we are speaking about the inventory of degradation, desertification and other undesirable effects in the development of soil resources and various farming lands located on them. Undoubtedly this is important, but this creates an impression that mankind only spoils its land resources.

Such emphasis does not reflect what has been done and what is being done by mankind in respect to improvement and raising fertility of soils and land resources.

Therefore, we think that the Report and the draft should be supplemented with the chapter dealing with the problem of "soil degradation or improvement";

(ii) Comments and suggestions are aimed to include into the Report and the draft a chapter on methodology and methods which would present a methodological basis of the draft and methods of both data collection and especially of the principles and their application. To determine soil fertility it is necessary to show how and for what purpose the data on climate, soil properties etc. are collected and used. It is unclear, however, what is the difference between the soil productivity and fertility and how they should be established. These are all important problems of the methods to be employed which would result in the successful implementation of the project.

(iii) It remains unclear how it is possible to start global inventory of soil and land resources at once without verifying the suggested statistical-mathematical calculation of data and without verifying or checking on practice the suggested methods using a number of representative examples covering various weather and climatic conditions typical of the developing countries.

In this respect it would be advisable to verify and check suggested ways and methods in special test areas covering various types of land resources use. We think that these test areas could be used for joint research conducted by a number of countries. Similar test areas in the future could become testing grounds for practical work to be carried out by the representatives of the developing countries.

(iv) The report placed insufficient emphasis on remote sensing methods whereas these methods should be main ones if we want to carry out the collection of materials quickly together with land resources monitoring and soil degradation.

Here I would like, first of all, to make a comment on the Report. It says that the Soviet Union does not provide information on remote sensing. This is not exactly so since it was today that I have handed an Atlas of one of the autonomous republics of the USSR containing satellite pictures over to Prof. I. Garbouchev. I would like also to underline the significance of a joint development of methods for

visual and computerized deciphering of aerial and satellite materials.

A joint development of these methods initiated by NASA in the US and Intercosmos in the USSR in the field of geography was very useful and productive. We hope that joint developments on this project would be beneficial. The Institute of Geography of the USSR Academy of Sciences is ready to cooperate in this direction.

7.3.7 Comments by Dr. K.G. Tejwani

1. I would like to comment on the aspect of data base of the proposal and emphasize the viewpoint of users and developing countries.

2. With respect to the data base we should use and retrieve information which is meaningful and useful for immediate application.

3. It appears it is easy to agree that their is need of global land/soil monitoring. While we agree to this we should make certain that we carry the developing countries along with us. As far as the developed countries are concerned they already have their own monitoring systems and global scale monitoring will be an additional tool for them. As far as the developing countries are concerned, some of them may not even have topographic maps, leave aside any data base. For them global monitoring of land/soil on global scale has no meaning. If we wish them to benefit from this monitoring system we should make certain that they start generating land/soil information firstly for their use and secondly for participating in the global monitoring system.

4. Further in developing countries today, land degradation is a major issue - so while we are developing the global land/soil monitoring system, we must make certain that monitoring of land degradation receives prior attention because this information can be immediately used.

5. We must develop a system which gives information about conditions in watersheds, as land-water-plant systems will need to be managed in watershed basis.

6. As the monitoring proposal system is untried, it is essential to take up three pilot principles at three scales namely global scale, national scale and international or watershed or project scale.

7.3.9 Comments by N.F. Glazovsky and I.A. Pachepsky

(Institute of Soil Science and Agricultural Chemistry, USSR Academy of Sciences).

It should be acknowledged that UNEP's consultants have made great and useful contributions to the elaboration of the global soil monitoring system.

We propose to supplement the Consultants' report with the following recommendations to UNEP (in addition to those made by the consultants):

1. It is necessary to envisage monitoring not only of soil degradation but also of soil improvement. Therefore, a special entry in the report should contain the following recommendation to UNEP: "A team of qualified experts should determine the criteria for the assessment of soil improvement".

2. In monitoring soil productivity the biological parameters should include not only agricultural crops but also natural vegetation (forests, rangelands, tundra etc.).

Therefore, expansion of work on the assessment of biological parameters envisaged in the Consultant' report should also the natural vegetation.

3. The Consultants' report should be supplemented by the recommendation to UNEP: "Different systems of criteria for monitoring soil degradation and improvement should be specified depending on the selected scale of monitoring".

4. Mathematical models of productivity of agroconoses and soil fertility can undoubtedly allow us to make a more efficient use of experimental information for monitoring. In this connection, the following recommendation to UNEP should be included into the Consultants' report: "UNEP should encourage investigations into mathematical modelling of productivity of agrococnoses and soil fertility".

5. In realizing the Project it is expedient to take into consideration the experience of monitoring ecosystems and their biological productivity accumulated in the USSR and specifically at the Institute of Soil Science and Agricultural Chemistry, USSR Academy of Sciences.

7.3.10 Comments by J. Thie, (Canada)

Comments are based on a review of the report by Dr. I. Crain, Chief, Canada Land Data System and J. Thie. We support the initiatives taken by UNEP in proposing a

Global Land/Soil Monitoring System. The report prepared by the consultants provide a good starting point for the design of a system. We are interested in sharing and contributing to the development based on our long standing experience in spatial data processing. We have now operated the Canada Land Data System (CLDS) and the Canadian Soil Information System (CanSIS) for more than a decade. Both systems are used for tasks (monitoring land use change, land quality at national, regional and local levels) which are similar to the objectives proposed for the global system.

Our comments fall in two areas: 1) Purpose of System, by whom and for what is the information to be used. 2) Technical and implementation considerations.

1. Purpose: An effective systems design will depend on the clarity by which objectives, users, and projected user of the information can be defined. Although the present report refers to respective soil policies and land resource issues, relatively little attention is given to ultimate use of the information. As a result, the proposed system tends to emphasize data gathering, storage and analysis at a greater level of detail (and at a greater cost) than appears to be required.

This weakness can be adjusted through adding a chapter on Users and Uses, which would identify specific user agencies, and give examples of specific decision processes at the international level and their information needs.

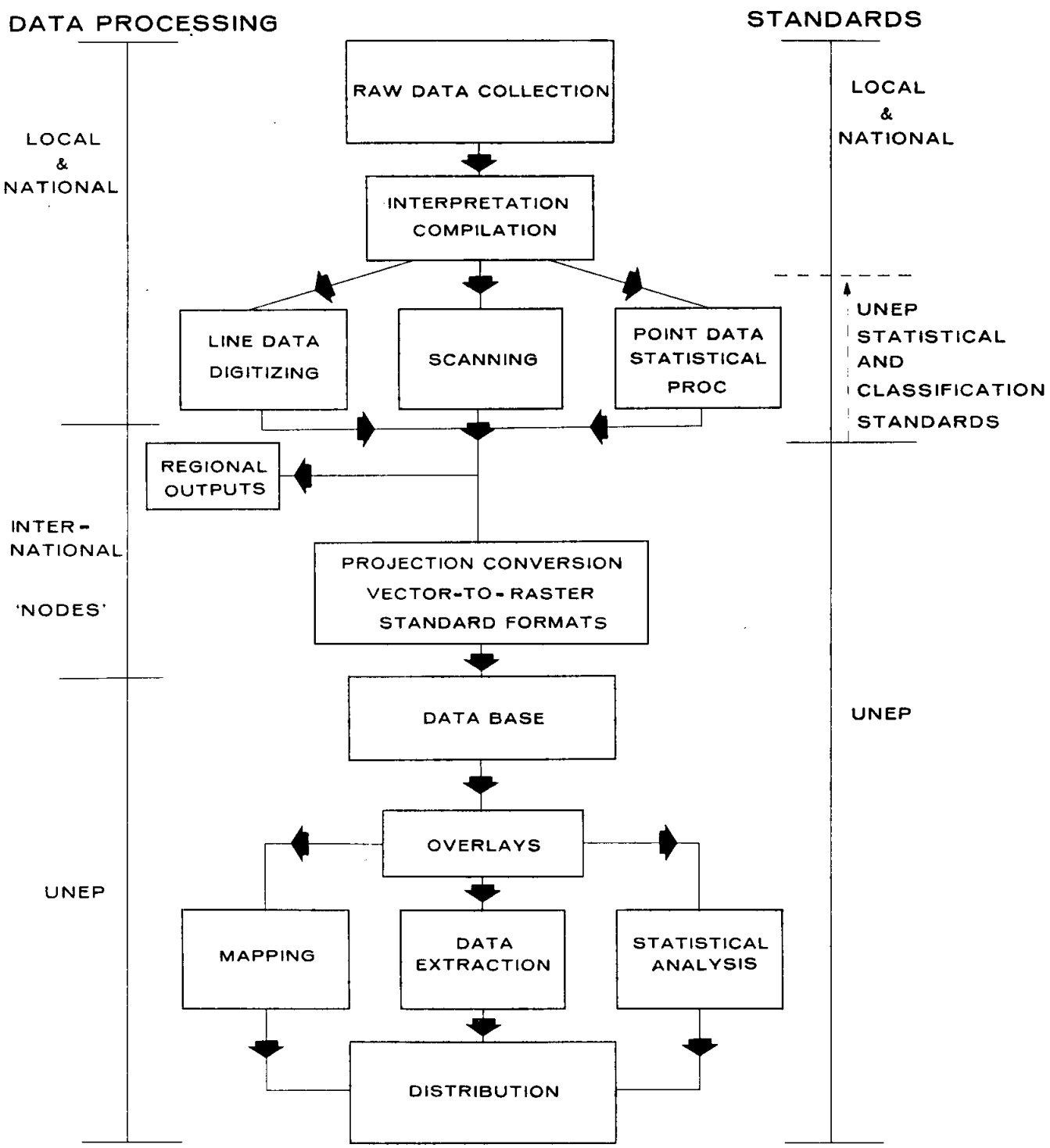
Technical and implementation considerations:

The technical design put forward in Fig. 5 is basically reasonable as a concept for the overall system, although it need not be all in one computer. There are some discrepancies between the text and the diagrams. They have been discussed with the Consultant and can easily be rectified.

We suggest that the UNEP system should consist of:

1) Maintenance of a central data base of gridded data.
2) Statistical data analysis software for data interpretation on a region scale.
3) Overlay and output display capabilities.
4) Selection , data retrieval capabilities to obtain digital data for users.

Data suppliers should perform the other functions, perhaps through a network of 'nodal' establishments in various countries. These functions are:


DATA PROCESSING
STANDARDS
RAW DATA COLLECTION
INTERPRETATION COMPILATION
LINE DATA DIGITIZING
SCANNING
POINT DATA STATISTICAL PROC
REGIONAL OUTPUTS
PROJECTION CONVERSION VECTOR-TO-RASTER STANDARD FORMATS
DATA BASE
OVERLAYS
MAPPING
DATA EXTRACTION
STATISTICAL ANALYSIS
DISTRIBUTION
LOCAL & NATIONAL
INTER-NATIONAL 'NODES'
UNEP
LOCAL & NATIONAL
UNEP STATISTICAL AND CLASSIFICATION STANDARDS
UNEP

1) Data gathering and compilation
2) Digitizing in point, polygon or raster format as required by internal and/or local needs.
3) Conversion of data to standard grid format required by UNEP.
4) Supply of appropriately annotated digital data (gridded) to UNEP for integration into the data base.

The system conceptual diagram would then look like the figure on page 25.

Cost: The proposed hardware configuration does not seem to match the proposed system description. In general we feel that cost for software, hardware and operation are underestimated. The proposed mini appears to be too small; disc storage seems inadequate, and more tape drives are needed as well as scanners and digitizers.

Implementation: Rather than one central system, we prefer to see a distributed system with various nodes around the world.

Almost all the proposed components of the system exist in Canada in the Canada Land Data System, CanSIS, Stats Can or Canada Centre for Remote Sensing (CCRS). A standard data transfer format has been developed between these systems for data exchange. As a result we can effectively do all the preliminary stages - scanning, digitizing, encoding projection conversion, vector to raster conversion, supply of data in gridded formats, satellite image analysis, overlay and map output functions.

Canada could feasibly be an interim host for a global monitoring system and through its existing capabilities provide a relatively low cost opportunity to test aspects of system implementation and carry out pilot studies. It could with operational demonstration projects to improve the dialogue with users and test end uses of the anticipated data base.

8. WORKSHOP DISCUSSIONS AND RECOMMENDATIONS

8.1 General

After discussion of consultant reports, background papers and comments by panel members, detailed discussions were continued in three workshops:

1) Workshop on Minimum Data Sets - Dr. Arnold, Chairman
2) Workshop on Characteristics of Input Data and realization of the Data Handling System. Dr. Sadovski, Chairman.

3) Workshop on Implementation of the System. Dr. Tejwani, Chairman.

For each workshop a terms of reference and a set of questions were prepared taking into account issues raised in background papers, comments and the Consultant report. Workshop discussion took most of the 3rd day of the Conference. Chairmen and rapporteurs reported the results of the workshop session on the morning of the 4th day in a plenary session. Where required they were elaborated on by other members of the workshops. Comments made by the plenary session were noted by the chairmen during the discussion and are incorporated in the final workshop reports. These final reports were reviewed in the closing plenary session, modified when required and approved.

8.2 REPORT OF WORKING GROUP I - MINIMUM DATA SETS

Our committee of about 18 people discussed many aspects of Chapter 3 of the Consultant report. There was a very open and frank sharing of opinions and concerns about the data sources and the parameters mentioned in the report.

We were hampered somewhat by not having a copy of the FAO documents that describe the methodology and definitions used in their work. It would have been of great benefit to us if these documents had been available at this meeting.

As we talked about the approaches to obtain data and the validity of parameters it became very clear to us that a systematic elaboration of the rationale or the principles underlying the selection of criteria and parameters was needed if we were to come to reasonable conclusions. Nevertheless, we covered the main item in chapter 3. In general we agree with the consultants' recommendations and have made an attempt to supplement their conclusions.

Our deliberations and recommendations are as follows:

1) Land use. It is very important that a multicategoric scheme of land types be presented and evaluated by participants and others throughout the world.

   We recommend that a scheme of land types be prepared with definitions of the classes in each category. We believe that there should be 6 to 8 classes at the highest level and should include as a minimum: agricultural crop land, range or grasslands utilized primarily by livestock, forested land, industrial land, settlements such as cities, villages, etc. and perhaps including transportation and probably water bodies recognizable at an acceptable scale of observation, and waste or barren land. These classes should be subdivided to enable data collection to recognize and aggregate their results. Mutually exclusive definitions are necessary for testing and for final agreement.

We further recommended that UNEP in cooperation with FAO and other experts draft such a scheme for testing within 6 months and a final conclusion to be made within one year.

2) Land Productivity. The participants struggled a long time with the concepts currently being used to estimate or measure productivity. It is obviously a very complex subject and as scientists we were not able to offer suggestions that are universally acceptable.

a) Climalogical characteristics. We concur with the consultants in that FAO criteria are satisfactory for testing on a global scale.. It appears that most climatic data is available and only calculations and preparation of maps and definitions is required as a first step. The climatic zones would provide us with regions or zones that have similar characteristics of radiant energy and moisture. These zones may be a convenient device for describing important landscape, processes, vegetative potential and kind of soils.

We recommend that UNEP encourage and support FAO-WMO and other organizations in completing climatological characteristics of the world. It is important that nations have an opportunity to be involved in the work to evaluate the climate zones of interest to them. It would be desirable to complete this work as soon as possible, certainly within one year.

b) Biological Characteristics. We needed to be more familiar with the FAO methodology for estimating potential productivity of crops (FAO, 1978). We therefore, generally agree with the consultants, that the FAO methodology be tested and extended to other crops.

We believe that the selection of crops of worldwide distribution is an important principle. In addition we feel that natural vegetation including forests and grasslands need to be considered. We also suggest that other crops should be included for these agroecological zones where the crop or vegetation is a major basis for the agricultural economy in that zone.

We recommend that the FAO methodology be expanded or extended to other crops, to forests and grasslands, and to other crops relevant in specific ecological zones.

c) Soil Characteristics. We had many excellent opinions concerning soil characteristics. We agreed that only those features significant to a zone need be considered. In some areas or zones characteristics other than those specified by FAO likely should be included.

We feel that reoccuring events, such as flooding, and catastrophic events, such as deposition of volcanic ash,

could be handled or considered with the characteristics of degradation and regradation rather than with the soil attributes.

We agreed that the FAO/UNESCO World Soil Map should serve as the basis for describing the composition and distribution of soil characteristics relevant to biomass production and other uses of land. Because of the limited experience of most participants in using or evaluating the FAO methodology of soil productivity, we feel several areas he selected for additional testing. Such areas may be in the USSR and USA and would permit more exchange of information about the merits of such work for global assessment.

We do not yet have much experience in presenting soil data sets for the FAO soil map units in an agro-ecological zone as defined by the FAO methods. Some soil factors important for forest and range productivity likely are not included in the current list of soil characteristics and needs further elaboration.

We recommend that UNEP consider ways to extend the list of attributes and methods that will permit assessment of soil productivity for trees/grasses, and other crops of special interest.

d) Socio-economic Factors. Because most of us are not economists we did not make many judgements about these factors. We feel, however, that more classes of the factors may be needed and not just those of high and low.

Methods of such data collection may be very difficult. Land holding patterns could be cross-checked by remote sensing techniques but many other factors likely depend on the availability of national and FAO statistics and census reports.

We concur with the consultants' recommendation that work on definitions and methodology should be stimulated and proposals for testing and evaluation be prepared as soon as possible.

Conclusion about land productivity

There are many complex models of soil productivity being developed and evaluated throughout the world but for global assessment a relatively simple model appears to be needed. Such measures of productivity must be consistent with either available data or utilize easily obtained information. We feel that out of the existing methods and procedures for measuring and monitoring soil productivity, one should be selected that is appropriate and feasible, both scientifically and financially, for use by UNEP and other international agencies.

This we consider as very urgent and we recommend that UNEP and FAO prepare a document on definition methods, and rationale (principles) dealing with soil productivity for the purpose of global land/soil monitoring as soon as possible. If this were done in 6 to 8 months it could be field tested by interested agencies and institutions and final modification and adoption take place in perhaps 18 to 24 months.

3) Soil Degradation. There is general agreement on soil degradation processes and many of the factors influencing the process as mentioned in the report. We did not discuss these in detail because of the upcoming meeting to be held in Rome to decide on an acceptable methodology. We did feel that a number of features suggested for measurement may be very site specific time consuming, and expensive to measure. Thus there may be a danger of loss of information when generalized for a global overview.

Our recommendation is to wait for the results of the FAO meeting on soil degradation. We did discuss placing catastrophic events such as flooding, volcanic ash fall, prolonged drought, and so forth in this section because such processes or events are important in soil productivity and land use.

We noted a lack of measures or attributes associated with land/soil regradation or improvement. There is a lot of interest and concern about the loss of productive land but we also need to consider the development and gain of productive land in those regions where such processes are possible.

We recommend that UNEP encourage FAO and other agencies or institutions to prepare draft documents about sil/land improvement that would be relevant for a global overview of such changes.

Summary

We were not able to suggest minimum data sets for the global assessment of land types, soil/land productivity, or changes of land qualities (degradation, desertification, improvement).

We believe that pilot studies using existing methods for observations (FAO, others) could serve as data for calculating and evaluating information content. Other mathematical methods should permit us to select those attributes and characteristics that provide meaningful results and yet constitute a minimum number. In all of our deliberations we could only focus on lists of attributes and had no satisfactory ways to test or to select a real minimum data set.

We recommend that a major purpose or goal of other UNEP sponsored or supported activities should be to develop strategic for preparing minimum data sets relevant for global assessments. Sensitivity methods such as principal component or vector analysis may be helpful in evaluating such results.

Our final recommendation is perhaps our most important one to the sponsors.

We recommend that UNEP undertake the preparation of a Project Proposal for a global land/soil monitoring system during 1983. The results of the consultants' report and deliberations of this meeting in Kiev should serve as background information to assist those who would prepare a formal project proposal.

8.3 Report of Working Group on Characteristics of input data and realization of the data handling system - software/hardware

1. The Working Group 2 accepts in principle the basic theses of the consultants' report (CR), especially Chapter 5.

2. We propose some requirements to the data base:

   (a) the data base should include three types of information: basic files - climatic data, soil data, biological data (vegetation), land use and agrotechnical data, socio-economic data; reference files (parameters, standard data) temporary files (intermediate data).

   (b) It should be able to handle several types of data (nominal, ordinal, ration, absolute, etc.).

   (c) The categories of data to be accepted by different modules should be:

   DIGITIZER - point, line, polygon data
   INPUTER - alphanumerical data
   GEMS EXCHANGER - alphanumerical data
   REMOTE IMAGE ANALYZER - raster images data.

   (d) Standard formats and procedures have to be developed for preparing the data at national and regional centres in a compatible form acceptable to the central processing system.

   (e) The Data Base Management System (DEMS) should be able to build and maintain several structures of data (networks, trees, lists and files with different type of records).

3. The Modular System must be opened for including new modules. It should work in interactive mode.

4. We suggest some changes in the module CLASSIFICATION and its submodules (see Figures).

5. A new module USER INTERPRETATION is proposed to the system, which will include several submodules such as:

   LAND PRODUCTIVITY EVALUATION
   LAND USE MONITORING
   SOIL DEGRADATION ASSESSMENT etc.

   Here is the logical place of the REPORT GENERATOR module, which has to be taken out of STATISTICS.

6. We consider essential the development of models describing the relationships between input characteristics and land productivity soil degradation characteristics for implementation of the USER INTERPRETATION module.

7. The choice of the application software (program packages) must be based on written specifications and evaluation made by experts. For this purpose a special UNEP task force (working group on software) is necessary to be set up.

8. We propose the following configuration of the computer system for GLSMS:

   Minimal

Qty	Type	Prices
1	512 K Bytes (min) 16 Bit (or more) minicomputer	
3	200 M Bytes (min) disc drive	
3	800/1600 BPI magnetic tape drive	
1	line printer (speed >600 LPM)	
1	colour plotter	
1	interactive colour monitor	
1	graphics screen	
1	digitizing table	
1	scanner	
2	alphanumerical screen w/raster option	
2	CRT terminals	
2	key to tape data preparation unit	

   Option 2 is to be excluded.

9. The staff required for the normal functioning of the monitoring system should include:

   1 earth-science-minded computer scientist
   2 computer-minded earth scientists
   1 system software programmer
   1 computer hardware service person
   2 data preparation operators

   This staff will be in a position to perform some routine calculations for other GEMS activities.

10. We consider the following important system software requirements:

    - operating system with capabilities of virtual storage, multi-programming and time-sharing;
    - built-in data base management system;
    - compilers for several high-level languages;
    - efficient sort/merge routines.

11. some other organizations have to be included in the list with sources of high-quality software, such as:

    - Syberian Branch of the Academy of Sciences of the USSR, Novosibirsk;
    - Rothamstead Experimental Station, Harpenden, England;
    - North Carolina State University, USA
    - Computer Centtre of the Academy of Sciences of the USSR.
    - FAO Remote Sensing Centre.

12. Suggested changes in the module CLASSIFICATION and its sub-modules.

SUBMODULE PROPERTIES SPACE (Part of Classification)

PURPOSE: To create a set of informative properties and exclude non-informative ones (informative role in terms of retaining the structure of the set of objects in the properties space or minimal sets of properties ensuring separation of classes).

OUTPUT: List of properties arranged according to the degree of informative role.

INPUT: Array of objects, number of classes and objects in them.

SUBMODULE DIAGNOS

PURPOSE: Classification of new objects in known classes.

INPUT: Classified objects and rules of decision.

OUTPUT: Numbers of classified objects and classes to which they are related.

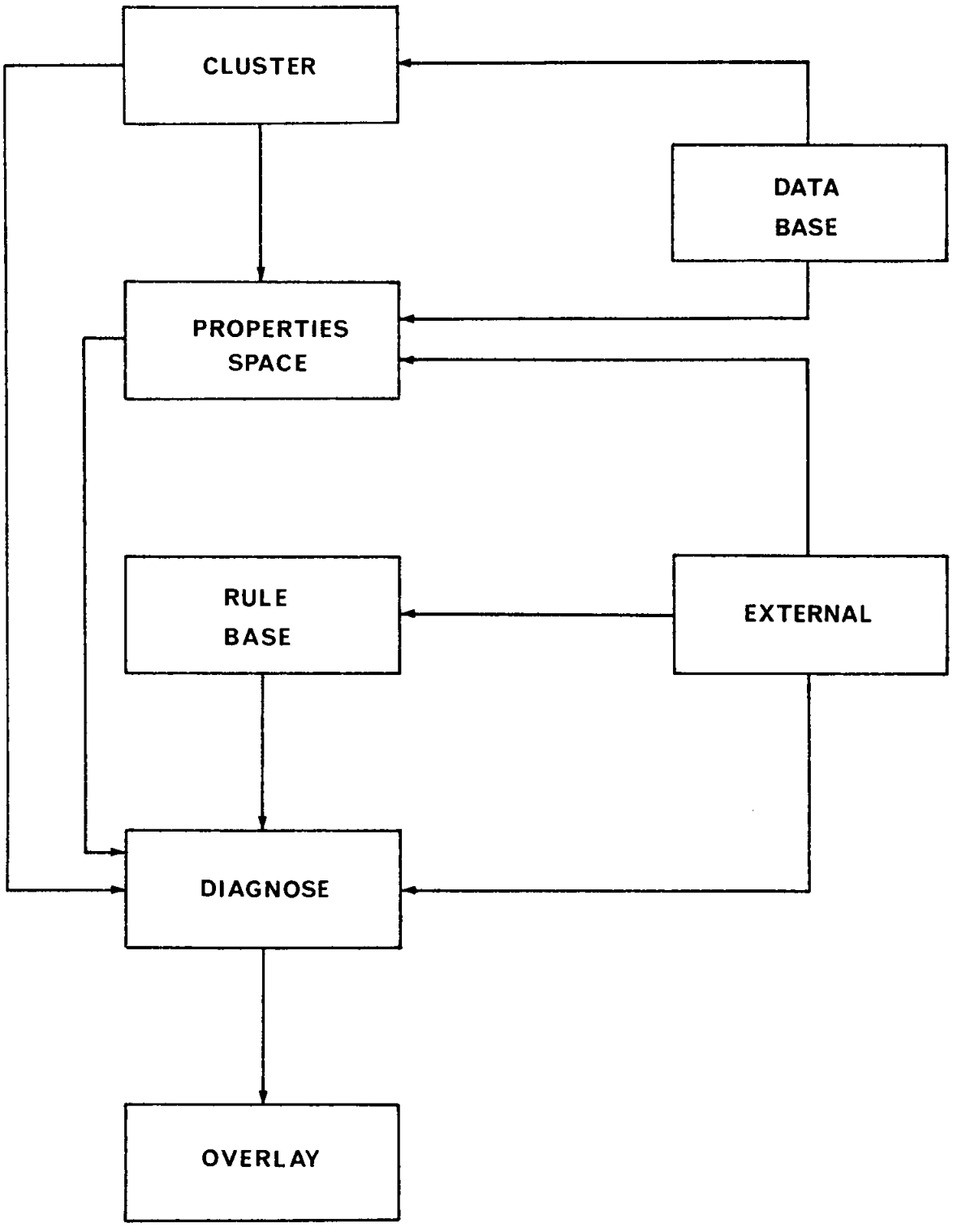
NOTE: 1. The use of discrimination analysis and various estimates on the basis of similarity and distance is included.

2. There may be cases of refusal from classification of the object.

MODULE USER INTERPRETATION

PURPOSE: To allow user to design suitable alphanumeric outputs (tables, reports) and to perform estimation of land productivity, soil degradation (improvement and response) of terrestrial ecosystems to anthropogenic and natural changes in the environment for preparing recommendations to the governments.

SUBMODULES: REPORT GENERATOR
LAND PRODUCTIVITY EVALUATION
LAND USE MONITORING
SOIL DEGRADATION ASSESSMENT, etc.



MODULE: CLASSIFICATION

8.4 Report from Working Group 3: Implementation of the System

Purpose:

The system is primarily for use by the UN and all international agencies facilitate decision making processes with respect to land, soil and renewable resources in general. The level of detail should be such that UNEP will be able to provide sound advisory services to individual countries on resources development and environmental protection.

System Design

a) The group discussed alternative solutions to the system design and felt that the data processing facilities and systems may be centralized.

b) Regarding data collection and preparation in a form that is compatible with the processing system, the group discussed two alternatives:

i) The first alternative is to collect the data in their original form and convey them to the central base for preparation and processing.

The group felt this alternative would involve major logistic problems.

ii) The second alternative is to prepare the data at regional centres and convey them to the central base in compatible form acceptable to the processing system. Since many regional and national data-processing facilities in different parts of the world are available, the group would like to recommend this second alternative.

Regarding the regional centres, they may be brought into existence as the system evolves. It is, perhaps, necessary to add that a common format will have to be worked out to guide the operations of the regional centres if they are to convey compatible data and information to a single processing centre.

Pilot Projects

The general consensus in the discussion at the plenary sessions has been that the proposed Global Land/Soil Monitoring System would need to be tested by means of pilot projects. Since the entire system is to have a global focus, the pilot projects would also need to be undertaken on a global scale or level. The group discussed the number of pilot projects to be undertaken, considering that there is variability in data base from one part of the world to another, the group suggests that 2 projects be set up, one in a region with a well-developed data base and another in a region which does not have such a data base at the moment. The

project should be so located to take account of the complexity of the land use system in each area.

The pilot projects should attempt to achieve the following objectives:

i) Identification of potential data sources.

ii) Evaluation and comparison of methods and sources of data collection and preparation in a form to be compatible with the data processing facilities.

iii) Definition of the minimum data requirements for monitoring land use, land productivity, soil degradation and improvement and desertification.

iv) Establishment of appropriate scales and rules of generalization.

v) Identification of the constraints and needs of working the system as well as the likely benefits and uses of the system.

vi) Further recommendations are needed on soil improvement. The group proposes that a special group of consultants be asked to prepare a pilot project proposals.

Possible Bodies

Climate

1. WMO
2. National Meteorological Services
3. International Research Institute

Soil and Land Use

1. FAO
2. National Soil Survey Organizations
3. International Research Institutes
4. International Society of Soil Science
5. Provincial, State/Regional Soil Survey Organizations
6. Agricultural Forest Universities and Institutions.

Vegetation

1. FAO.
2. UNESCO.
3. National Botanical Survey Organizations.
4. National Forest Services.
5. Agricultural Universities/Forest Institutes.

Costs

The group did not consider this item on its terms of reference as it felt that this is a rather specialized subject which could not be handled in the limited time available. In any case the group felt that reliable cost estimates can not be made until the system design and its various components have been agreed upon.

Members of the group:

Dr. K.G. Tejwani
Dr. O. Areola
Mrs. C. Torres /UNEP/
Dr. L. Venkataratnam
Dr. Pachefsky

8.5 Discussion on Workshop Recommendations

The discussion on workshops result was fairly elaborate. Not all elements of this discussion are reproduced in this report. The following represent the questions and answers for which the involved individuals provided a written record to the rapporteur.

Stein W. Bie's comment to Dr. Noko's statement on report imbalance between soil/land data recommendations and the data system part:

The Consultants have relied heavily on FAO publications on methodological proposals. They assume that these internationally available documents will be consulted by readers of the Report, who then may consider the relevant FAO publications as defacto appendices to the Report.

No such publications exist on the suggested data system side, so that more pages were required to explain this.

Stein Bie: Comments re Discussion on Purpose

The size of cell should not be related to the total area to be covered, but to the intricacy and complexity of land use/natural phenomenon. Even if a 10km x 10km cell is adequate for e.g. Canadian purposes, many tropical countries have small holdings requiring detailed information capabilities in a monitoring system. Thus 10km x 10km may not be too large even on a global cell size.

Comments by Dr. O. Areola on Scale

Talking about scale, I think we should make a distinction between the scale at which we collect data and information and the scale at which the results of data analysis are presented for decision-making. We should follow the principle that guides all survey exercises; that the fieldwork is normally done at a scale greater than that at which the resultant map is produced. For the proposed monitoring system, I believe that the greater the scale of the data gathering framework, the better as this would allow greater freedom in the manipulation and generalization of data.

Comments by Dr. K. Venkataratnam

FAO/UNESCO has got a world soil map on 1:5,000,000 scale and the data collected in the field can be superimposed in this map which may act as Map base. It is economical to collect the data on large scale which can be again generalized according to need i.e. national level monitoring or global monitoring.

Response by Stein Bie to WG 2 (Sadovski)

1. The suggestion of creating a new submodule USER INTERPRETATION in CLASSIFICATION would seem superfluous, as submodule RULE-BASED contain the necessary functions to achieve land use recommendation etc.

2. It is important that software development be not fragmented. Programs should be developed by one organization, possibly after a competition.. This main contractor may be helped by sub-contractors and UNEP may wish to take this into account when awarding the contract.

9. APPROVAL OF RECOMMENDATIONS

In the closing session of the meeting the expert panel discussed and approved the various recommendations.

The first and most important recommendation is as follows.

1) The Expert panel recommends that UNEP undertake the preparation of a formal project proposal for a global land/soil monitoring system during 1983. The results of the Consultants report and the deliberation of the expert panel have indicated the technical feasibility and reiterated the need for a monitoring system. The results of this meeting should serve as background information to those who will be charged with the preparation of a formal project proposal.

   The conference considers it important to further encourage the activity aimed at agricultural land conservation for securing the growing demands in food. It recommends UNEP in the framework of the global soil policy to work out measures on special protection of unique soil complexes and use them exclusively for food production.

2) The second group of recommendations concerns the technical and implementation aspects of the proposed system.

   They are reflected in the three working groups' reports outlined earlier. The suggestions and recommendations of the working groups were approved in the plenary session. The expert panel recommends that these (see 1 above) from the framework for the development of a formal proposal.

3) The conference expressed its belief that on essential precondition for a solution of environmental problems includes the struggle for peace disarmament and detente. The meeting expressed its support for the Nairobi Declaration (1982) emphasizing that the atmosphere of peace and security on the international scale, free from the threats of any war, especially a nuclear one, and expenditures of intellectual and natural resources on weapons, free from apartheid, and all forms of discrimination, race segregation, colonial and other forms of oppression and foreign domination would have a significant and favourable impact on the environment surrounding man.

APPENDIX A. OPENING REMARKS

A.1. Address of Prof. I.P. Garbouchev Chairman of Soil and Water Task Force of the EMS/UNEP

Mr. Chairman, Dear friends, Ladies and gentlemen

I was greatly honoured to represent the Executive Director of UNEP at this Expert Group Meeting and to convey his greetings and best wishes to the participants for a successful achievements at this forum.

First of all, I would like on behalf of the Executive Director, to extend UNPE Secretariat's gratitude to the Government of the USSR and particularly to the Government of the Ukrainian SSR who have kindly accepted to host this meeting in the capital of the Republic, the City of Kiev. A special gratitude is also due to the staff of UNEPCOM, who was carrying out all technical arrangements necessary for organizing this Expert Group Meeting.

As you were informed by a letter of last May, the topic of this Expert Group Meeting is a constructive discussion of a Working Paper on Criteria/soft-hardware for a Global Land and Soil Monitoring System, as a part of the GEMS, responsibility to which is endorced by the General Assembly of UN to UNEP Secretariat.

You have also received two documents:

(i) Draft World Soil Policy, definition and objectives, and
(ii) Draft-Development of the Plan of Action to implement a World Soil Policy.

It is worth informing you that the 10th UNEP Governing Council session, last May, by the decision GC 10/14-III endorced the World Soil Policy - definition and objectives and requested the Executive Director of UNEP to transmit the second document to the Governments and International organizations for comments, so that the last draft of the Plan of Action for World Soil Policy implementation be considered by the 11th UNEP Governing Council session, 1983.

In this respect, our Expert's Meeting is fully on line with the above quoted UNEP Governing Council's decision and document UNEP GC 10/5 Add.4, para. "g" which reads: "to monitor changes in soil quantity and quality and in land use". Our meeting is also related to the objectives of W.S.P., particularly to the actions required to implement the W.S.P. at international level, para. X, small "b", which reads: "Develop common methodologics for monitoring soil degradation and changes in land use".

To this end I would like to take this opportunity and to draw your attention to the draft "Development of the Plan of Action to implement a W.S.P., program 2.3.1.6 "Criteria and Methodology for Global Soil and Land Resources Monitoring", which was adopted by

the Expert Group Meeting on W.S.P. and Plan of Action for its implementation, last March in Geneva. I would rather not waste time in repeating the background, five objectives and output at the program, as it was defined by the Expert's Meeting in March this year.

There are few other programs, which are also closely related to above marked program, such as:
2.3.1.2. Updating FAO/UNESCO Soil Map of the World.
2.3.1.3. International Methodology for Land Evaluation.
2.3.2.2. Field Projects on Soil Inventory, Mapping, Monitoring, Classification, etc.

In front of us in addition to these documents is also a Working Paper developed by two UNEP's consultants, who are well-known as active members of the Working Group on Soil Information Systems of ISSS, Dr. Stein Bie and Dr. J. Lamp, attending this Meeting.

In fact, the World Soil Policy as a definition and objectives were endorsed by the 10th UNEP Governing Council for implementation. It would be impossible, both at international and national levels, without establishment of a compatible system for Global Monitoring of changes in the quantity, quality and use of land and soils all over the world.

In my opinion, this Meeting should formulate recommendation to the Executive Director of UNEP on the criteria for quantitative and qualitative assessment of land and soils available and methodology as well, for collecting the information periodically, capable for a respective computerized analyses.

This subject was already broadly presented by me, at the last meeting of the Working Group on Soil Information Systems of ISSS, 14-17 September 1981 in Paris and briefly discussed by the participants.

By now we have as it was already been mentioned, a Working Document and official decision of the 10th UNEP Governing Council on W.S.P. which will, no doubt, serve as a sound base for the discussion at this Expert's Meeting.

With this brief introduction I would like to express the firm belief of UNEP Secretariat that the Expert Group Meeting held in Kiev will be a very successful one and will further outline the criteria and methodology of a Global Land and Soil Monitoring System as a part of GEMS.

I am taking the liberty once again to thank Ukrainian SSR authorities for the efforts made to organize this Expert's Meeting in the beautiful capital of the Republic, the City of Kiev, and on behalf of the Executive Director of UNEP to thank all of you attending the Meeting and to express best wishes for further progress in our soil scientists' mission.

Thank you.

A.2. Address by Mrs. D.I. Protsenko, Chairperson of the Ukrainian SSR State Committee on Nature Protection.

With satisfaction de we underline the fact that the UNEP pays considerable attention to one of the most urgent problems facing mankind, i.e. the problem of soil protection and improving soil fertility.

We are especially grateful to the Secretariat of the UNEP and to Professor Garbouchev who exerted much effort to organize the present meeting.

We consider the choice of Kiev as a venue for the Conference as recognition of the successes of the Ikrainian SSR in the solution of this problem.

The Soviet Ukraine is an economically developed country, possessing powerful industry, power engineering, transport, and intensive agriculture. Taking all this into account we place a special emphasis on a efficient utilization of soil resources. Our state carries out systematic control over the use of land by enterprises, organizations and individual citizens and provides thus reliable protection. A long-term complex program of improving soil fertility has been developed in the republic and the General Project of Anti-erosion Measures is being successfully implemented. Over many years the Ukraine concentrated many efforts on field protection and aforestation which resulted in the creation of a closed network of forest green belts.

Recultivation of lands which were reclaimed from minerals extraction use added much to land conservation.

Much attention is given to proper storage and application of fertilizers and chemical means of plant protection. We do not use highly toxic chemical substances harmful for man's health and environment in our agriculture. The scope of of the application of biological means of plant plantation has been considerably widened. Large-scale work is being carried out in the Ukraine in the field of land reclamation.

The implementation of land protection and conservation measures on a planned basis has made it possible to improve the structure of lands, to raise productivity.

The protection and improvement of environment including the protection of land should become a strategic issue of the state policy of all countries.

Preservation of the natural wealth for future generations can become possible under conditions of lasting peace on earth, constructive cooperation and mutual understanding between peoples

and states. And the efforts of our country and all progressive forces of contemporareity are directed to this end.

A.3. Opening Remarks by Mr. Z.D. Kalensky, representing FAO, ROME.

Mr. Chairman, Ladies and Gentlemen: I am grateful for the opportunity to address the opening session of this Conference on behalf of FAO. I would like to extend warm greetings to all of you and the best wishes for the success of this important Conference from Dr. Saouma, Director General of the Food and Agriculture Organization of the United Nations, Dr. Bommer, Assistant Director General Leading the FAO Agriculture Department and from Dr. Dudal, Director of its Lands and Water Development Division.

As you know, development of the Global Land Soil Monitoring System is of great interest to FAO. Soil, as the basic agriculture resource is pivotal to the programme of the FAO Agriculture Department. FAO has been executing numerous soil survey and land capability projects in many developing countries. Together with UNESCO it has produced the Soil Map of the World which was published at the scale 1:5M in the years 1972-1979. In order to support these activities, the FAO has developed a number of methodologies for soil surveys and land capability studies. Of particular interest to this Conference are the FAO proposal for establishment of an International Soil Data Bank, the Framework for Land Evaluation and the Guidelines for Coding of Soil Data. At present, these activities are further continued through such projects as the Global Agro-Ecological Zone Land Inventory, Desertification Mapping and Monitoring and others.

FAO therefore welcomes the opportunity to participate in this Conference and to cooperate on the development of methodology for the Global Land/Soil Monitoring System. Such a system, when established, will provide one of the baseline data for monitoring the food security in developing countries and thus will contribute to combating hunger on our planet, which is the FAO's first priority task.

In conclusion, let me express my pleasure of being able to participate at this Conference, organized in the beautiful city of Kiev. The USSR has a great tradition in the soil science and thus it has been most appropriate that it was selected to host this conference.

Thank you Mr. Chairman.

Appendix A.4. Opening Remarks by Dr. R. Arnold representing Commission V of the International Soil Science Society.

As the present chairman of Com. V of the International Soil Society I bring warm greetings from all soil scientists throughout the world to this important meeting.

The concern with the land and soil degragation is truly an international concern. The importance of being able to measure relevant attributes of soil, land, vegetation and water has never been greater in the history of mankind than it is in 1982.

The ISSS stands ready to assist in implementing procedures to collect field observations and to help evaluate the implications of such data for the well-being of our world.

The members of the ISSS share the concerns of the world because they think internationally. Each of us works in a limited physical part of the world, be it a district, a state, a republic, or a nation. Yet our knowledge and thought are not limited by physiographic or political boundaries.

Comm. V of ISSS is a very active committee with more projects and working groups than any other committee. This attects to the desire tackle international problems and strive for meaningful solutions. We are proud to be pedologists - we are pleased to have the opportunities to work together - not only as said scientists - but also as members of interdisciplenary groups. This means that we want to learn from others while at the same time we teach and share our special skills and knowledge about soils.

Thus on behalf of the thousands of soil scientists in all countries throughout the world we thank you once again for this excellent opportunity to join together with other experts to chart a committee for the future.

It is appropriate that we are meeting here in Kiev in the. We recognize that here is a sign of history - some and using soil. And as we can see there are also the symbols of struggle, of triumph, and visions for the future.

It is the vision for a better future for all people in all countries - that brings us together this week to work on a plan for measuring and monitoring soil and land. The plan is not for just a ration - it is for a global assessment.

In this spirit of cooperating - ISSS offers its strong support to this activity. We wish you all success in your deliberations and proposals for the future.

Ladies and Gentlemen, the ISSS is pleased to be represented and we thank the UNEP organizers and the Soviet implimentors for these fine arrangements and facilities.

Thank you all.

APPENDIX B. SPECIAL PRESENTATIONS, BACKGROUND DOCUMENTATION

B.1. Summary of the Presentation by Dr. Bogdanov president of the VASHNIL PRESIDIUM/Southern Department

The material underlined in the report of Dr. Bie and other questions discussed on the International Conference of Global Soil Monitoring are up-to-date and deal with the tasks of protection and conservation of soil resources as well as enlargement of food production in the world.

Soil protection, conservation of land resources and improvement of general productivity of farming is the constant concern of the Soviet Government. The Ukraine, the territory of which is 60 million hectares, is situated in three different physio-geographical zones - Polesie, Forest-Steppe, Steppe zones. The differences in these zones are: geomorphological structure, characteristics of soil degradation, moisture, erosion as well as characteristics of productive specialization of using the lands. This requires differing approaches to develop farming systems and means of soil protection.

Planned soil policy, bettering the method of soil cultivation and fertility measures, creation of highly intensive variety of agricultural crops secure stable enlargement of yields and gross output of plant growing production.

The counterpart of the soil protection complex is organizational-cultural and agro-technical: grassland improvement, forest improvement and hydro-technical measures.

In the Ukraine, the system of soil cultivation is adopted to the different environments it is applied to. It considers preservation and reproduction of fertility, creation of measures necessary for work and plant growing, and introduction of energy-efficient technology in growing of agricultural crops.

According to our opinion, methodological development and practical realization of soil protective measures in the Ukraine, is a counter-part of the Global Soil Monitoring.

B.2. Scientific Fundamentals for the System of Fertility Control and Monitoring of Ukrainian Soils

B.S. Nosko, Director of A.N. Sokolovsky Institute of Soil Science and Agrochemistry
D.I. Kovalishin and R.S. Truskavetsky, Senior Research Workers.

Summary: The scientific fundamentals for the soil fertility control system and for soil monitoring are presented including materials of large scale soil mapping and specific soil cover zoning, qualitative soil valuation, and a standard base for the application of fertilizers and ameliorants.

The opinion is expressed that it is more reasonable to consider soil monitoring within the soil fertility control system. In this connection, methods for a constant surveillance of the fertility elements dynamics, necessary for the operational control are proposed as well as methods for a periodical determination of the

direction of anthropogenic changes of soils and soil productivity necessary for elaborating control strategy.

Methods for determining integral indices of the changes of soil properties are proposed. These methods are based on the investigation of soil buffering capacity and buffering ability regarding separate fertility elements.

B.3. Land Evaluation and Land Productivity in the Ukrainian SSR by Dr. L.J. Novakovski, Director of Ukrainian Research Institute on Land Management, Candidate of economic sciences.

The report "Criteria, software and hardware of the global soil/land monitoring system" is characterized by the adequate argumentation of the most suggestions and seems to be a proper bases for discussion and elaboration of actions directed towards further improvement of the proposed monitoring system. Much attention in it is devoted to the problems of hardware, while criteria and software have not been developed so completedly, and such problems as land classification, social and economic aspects of the land use have not been treated at all.

Authors of the report used to call land resources monitoring as monitoring of the land/soil. We believe it to be more reasonable to use the term "land monitoring" as far as soil together with agronomic, climatic, social and economic factors is included into composition of land re sources/lands.

In the Soviet Union there is a system of the national land monitoring based upon data of the state land registry. Land Registry Cadastre includes registration of land utilization, evaluation of the land quality and quantity, soil bonity and economic evaluation of soils. Registration ensures data on the legal and economic state of the lands. Qualitative evaluation characterizes land composition accordingly to their types, subtypes and separately for ameliorated lands, type of the land utilization for administrative regions, districts, republics and the territory of the USSR at whole. This evaluation is based upon the plan-cartographic materials.

Qualitative evaluation takes into account soil texture, salinity, alkalinity, acidity, soil moisture, erodability, deflation danger, as well as relief inclination. Arable lands are also classified accordingly to agro-productive parameters, whereas grasslands and pastures by the degree of their cultivation. All the lands are divided into seven classes accordingly to their suitability.

Soil bonity and qualitative evaluation are carried out once in five years. Gross production, justification of expenses and differential income are used as parameters of economic evaluation.

The report on the land distribution between the users of agricultural lands is made annually by the 1st of November, the complete report which includes besides data on qualitative

evaluation and characteristics of lands, is introduced once every five years. Together with analysis of changes and causes this report is introduced to the Ukranian Government for consideration and endorsement. Land exclusion, land conservation practice, utilization of the land fund is submitted by the Ministry of Agriculture, State Committee on Environmental Protection and the Ukrainian Academy of Sciences.

Compilation of the land registry is carried out by the land management service of the Ministry of Agriculture of the USSR, whereas works on survey, research and evaluation/soil, geobotanic, agronomic, irrigation/ are carried out by the experts of our institute.

B.4. Mapping of Land/Soil Degradation Using Multispectral Data by L Vankataratnam, National Remote Sensing Agency, Galanagar, Hyderabad-500037 India.

Summary: Soil is an integral part of the natural environment, related to and affected by, relief and ecology, climate and vegetation. The indicators of soil degradation are water and wind erosion, salinization/alkalization, ravines, water logging, depletion of human and nutrients and desertification.

Out of total geographical area of 328 million hectares of our country, about 145 million hectares of land representing 44% of total area is in need of various soil conservation measures. It is alarming to note that 58% of agricultural land, 33% of forest land, 86% of cultivable waste land, 95% permanent pastures and grazing lands, 74% of fallow land, 55% the land not used for agriculture are subject to severe erosion.

In India, according to an estimate about 7.0 million hectares of land has been affected by salinity/alkalinity, 2.7 million hectares of land is subjected to shifting cultivation or huming which is susceptible for erosion, 3.67 million hectares are affected by ravines and 6.0 million hectares of land was subjected to waterlogging problems of which 3.4 million hectares are subjected to surface flooding and 2.6 million hectares have high water tables.

It is a recognized fact that the soil is finite resource and continuously increasing demands are being placed on this resource to feed and clothe the growing population.. So it is very essential to ameliorate the salt-affected land, stabilize the sand dunes, control sand drifts, check soil erosion, and reclaim the ravine-infested land. For this purpose, soil maps are needed as a first step showing these areas which have to be corrected so that the respective government agencies may plan optimum land use after necessary reclamation.

Although soil maps are prepared higher to by ground surveys which are tedious and time - consuming now air and space borne multispectral data along with computer assisted multispectral data

analysis systems are providing the resource scientists with a new mapping method at a much faster speed. Apart from preparing small scale soil maps, satellite data have been used in India for delineating and mapping the areas affected by various soil and land degradation hazards. Several examples of this show that these maps can be prepared up to the level of association of soil sub-groups at 1:250,000 scale which could be used for regional planning by various administrators, planners, and officers of agricultural departments.

The soil maps using the Landsat data have been prepared in India by visual interpretation of Landsat imagery as well as by utilizing the computer aided Multispectral Data Analysis System (MDAS). Several programmes have been developed in National Remote Sensing Agency (NRSA) for image enhancement, and for delineation of various degrees of soil salinity and ravine.

B.5. The Canada Land Data System/CGIS History and Use of a Landscape Information System in Canada by Jean Thie, Director, Land Resources and Data Systems Branch, Lands Directorate, Ottawa, Canada.

Canada is a big country. Its landmass covers about 10 million km^2. Its economy is based on the management and use of its resource sector. Forestry, agriculture, mineral, oil and gas combined with the use of high technology, to form the backbone of Canada's long-range economic strategy. To solve land use conflicts, and improve integrated management and encourage multiple use of the land, the federal and provincial governments launched the Canada Land Inventory program (CLI). CLI provides land capability data for almost 3 million km^2 of the settled portion of Canada, for forestry, agriculture, wildlife (ungulates, waterfowl), recreation, fisheries and present land use. The CLI produced about 20 thousand maps at scales of 1:250 thousand and 1:50 thousand.

To handle this large volume of spatial data, the Canadian Geographic Information System (CGIS) was developed. This system has now become part of the Canada Land Data System (CLDS) of the Lands Directorate, Canada Dept. of Environment. The CLDS was set up to handle data sets at the national (macro), regional, and local (micro) levels. It is a polygon based system, which carries out overlay and edge matching functions to provide for one large continuous national data digital base. It handles polygon, grid, line and point data and puts out information in maps, reports and digital tapes. At present, using a drumscanner, about 1000 maps are added to the data base per year. The data base includes forestry, wildlife, recreation, fisheries, land use information, watershed, administrative boudaries and landscape ecological information. A link exists with the Bureau of Statistics in Canada to integrate socio-economic data. The CLDS is a federal government system; services are provided to provincial and local governments and industry on a cost-recovery basis. Access can be obtained through a series of regional terminals in the major

cities of Canada. Typical application of the CLDS and its data base can be grouped into:

1. national perspective studies, strategic planning and policy development.
2. provincial and regional planning and policy development. For example the development of regional land use plans; planning for hydro electric development, pipeline corridors, etc.
3. management applications (e.g. forest inventory and management, national parks management).

The success of an operational landscape information system depends on:

1. the comprehensiveness of the data base
2. the flexibility of that data for interpretations
3. the timely delivery of that information
4. the appropriate format and
5. the cost-effectiveness of the system.

To improve the information base, the Canada Land Inventory sponsored the development of an ecologically integrated Landscape Classification System. This ecological land classification system recognizes a hierarchy of information which corresponds with the various levels of planning (from macro-micro). In addition, the CLDS is being linked with other information systems through a standard data transfer format.

This includes monitoring land use change (i.e. loss of agricultural land due to urbanization) assessing impact of environmental concerns and the land resource (i.e. acid rain).

Record of discussion related to papers in Appendix B

Question by Mr. Arnold (U.S. Dept. of Agriculture).

When you monitor chemical or other soil related changes, is this done on a statistical sampling basis?

1. Answer by Mr. Novakovsky: For the purpose of national monitoring, concerning soil changes, we use materials of soil surveys conducted on a systematic basis all over the territory as well as other soil sampling surveys.

Question by Mr. Areola (University of Ibadan, Nigeria):

Does the Ukrainian republic have its own soil and land use classification system, developed specifically for its region, or is it using a national system developed for the whole USSR?

2. Answer by Mr. Novakovsky: There is a unified classification data system established for the Soviet Union as a whole.

Question by Mr. Kalensky (FAO):

Are the satellite remote sensing data used for soil survey and land evaluation in the Ukrainian SSR?

3. Answer by Mr. Nosko: No, methodology for utilization of satellite images in soil surveys is being developed in the Dokuchaev Soil Institute in Moscow.

Question by Mr. Venkataratnam (National Remote Sensing Agency of India):

Are aerial photographs used for land monitoring in the Ukrainian SSR?

4. Answer by Mr. Novakovsky: In addition to ground surveys we also use aerial photographs.

APPENDIX C. TABLE OF CONTENTS OF CONSULTANTS REPORT

APPENDIX D. LIST OF PARTICIPANTS AND OBSERVERS FOR THE INTERNATIONAL MEETING ON GLOBAL MONITORING

October 4 - 8, 1982, KIEV

NAME		PLACE OF WORK	ADDRESS
1. ANDRONIKOV V.L.	(USSR)	Dokuchaev Soil Institute	109017, Moscow, Piszhevski st. 7
2. AREOLA O.	(NIGERIA)	Department of Geography University of Ibadan	Ibadan, Nigeria
3. ARNOLD R.W.	(USA) (ISSS)	USDA/Soil Conservation Services	P.O. Box 2890, Washington, D.C. 20013 USA
4. BIE S.	(NORWAY)	Norwegian Computing Centre	P.O. Box 335 Blindern, Oslo 3, Norway
5. KALENSKY Z.D.	(FAO)	Food & Agriculture Organization of the UN	Via delle Terme di Caracalla 00100 Rome, Italy
6. KALININ A.M.	(USSR)	Geographical Problematic Laboratory of Soil Errosion	Moscow, B-234, State University
7. GARBOUCHEV I.P.	(UNEP)	UNEP/EMS	UNEP, P.O. BOX 30552 SOWAT, Nairobi, Kenya
8. NOSCO B.S.	(USSR)	Ukrainian Institute of Soil & Agrochemistry, Director	Kharkov, Tchaikowsky St. 4
9. NOVAKOVSKY L.Ya.	(USSR)	Ukrzemprojet Institute, Director	Kiev, 151, Narodnogo Opolchenia,
10. PACHEPSKY YA.A.	(USSR)	Institute of Soil Science & Agricultural Chemistry	Moscow region, Puschino IP & FAO
11. PROTSENKO D.I.	(USSR)	Ukrainian Committee on Environmental Protection, Chairman	Kiev, 8, Sadovaya st.3
12. ROZHKOV V.A.	(USSR)	Dokuchaev Soil Institute	109017, Moscow, Piszhevsky st. 7
13. SADOVSKY A.N.	(Bulgaria)	N. Poushkarev Institute of Science	Bulgaria, Sofia
14. TEJWANI K.	(INDIA)	Land Use Consultants (International) Director	25/31, Old Rajiwdranagar, New Delhi, 11060, India

15. THIE J.	(CANADA)	Lands Directorate, Environment Canada	Ottawa, Canada, K1A OE7
16. TORRES C.	(UNEP)	UNEP/GEMS	Nairobi, Kenya
17. VENKATARATNAM L.	(INDIA)	National Remote Sensing Agency/ NRSA/	NRSA 4, S.P. Road Secunderabad-500003, A.P., India
18. ZONN S.V.	(USSR)	Institute of Geography	Moscow, Staromonetni per., per., 29

O B S E R V E R S

(USSR)

1. GAMAL V.A.	Ukrainian Institute of Soil Anti-Erosion Protection	Voroshilovgrad
2. GENADIEV A.N.	Moscow State University	Moscow B-234
3. GLAZOVSKY N.F.	Institute of Agrochemistry & Soil Science	Moscow reigon, Puschino
4. GORELIK V.N.	Institute of Photography	Mocow, Staromonetni, 29
5. FILIPIEV I.D.	Institute of Erosion Farming	Kherson
6. LAVROVSKY A.B.	Ukrainian ---------- Soil Science	Kharkov
7. KOVALISHIN D.I.	Ukrainian --------- Soil Anti-Erosion	Voroshilovgrad
8. KUCHER S.I.	Council of -------- Ukrainian	Kiev
9. MOSKALENKO V.M.	Ministry of Agriculture of Ukrainian SSR	Kiev
10. OKIPNAYA	Kiev Region Inspection of Environment Protection	Kiev
11. OBRAZTSOVA N.R.	Ukrainian Institute of Land Resources	Kiev
12. PASTERNAK P.S.	Ukrainian Institute of Forestry & Agroforestry Improvement	Kharkov
13. PAVELIEV V.G.	Centre of International Projects USSR, State Committee of Science & Technology	Moscow
14. POPOVITCH P.D.	Ukrainian Institute of Horticulture	Kiev
15. POPOV G.S.	Institute of Cybernetics of Ministry of Agriculture, USSR	Moscow
16. SOKOLOV I.A.	Dokuchaev Soil Institute	Moscow
17. SOBKO A.A.	South Branch All-Union Academy of Agriculture	Kiev
18. SHIKULA N.K.	Ukrainian Agricultural Academy	Kiev

19. TUNIK V.P.	Ukrainian State Committee of Environment Protection	Kiev
20. VEDENICHEV P.F.	Institute of Economy	Kiev