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PROYECTO CENTROAMERICANO
DE FERTILIDAD DE SUELOS

*Soil science in El Salvador. Classification,
fertility and conservation*

Harvey Newton
Peifer Duisberg

Anexo 19

CATIE



CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA
TURRIALBA, COSTA RICA

1978

CATIE
CENTRO AGRONÓMICO TROPICAL DE INVESTIGACIÓN Y ENSEÑANZA

SOIL SCIENCE IN EL SALVADOR
CLASSIFICATION, FERTILITY AND CONSERVATION

Compiled by:

H. P. Newton
P. C. Duisberg

Preliminary document for discussion prepared for the "Reunión Técnica Regional sobre Fertilidad y Análogos de Suelos", in San Salvador, El Salvador. March 13 - 18, 1978.

For review and completion by the Salvadorian soil scientists.

Turrialba, Costa Rica

1978

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SOIL SCIENCE IN EL SALVADOR*
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I. INTRODUCTION

This is one of six reports on the state of soils work in the countries of the Central American Isthmus. A similar outline and pattern is presented in each, in order to make the country reports as comparable as possible. Reports are based on interviews by members of the "Soil Analog Project" plus published information and reports available. However, no claim to completeness or full accuracy can be made. In Costa Rica the report was prepared with some participation by national soils scientists. In other countries time did not permit even this. It is hoped that these imperfect reports will serve as a basis for discussion during the first regional soils meeting at San Salvador, El Salvador from March 13-18, 1978, and that soils scientists from the different countries present will improve and complete the documents for their countries. The Costa Rica report is the best but still should be thoroughly revised and improved by national and other soils men.

* Preliminary document for discussion prepared for the "Reunión Técnica Regional sobre Fertilidad y Análogos de Suelos". San Salvador, El Salvador, March 13-18, 1978.

** Ph.D., Soil Scientist Consultants, Soil Analog Project, CATIE.

If all countries produce quality documents they can be used as a basis for a comprehensive document on the state of soils work in Central America and a realistic assessment of the weaknesses and needs for strengthening the field.

The field of soil science in Central America cannot serve as a basis for improving soil analogs unless it can be strengthened in every country. The analogs which have been possible through the soil analog subproject of CATIE/ROCAP for the Pacific area of Nicaragua, Honduras and El Salvador represent only a first step in supporting national development plans and agriculture by determining similarities between soils within and between countries. If basic knowledge and soils agencies can be constantly improved, the quality of analogs will also improve. The potential economic and social savings of identifying soils requiring very similar management, fertilization and conservation practices is enormous.

II. SUMMARY AND SUGGESTIONS FOR THE FIELDS OF SOIL
CLASSIFICATION, FERTILITY AND CONSERVATION

El Salvador seems to have gone through two phases in soil classification. In the first phase soils were primarily mapped at the level of associations of series and the results published on colored 1:50,000 topographic maps. This apparently led to a false feeling among policy makers that little remained to be done. In fact, the surveys were little more than reconnaissance level. Therefore, there was a quiet period of several years before Ing. Agr. Miguel Rico of the original group was able to get sufficient support within the Ministry of Agriculture for a special program to classify using the new taxonomy and determine land use potential. His group should be expanded to complete the basic soils work at semi-detailed level as soon as possible so that it might go into more detailed surveys in selected areas.

Recently the soils classification and soil fertility fields have become more closely allied and supportive. Soils fertility trials are now concentrated in CENTA.

It is becoming a practice for CENTA agronomists to make pits to take soil profile samples for classification analysis. This could lead to important relationships between classified soils and plant responses including detection of analogs. It would, however, appear that considerable improvement is possible in fertilizer trials. The partial results we saw indicated a rather high degree of variation. If this is generally true considerable should be done to analyse each step in the process to increase reliability. However, the basic organization of CENTA with soil fertility specialists included within crop teams and with the laboratories all working

in close proximity seems conducive to adequate standards of work and cooperation.

The Soil Conservation department within the Direction of Natural Resources does not seem to have been brought close to the other soils groups as yet. It has been occupied for about five years with the important FAO project in the Metapan area and has gained much very valuable experience. Now that it is on its own, it is to be hoped that it will expand rather than contract. The national needs are very great and soil conservation is closely related to maintaining soil fertility. The field could also benefit greatly by more basic knowledge about the erodability of soils from the classifiers.

Nonetheless, El Salvador seems to have the best balance between the principal fields of soils and a higher degree of interchange between them than any other country on the Central American isthmus. However, this is not as favorable as it appears because El Salvador also is the isthmian country with the most urgent needs for soil science to be efficient and effective and practically applied.

This is because El Salvador has one of the high population densities of the world while remaining primarily an agricultural country. This has created a much greater pressure on the limited land resource than in the other Central American countries. It is vital to increase food and crop production and reduce soil loss.

Much more must be done to obtain soils information and to use it effectively. There is still a great gap between its collection and its integral use with other kinds of information for national, regional and local planning.

One very promising step has been undertaken in this respect and this is the Zonification Project of the Direction of Natural Resources. El Salvador is the only country which has attempted to classify physical, and cultural information on a geographic grid so that it can be retrievable in various geographic combinations using a computer. This is a pioneer step in what could lead to methods for correlating and for devising useful relationships between different kinds of information. Soils information is fed into this system. However, considerable more should be added including soil series with possibly family, fertility trial data and additional analytical data. Among other important data to be added would be life zone transitions, rainfall intensity data and evapotranspiration.

III. SUMMARY TABLE OF SOILS AGENCIES

Table 1 only includes a suggested format. It is suggested that the Salvadorian soils scientists list the institutions and obtain the required information.

III SUMMARY OF SOILS INS

TAC

E N T I T Y	Major Soil Emphasis	1977 -1978 Budget Dol ars	S T A F F			Offices	Library (Books, Documents and Maps)
			Professional	Sub- professional	Clerical		

TITUTIONS IN EL SALVADOR

LE I

Access to:		Equipment		Other Collaborators (Major)	Mobility and transport	Outputs	Principal users of information
Laboratory	Greenhouse	On hand	Ordered				

1/2

IV. EARLY PERIOD FOR SOIL SCIENCE

A. Soil Classification

We have no knowledge of the earliest period. However, the main stimulus to soil classification came from W.C. Bourne, a soils expert supplied by the U.S. technical assistance program. From 1959 through 1966 soils maps were published on 1:50,000 topographic base maps covering about 60% of the country (12,000 km²).

The recent period described further on in this report began about 1974 and includes the revision, modernization and improvement of these maps. In between there was a period of a few years when the future for modern soil classification did not look nearly as promising as it does at present.

B. Soil Fertility

An agreement in 1942 between the University of Agriculture and Livestock and the U.S. Department of Agriculture resulted in a small program at La Ceiba beginning in 1943.

In 1945, the University received 140 hectares of land at San Andrés, and established an experiment station. A National Center of Agronomy was organized consisting at first of Departments of Agronomy, Plant Pathology, Horticulture and Agricultural Engineering. Later Departments of Soils Technology, Entomology, Animal Industry, Extension and Agricultural Improvement were created.

Starting in 1952 research projects were initiated and knowledge spread through practical demonstrations. Small irrigation projects were started and assistance given to farmers in soil management and conservation practices.

In 1955 the CNA was incorporated into cooperative "Servicio (SCASA)" between El Salvador and the U.S. government. A soils section was established by 1959.

After the phase out of SCASA in the early 60's the research and extension functions were received by a new Direction of Research and Agricultural Extension under the Ministry of Agriculture. In 1973 this direction became CENTA, whose activities are described later.

The soils laboratory for routine farm samples was improved and expanded beginning in the 60's under the stimulation of the North Carolina State Fertility project. Many soil fertility trials were carried out by the FAO and many fertilizer demonstrations with the help of Dr. Ben Birdsall of AID during the middle and late 60's. Although some spectacular results were achieved most records have been lost. El Salvador fertilizer consumption is now almost at a European level and undoubtedly reflects in part the influence and extension ideas promoted by the results of these projects.

The recent period began in the 1970's with the reorganization of agricultural investigation into CENTA and is described subsequently.

By 1972 it was reported that Salvadorian farmers using fertilizer based on recommendations obtained as a result of soil tests obtained yields 1.5 to 10 times the national average production and 2 to 25 times the production of farmers using no fertilizer. Seventy five percent of the soil samples analysed were deficient in phosphorous and some 40% needed potassium applications to correct deficiencies. Nitrogen was needed in practically all cases for increased yields. Observations also indicated Zn, B, Mg, and Mn deficiencies.

C. Soil Conservation

Too little attention was paid to problems of soil conservation through the 50's and 60's. Meanwhile, the country was almost completely deforested and rich recent volcanic soils badly eroded, especially on the extensive rolling and mountainous lands.

Nevertheless, the realization of the importance of soil conservation came earlier in El Salvador than in some neighboring countries. With the cooperation of the extension service an organization has been formed called "Amigos de la Tierra". The extension service has induced and helped many small farmers to build terraces and to practice contour farming. In 1970 the program had 2634 participants. While participation is small in relation to the problem, it shows a hopeful trend.

The government increasingly aware of the seriousness of the problem established a department of soil conservation and management and obtained a five year technical assistance project from FAO which began in 1971 and which is described later in this report.

V. PRESENT SOILS ENTITIES AND LABORATORIES

A. Ministerio de Agricultura y Ganadería

1. General

The Ministry includes the following organic operating divisions:

Renewable Natural Resources (Recursos Naturales Renovables)
Irrigation and Drainage (Riego y Drenaje)
Animals (Ganadería)
Training (Capacitación Agropecuaria)
Research (Tecnología Agropecuaria)
Pest Control (Defensa Agropecuaria)
Extension (Extensión Agropecuaria)

Within the Ministry but autonomous are:

Coffee research (Instituto Salvadoreño de Investigaciones de Café).

Agricultural Products Storage and Marketing (Instituto Regulador de Abastecimiento).

Agrarian Institute (Instituto Salvadoreño de Transformación Agraria).

Agricultural Development Bank (Banco de Fomento Agropecuario)

The Ministry also has an Agricultural Economics Division, an Information Department and a Sectorial Planning Office along with various administrative units. An organigram of the Ministry is shown in Figure 1.

The budget for the period July 1, 1975 - June 30, 1976 indicates the following amounts spent in soil, soils related or natural resources work:

Q2.5 = US\$1	Q (Colones)
Conservación y Desarrollo de los Recursos Naturales Renovables	4'546,574.00
Tecnología Agropecuaria	1'498,660.00
Extensión Agropecuaria	3'120,800.00

Q2.5 = US\$ 1	Q (Colones)
Capacitación y Educación Agropecuaria	1'677,532.00
Riego y Drenaje	2'132,777.00
Inventario y Banco de los Recursos Renovables	909,707.00
Zonificación Agrícola	397,264.00
Departamento de Información	512,443.00
Desarrollo Forestal y Ordenación de Cuencas Hidrográficas	2'461.671.00
Desarrollo Forestal	1'678,581.00
Conservación de Suelos y Control de Terremotos	783,090.00
Desarrollo de la Tecnología	1'147,930.00
Determinación del Uso	285,271.00
Potencial del Uso	836,424.00
Usos múltiples de los Recursos Hidráulicos	248,407.00
Desarrollo de Tecnología Agropecuaria	4'306,440.00
Instituto Salvadoreño del Café	582,240.00
Instituto Salvadoreño de Transformación Agrícola	4'560,760.00

Total budget of MAG in 75-76 was Q 85 millions or US\$ 34 millions.

2. Dirección General de Riego y Drenaje

This division carried out the following soils studies in 75/76:

- a. Classification of soils according to irrigation classes, 6020 ha, including 2386 physical determinations in the soils laboratory. These studies were for projects of cooperative farms.

- b. In cooperation with a commercial contractor (TRANARG S.A.),
104,000 ha were mapped according to irrigation classes.
- c. Another 980 ha were mapped for irrigation purposes in "Distrito de Riego y Avenamiento No. 2, Atiocoyo".

This division has a "Departamento de Estudios" which has an "Agrología" and "Agronomía" section, which apparently carried out the above studies.

3. Dirección General de Recursos Naturales Renovables

a. General

This division is charged with conservation and rational development of the renewable natural resources and of preserving a healthy environment. It has the following operating services:

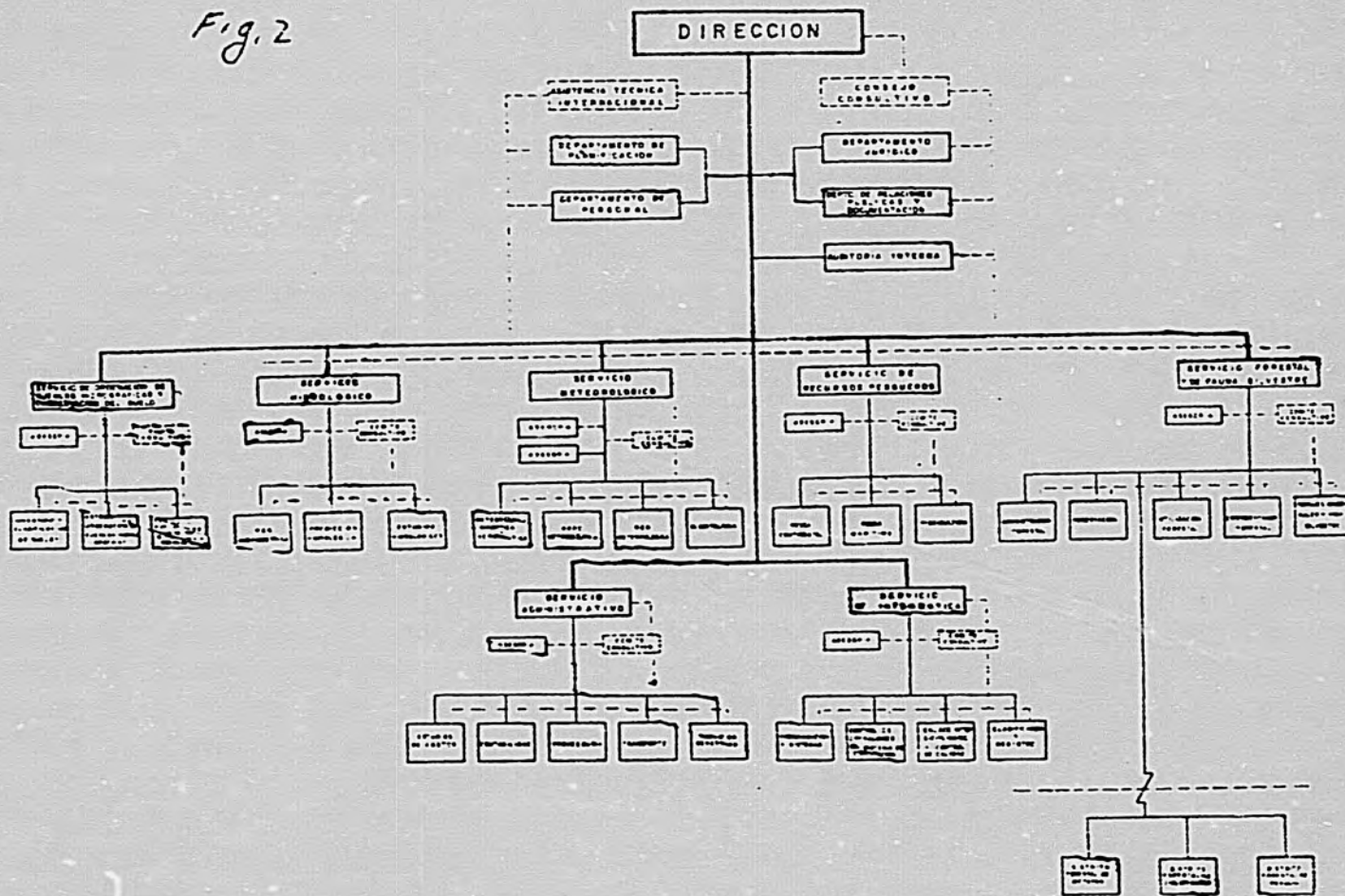
Watershed management and soil conservation.
Hydrology
Meteorology
Fish resources
Forests and wildlife

The division, among other tasks, has the function to protect, improve and reclaim soils through execution of soil conservation and control works. It is to plan the management of watersheds, map and classify soils, make an inventory of them and determine their best use. The division will give free technical assistance to all farmers who carry out work in soil conservation and flood control. They have to conserve and rationally develop water resources, collect climatic data for agriculture and to protect the general environment.

ANEXO I

ORGANIGRAMA ESTRUCTURAL DE LA DIRECCION GENERAL DE RECURSOS NATURALES RENOVABLES 1976

Fig. 2



VI-5

1302

The division is also charged with the protection, conservation, and appropriate use of all fish resources, forests and wildlife, including experimental forest plantings and reforestation. An organigram of the "Dirección General de Recursos Naturales Renovables" is given in Figure 2 and another organigram which gives a still more complete picture is in Figure 3.

b. Servicio de Ordenación de Cuencas Hidrográficas
y Conservación de Suelos

This service of watershed management and soil conservation has the task of controlling or preventing soil erosion, and it is also charged with watershed management and flood control.

The service is directed by Ing. Americo Vidaurre and contains the following departments:

- a. Watershed management (Estudio de ordenación de cuencas hidrográficas).
- b. Soil conservation and flood control (fomento y ejecución de obras de control de torrentes y conservación de suelos).

The service completed the following work connected with soil during 75/76.

- a. Soil surveys: 7400 ha in eight different areas for use by ISTA to distribute lots of economic size to settlers.
- b. Plans for watershed management covering 1185 ha.
- c. Several plans for soil conservation measures covering 5706 ha., but affecting erosion control in a much wider area.
- d. Flood control plans over an area of 6114 ha.
- e. Training courses in watershed management and soil conservation for personnel in the division.

- f. Research on erosion control and run-off in 12 forest lots through agricultural measures like plantings of leak trees.
- g. Publication of technical leaflets about 1) "Small structures for flood control", and 2) "General aspects of flood control".
- h. Assistance in flood control in 6 farms totalling 820 ha.
- i. Study of the problems of 6 watershed covering 3600 ha.
- j. Leaflet about soil conservation practices in areas of soils of marginal productivity.
- k. Assistance in the execution of soil conservation measures in various areas covering 4684 ha.
- l. Mapping and managing of 1600 ha.
- m. Organization of 4 citizens' groups in support of wise natural resources use.

In addition, the service is said to have produced a soil erosion map for the country at about 1:200,000 scale.

c. The FAO Metapan Project

FAO carried out a major project from 1971 through 1977 to try to restore a badly eroded and deforested area in the Northwest part of the country. This was contracted in association with the Service of Watershed Management and Soil Conservation. The FAO Chief was Ing. Delfín Goitia.

This project has been the largest related to conservation ever carried out in Central America. It produced a great number of documents and maps. It attempted to study and initiate actions to stabilize and improve the physical environment and to try to create conditions to reduce the pressures of the surrounding population on it. For various reasons it only achieved some of its objectives. However, it stands as a project

which should be studied carefully by all the countries of the isthmus. We did not find out the degree to which the Servicio has been influenced for the better and to which it can continue carrying the work forward.

d. Special Program to Determine Potential Use of the Soil

In 1975 Ing. Agr. Miguel Rico obtained MAG funding to revive the work of soil classification. He has updated the old classification of Bourne to conform to the new U.S. taxonomy.

For current work new aerial photography of 1:20,000 scale taken during the 1970-74 period is available. Funding for the present work is assumed until 1980. Thirty-four map sheets at 1:50,000 have been produced and cover practically the whole country, except for about 20 partial quadrangles along the borders of the country.

The base map is a 1:50,000 topographic map sheet upon which soils are mapped as associations. On the front each sheet has the legend indicating each soil or soil association mapped. On the back of each sheet an explanation of each mapping unit is given, which includes the classification according to the current U.S. Taxonomy, actual and potential crops, and a description of the topography the mapping unit covers. Along with this land capability classes for each mapping unit are given, and the percentage of each area within a given mapping unit falling into a respective capability class. U.S.D.A. capability classes I - VIII with corresponding sub-classes are used. In addition each map sheet has on the back a summary of all capability classes found on the map sheet, and a listing of the various mapping units which appear and have all or part of their area in the respective land capability class or sub-class. The number

of hectares of mapping units and capability classes on each sheet are given, but not related to the country as a whole. Thus a major soil may appear with only a small area on a given sheet or a minor soil might cover a substantial part.

One problem in the practical use for management purposes of this map or in using its mapping units in a system of soil analogs is that several capability classes or more than one soil appear within the same mapping unit. While this was unavoidable at the map scale used and often classes are close, some are quite separate (like II and VII in the same mapping unit).

In 1974, Rico published a 1:300,000 soils map relating the old and new taxonomy with a book explaining the relation of both for El Salvador.

A major objective of the program is to produce land capability maps at 1:20,000 scale. These maps of "Capacidad de uso de las Tierras" are available in the form of "Blue print" sheets with explanatory booklets. About 100 have been produced and approximately 36 are turned out each year. At this rate the important parts of the country should be complete in about a year.

Ing. Agr. Miguel Rico's deputy is Ing. Agr. Roberto Denys, who was part of the original team during the 1960's. There are five field men completing the soils maps, and six working on the land capability maps.

As it was found essential to combine climatic data with soil series in order to obtain useful soil analogs, Dr. J. Tosi, of the Tropical Science Center, San José, spent some time in El Salvador to improve the existing Life Zone Map of 1:400,000 to a level of life zone transitions on 1:50,000

soil maps. The sheets completed so far can be seen on the attached index map of El Salvador. Figure 4.

e. Servicio Forestal y de Fauna Silvestre

The Forest and Wildlife Service is engaged in the inventory of existing forests, their management, assistance in rational exploitation forest protection against fires. The Service also issues permits for the cutting of trees, distributed almost three million plants from its forest nurseries and collected 6000 Kg of seeds for reforestation.

They reforested 600 ha under a program of reforestation for watershed protection, and 847 ha under a program of reforestation for soil conservation.

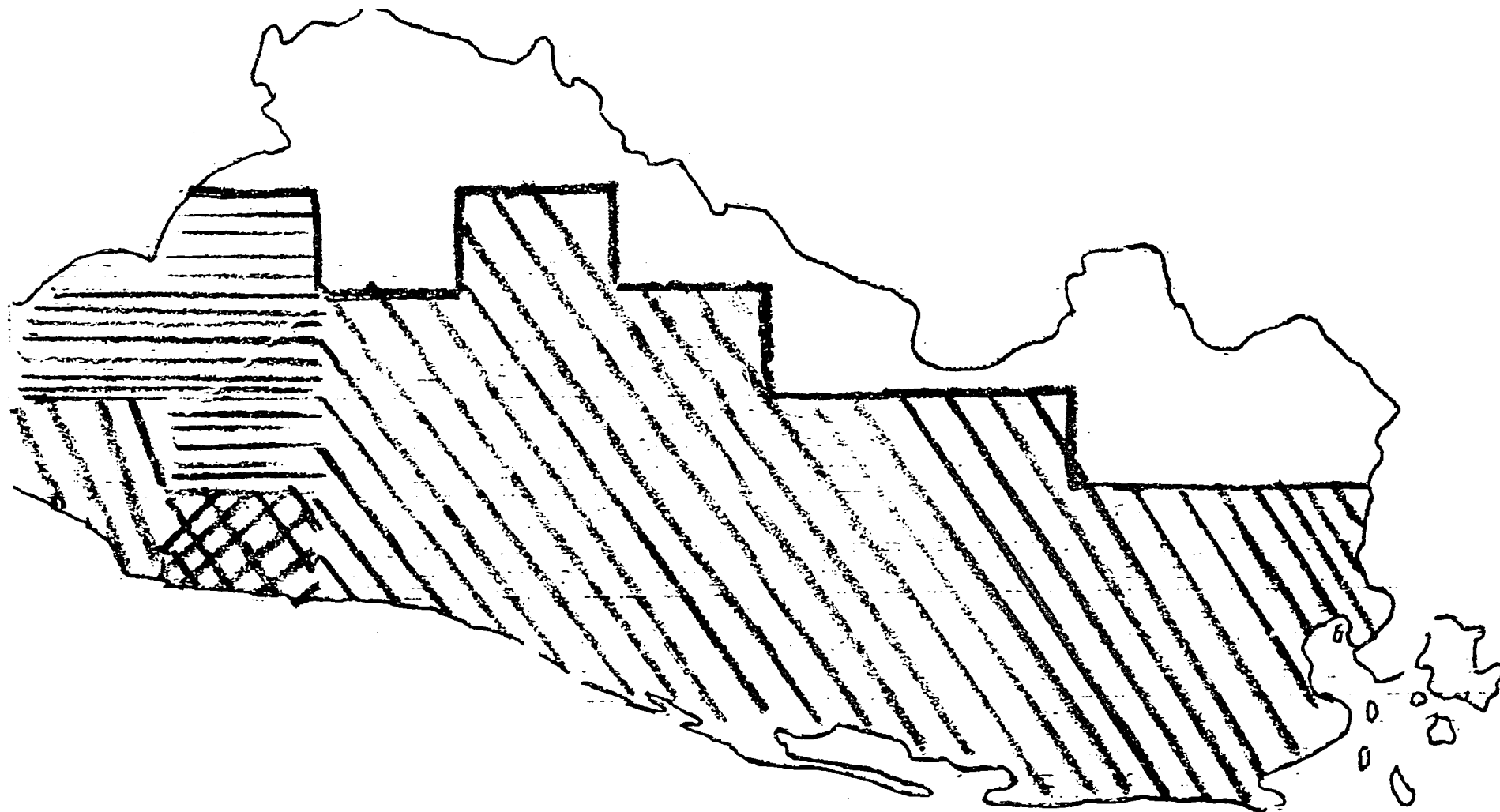
Other work of the service includes research in best use of forest products, experiments with new tree species, plan for the designation of possible National Parks and their protection, and the establishment of protected areas for the development of wildlife.

f. Servicio Informático

A major function of this office is to serve the other units of the Direction of Renewable Natural Resources especially with respect to computer expertise etc.

In 1973 it was designated to collaborate with an important OAS technical assistance project under Dr. Arnold Kreisman. This project was a follow up to a preliminary OAS study on Agricultural Zonification and regionalization.

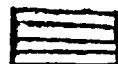
SUELOS PEDOLOGICOS



CUADRANTES PUBLICADOS



CUADRANTES EN PROCESO
PERO TRABAJO DE CAMPO COMPLETADO 1-27-77



CUADRANTES EN PROCESO
1-27-77

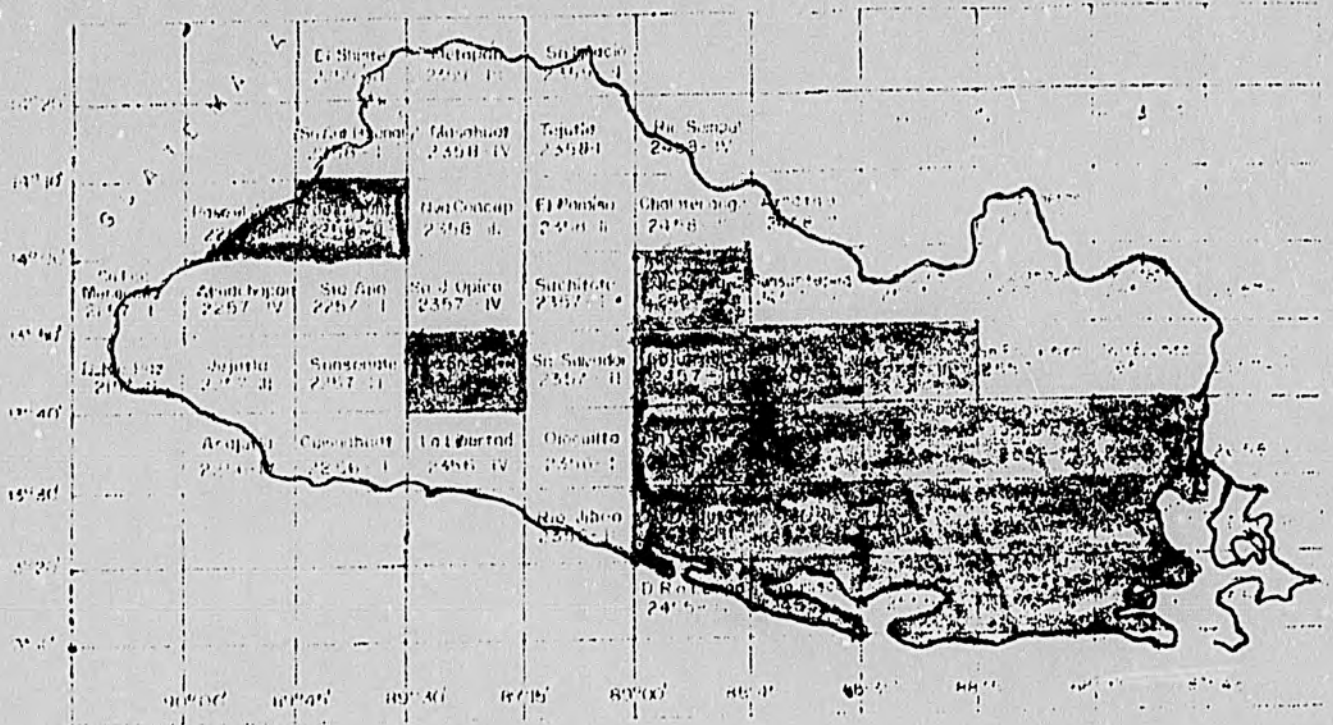
Mapas de Suelos

Pedologicos 1:50,000


ALGUNOS
(VIEJOS DE BOUTTE NECESSITO
REVISAR)


CAPACIDAD DE USO DE LAS TIERRAS INDICE DE CUADRANTES

EL SALVADOR



INDICE DE SUB CUADRANTES CUADRANTE

 *Completed Maps
at 1:20,000
with published
Booklet.*

 *Not Started
as of 8-27-1977*

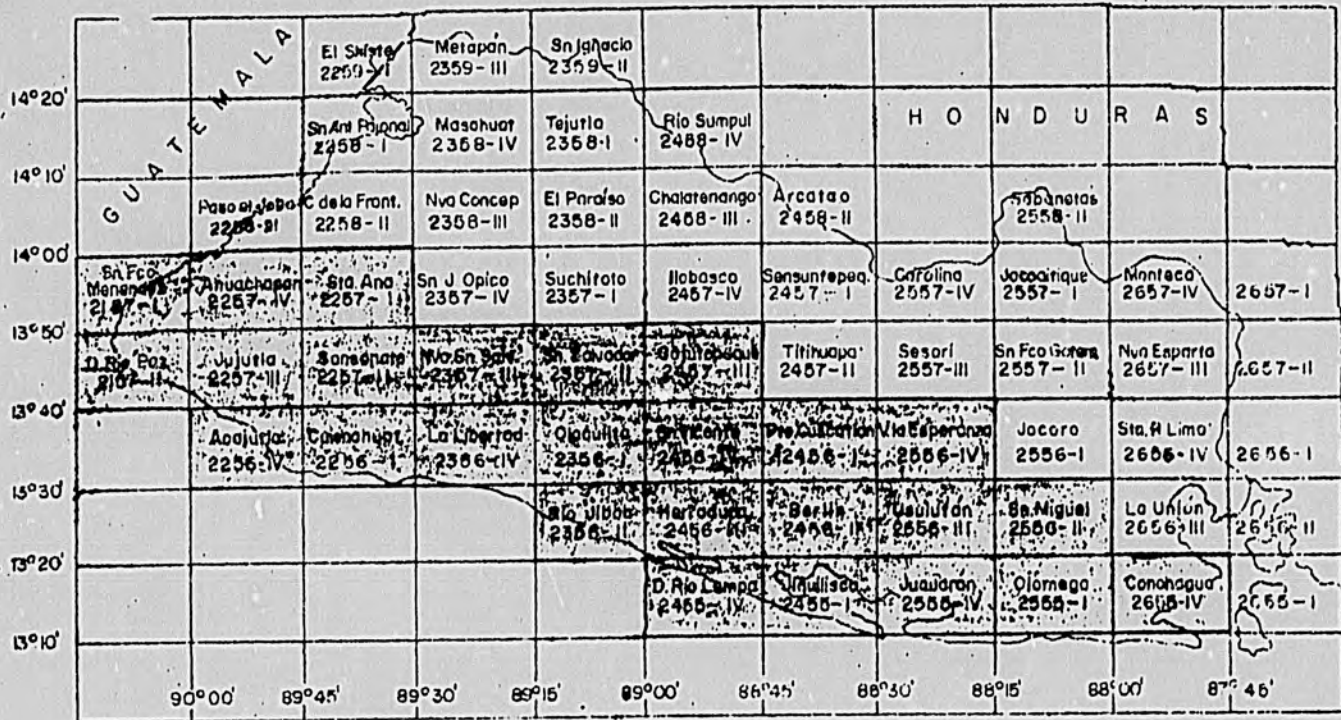
IV	I
III	II

*4 1:20,000 quadrants
make 1:50,000 sheet*

AREAS CUBIERTAS POR EL ESTUDIO DE ZONAS DE VIDA INDICE DE CUADRANTES

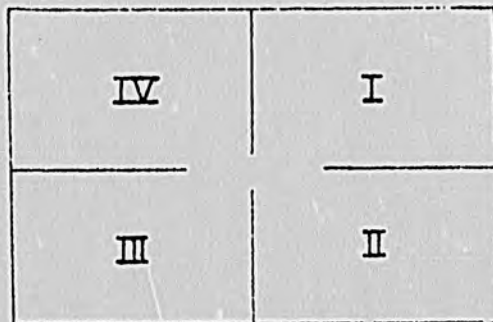
Fig. 4

EL SALVADOR | Por: Joseph A. Tosi, Jr.



INDICE DE SUB CUADRANTES

CUADRANTE



It involved an integrated natural and human resources inventory of one of the four regions of El Salvador and included an area of about 5000 km².

The inventory includes soils, vegetation, surface, cover, land use, hydrology, forests, roads and socio-economic factors with information delineated as overlays on 1:50,000 topographic maps and stored in a computer for each kilometer squared. The methodology and results have been published by the OAS Regional Development office and the overlays and maps are available in the project. Two things stand out about this project: first, this is the boldest attempt so far in Central America to systematize and classify resources information on the basis of small geographic units processed by computer. Second, the system is capable of containing, retrieving and correlating many additional types of data. Among notable additions which should be considered are soil series and suborders under the new taxonomy. Fertility trial results, additional laboratory data and life zone transitions.

The original project was started, and financed for only one region. Since the project is judged successful and it has been continued with about 20 Salvadorean technicians from the original group. Meanwhile, OAS has sent an expert to work on correlations and the use of the stored information in national planning. This project represents an attempt to systematically use the large amounts of natural resources data generated by integrated inventories. Nicaragua represents a case where even larger amounts of data have been generated but which are in danger of being lost unless better ways of storage, retrieval and use are found. In Panama results from a similar project have partially been lost.

The project is headed by Ing. Oscar López, Chief of the Servicio Informático, with Jorge García, Technical director. A very positive factor in El Salvador has been the excellent way in which the IGM has provided the photo and map products needed.

3. Centro Nacional de Tecnología Agropecuaria (CENTA)

a. General

The "Dirección General de Investigaciones y Extensión Agrícola" became CENTA in 1973. This agency was briefly combined with the Escuela Nacional de Agricultura. However, the two units are now separate.

CENTA works in agricultural research, extension and the production and distribution of improved seeds. Its aim is to improve agricultural production, diversify agriculture, produce new employment opportunities and increase rural family income and rural life in general.

The extension division, includes a Department of Technical Assistance and Rural Development, which works through regional offices and carries also out the programs on basic grains, vegetables and fruits, cotton, sugar cane, home economics and youth programs.

The research division includes the departments of plant sciences, soils, plant pathology, animal sciences, agricultural chemistry, agricultural engineering, agricultural economics and statistics. It also includes the experiment stations at San Andrés, Santa Cruz Porrillo and the Sub-station Izalco.

The seeds division includes departments on production and certification, plants for processing and storage, and seed multiplication farms.

The basic grains program is concerned with corn, beans, rice and sorghum. This program includes variety trials, studies on plant population and fertilizer trials.

The Program of Industrial Plants includes oil crops like soya, bean, cotton and sugar cane. The program on horticultural crops includes work with tomatoes, yuca, potatoes, cabbage, onions, and quisquil; and the fruit program citrus, bananas (sweet and platanos), avocados, and temperate climate fruits like apples, plums, apricots and peaches.

CENTA includes an agricultural chemistry laboratory (mostly forages and feed concentrates), a quality control laboratory (mostly pesticides and fertilizers) and a soils laboratory. An organigram of CENTA including names of principal personnel is in Figure 5.

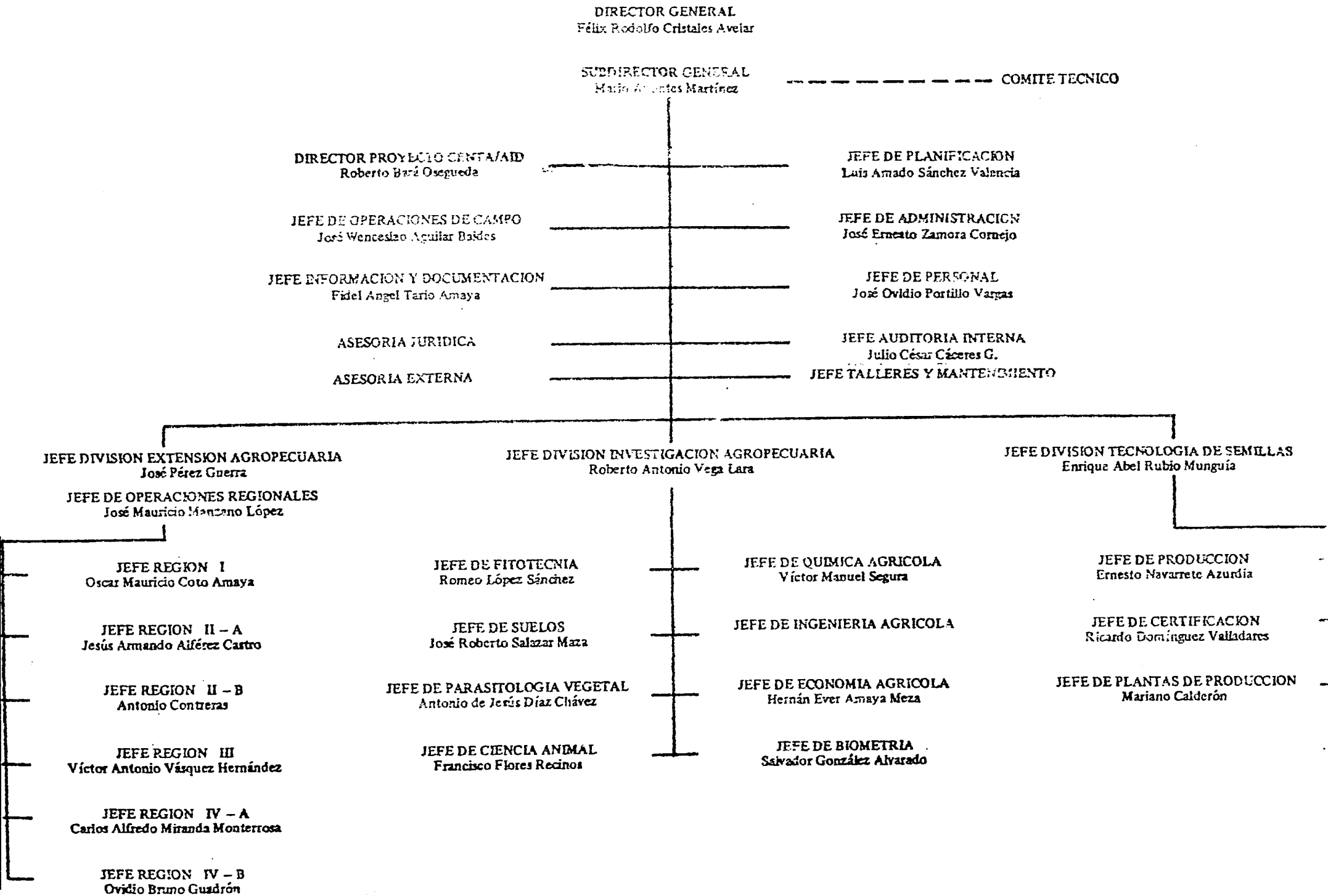
b. Soils Work - CENTA

The Soils Department is headed by Ing. Agr. José Roberto Salazar. Advisor to the Department is Dr. Frank Calhoun under a CENTA-AID-University of Florida Contract. Thanks to Ing. Salazar and Dr. Calhoun profile descriptions and soil samples in detail will be taken in the future at all fertilizer experiments, as requested by the soil analog project. This will be valuable to the national soil classification project under Ing. Rico and will help greatly in relating yields and fertilizer responses to definite soil series and therefore in producing future soil analogs.

A breakdown of workers in soils, their activities and projects as given in the 1977 CENTA plan of operations is given below:

FIGURE 5

PERSONAL DIRECTIVO Y EJECUTIVO DEL CENTRO NACIONAL DE TECNOLOGIA AGROPECUARIA



Workers in soils according to the 1977 plan:

<u>No.</u>	<u>Type or Degree</u>	<u>Activity</u>	<u>Project</u>
3	Ing. Agr.	Soil Fertility	Corn
1	" "	Irrigation-Soil Management	"
1	Chemist	Soil Analysis	"
1	Ing. Agr.	Soil Fertility	Gross legumes
1	" "	Irrigation-Soil Management	" " "
2	" "	Soil Fertility	Rice
1	" "	Irrigation-Soil Management	"
1	Sub-Professional	" " "	"
1	Chemist	Soil Analysis	"
2	Ing. Agr.	Soil Fertility	Sorghum
1	" "	Irrigation-Soil Management	"
1	Chemist	Soil Analysis	"
2	Ing. Agr.	Soil Fertility	Oil Crops
2	" "	Irrigation-Soil Management	"
1	Chemist	Soil Analysis	"
1	Ing. Agr.	Soil Fertility	Sugar cane
1	" "	Irrigation-Soil Management	"
1	" "	Soil Analysis	"
1	" "	Soil Fertility	Fiber crops
1	Sub-professional	Irrigation-Soil Management	"
1	Chemist	Soil Analysis	"
4	Ing. Agr.	Soil Fertility	Vegetables
1	" "	Irrigation-Soil Management	"
3	" "	Soil Fertility	Fruits
1	" "	Irrigation-Soil Management	"
1	Chemist	Soil Analysis	"
5	Ing. Agr.	Soil Fertility	Forage crops
1	" "	Irrigation-Soil Management	Forage Crops + pastures

Actually, it is reported that there are only 11 agronomists in the Department and the Head of the Department should correct this text to the extent that it is in error about his program.

Summary:	Agronomists	35
	Chemists	6
	Professional (total)	41
	Sub-professional	2
		<hr/> 43

CENTA proposed an extensive program for field experiments to study soil fertility and responses of the various crops. The list below indicates 59 field experiments were planned country-wide for 21 different crops and combinations of crops. How many were actually started and for how many valid data was obtained is not known at this writing. The list of crops, number and type of fertility experiments is given below.

CENTA - SOIL FERTILITY FIELD EXPERIMENTS - 1977 PLAN

<u>Crop</u>	<u>Number</u>	<u>Remarks</u>
Corn	4	Different fertility levels density
Corn	3	3 level N + 3 types of N
Corn	3	P x Zn
Corn	5	Foliar application
Beans	2	Organic
Beans	1	N with corn interplantings
Beans	2	N, Zn, B
Rice	2	Levels N x density x distance
Rice	2	P and level of N
Sorghum	2	Levels of N x density
Peanuts	3	Fertilization not specified. Natural fertility
Sesame	2	Levels of N, P. Residual fertility
Soybean	2	Several levels + inoculant
Sugar cane	1	Subsoil fertility + fertilizer
Henequin	1	N, P, K levels
Tomatoes	2	N, P, K
Potatoes	1	Not specified
Sweet pepper	2	3 levels of N, P, K
Cabbage	3	3 levels N, P, K x 4 varieties
Yuca	2	various levels of N, P, K
Carrots	2	3 levels N, P x distances
Onions	2	3 levels N, P, K x density
Hot pepper	2	3 level N, P
Plátano, banana	2	3 levels N, P x density
Papaya	2	3 levels N, 2 levels K
Multicultivos	3	levels, time, method of application
Knolzu + Pangola	<u>1</u>	Different levels

Summary by crops:

Corn 15, beans 5, rice 4, sorghum 2, oil crops 7, vegetable and similar 16, fruits 4, other 6.

Other work reported by CENTA in its 1977 operations plan includes the following:

- a. Soil conservation assistance to cotton growers on 4200 ha.
- b. Soil management assistance to 204 cotton growers covering 84,000 ha.
- c. Soil samples taken from cotton fields: 600.
- d. Leaf samples analysed for fertility work: 4000.
- e. Analysis of fertilizers and organic fertilizer: 1200
- f. Routine determinations on soil samples: 7500
- g. Special determinations on soil samples: 5000
- h. Fertilizer recommendations to farmers: 7000
- i. Bulletins with fertilizer recommendations for corn.
- j. Bulletins with fertilizer recommendations for beans.
- k. Bulletins with fertilizer recommendations for rice.
- l. Project to classify soils used in fertility work in the different regions of the country (to be completed in region II, Zona Central in 1977).
- m. Field and greenhouse studies with organic fertilizer (produced through a heat fermentation process).
- n. Greenhouse studies to determine the fertility levels of important agricultural soils of the country.
- o. Studies on the fixation of P on important agricultural soils of El Salvador.
- p. Greenhouse studies of the absorption of trace elements by various soil series.
- q. Evaluation of different analytical methods for the determination of trace elements.
- r. Soil and leaf analyses to correlate data from fertilizer field trials.
- s. Classification and determination of the variability in soils of the Experiment Station.

c. CENTA - Soils Laboratory

This laboratory made 67,189 determinations during the reporting period (75/76) including determinations for N, P, K, texture and pH to make fertilizer recommendations for farmers. The laboratory also performed 5116 special soils analyses, presumably for research workers. Main demand

for the services of the laboratory was during the month of February, March, April in preparation of planting. Most of the soil samples originated in the Departamento de San Vicente, Usulután, La Libertad, La Paz, San Miguel and Santa Ana in this order.

Since early 1976 the number of samples received by the soils laboratory has increased greatly as a result of a campaign to acquaint the small farmer with the services and benefits available to him through the laboratory.

Samples analysed by the laboratory are as follows:

<u>Year</u>	<u>Approximate number</u>
69/70	6000
70/71	6600
71/72	8600
72/73	9100
73/74	8200
74/75	9000
75/76	14000

Thanks to an agreement with AID, new laboratories have been constructed by CENTA covering 7471 m². Of this about 21 sq. m plus auxiliary facilities like sample drying and storage room constitute a soils laboratory.

Besides space for soil testing and soil chemistry work the new buildings were planned to contain office space for 21 research professionals in soils, 5 research assistant, 2 extension specialists, 2 technical advisors and secretarial staff.

d. Division de Enseñanza

This is a division of CENTA, a three year agricultural school having 332 students enrolled in 75/76. Their curriculum includes the following soils courses: Soils, Soil Fertility. This school apparently developed from the National School of Agriculture "Roberto Quiñonez". It is located in the valley of San Andrés and gives the title of "Perito Agrícola". Top students can be accepted at U.S. Universities like the University of Florida and obtain a B. Sc. in two years. The school has been assisted by the University of Florida. Plans called for increased enrollment to about 450 students and for a fourth year in the curriculum.

e. CENTA-BID Project

This work at CENTA is coordinated by Ing. Agr. Miguel Menéndez. He had about 40 field trials during 1977 undertaken in cooperation with the extension service. Trials are located in the Department of Ahauchapán and Santa Ana in the North and San Miguel and Morazán in the South. As part of the program 41 profiles were sampled by making 2 m deep pits and each site described and analysed. This information will be valuable in providing additional information to supplement the work on soil classification of the "Programa de Uso Potencial del Suelo" of Ing. Rico. It will also be valuable in testing of Soil Analogs.

4. Instituto Salvadoreño del Café. MAG

a. General

The Institute has the following departments:

- a) Genetics
- b) Agronomy
- c) Pest Control
- d) Agricultural Chemistry
- e) Technical assistance and information
- f) Administration

b. Fertility

An organigram of the institute is in Figure.....

The Department of Agronomy has the following sections:

- a) Coffee production (cultivo de café)
- b) Fertility
- c) Management of rust resistant varieties

And the Department of Agricultural Chemistry consists of:

- a) Chemistry and diagnosis.
- b) Analysis of soils and plants
- c) Technology of coffee processing

The fertility section carries out 16 projects in various parts of the country fertilizing coffee with the major elements and also trace elements, especially P and Zn. The latter two elements are believed to be lacking in most coffee areas of the country. However, field experiments done with Zn have been inconclusive until now.

On the other hand, results indicate little benefits from the application of P, K and Mg throughout the country, with some exceptions.

c. Agricultural Chemistry

The institute maintains a laboratory to analyse soil samples and leaf samples in order to make fertilizer recommendations to coffee growers.

During the year 1975/76, 19,683 determinations were made on soil samples and 15,137 on leaf samples.

Soil samples are generally analysed for pH, P, and K and often also for Ca, Mg, Al, and organic matter,

Leaf samples are generally analysed for N, P, K, Ca, Mg and often for S and Mn also.

All samples are routinely analysed for P and Zn to obtain information of the persistence of these elements in soils and plants.

5. Instituto Salvadoreño de Transformación Agraria (ISTA) - MAG

ISTA came into existence in May 1976 replacing the "Instituto de Colonización Rural (ICR)". Its main task is the improvement of rural life through training and organizing the "campesinos", to provide land for those needing it and providing them technical assistance. It works closely in cooperation and through other divisions of MAG. In 1976, as the result of ISTA's initiative, several soil conservation works were undertaken like stonewalls, strengthening and repair of irrigation canals, and vegetative protection strips affecting about 2000 ha.

B. University of El Salvador

The Faculty of Agriculture of the University offers a 5 year course leading to an Ingeniero Agrónomo degree. There is little possibility to specialize at the undergraduate level. The head of the soils department is Prof. M. Montevini (details on training and research should be filled in by Salvadorian soil scientists who revise this report).

The overwhelming majority of research workers at CENTA (about 80% in 1972) are graduates of the university. The university accepts students from the National Agricultural School; however, it requires them to attend for another 3 years before they will receive their Ingeniero Agrónomo degree. If they are well qualified, a U.S. university will grant them a B. S. after 2 years of additional study.

C. FERTICA

FERTICA has a laboratory in El Salvador. The laboratory analyses about 7000 samples per year originating from all countries. This laboratory goes under the name of "Pro-Agro" and is also capable of analysing plant tissue samples. It can analyse for pH, P, K, Ca, Mg, Al, Fe, Mn, Cu and Zn.

It also has two agronomists who are responsible for about six fertilizer trials per year in sugar cane, corn, sorghum and cotton among other advisory services.

FERTICA has a fertilizer plant in Acajutla.

VI. RELATION OF SOILS TO OTHER NATURAL RESOURCES AGENCIES

The organigram in Fig. 6 shows the approximate relationship of the various organizations in the natural resources field in El Salvador.

Many have been described in Section V because they contain soils components. The others are covered in this section.

A. Instituto Geográfico Nacional

1. Topographic mapping at 1:50,000 was completed some years ago as well as important areas at 1:25,000. The Institute is now engaged in updating and improving the 1:50,000 series by a process of reducing contours from 1:50,000 and 1:10,000 orthophotos from the National Cataster Project.

2. The IGN has three photo aircraft. Weather conditions in El Salvador are more favorable than any other Central American country, and the IGN is relatively well supported. There have been few problems in obtaining or financing photography deemed important for development.

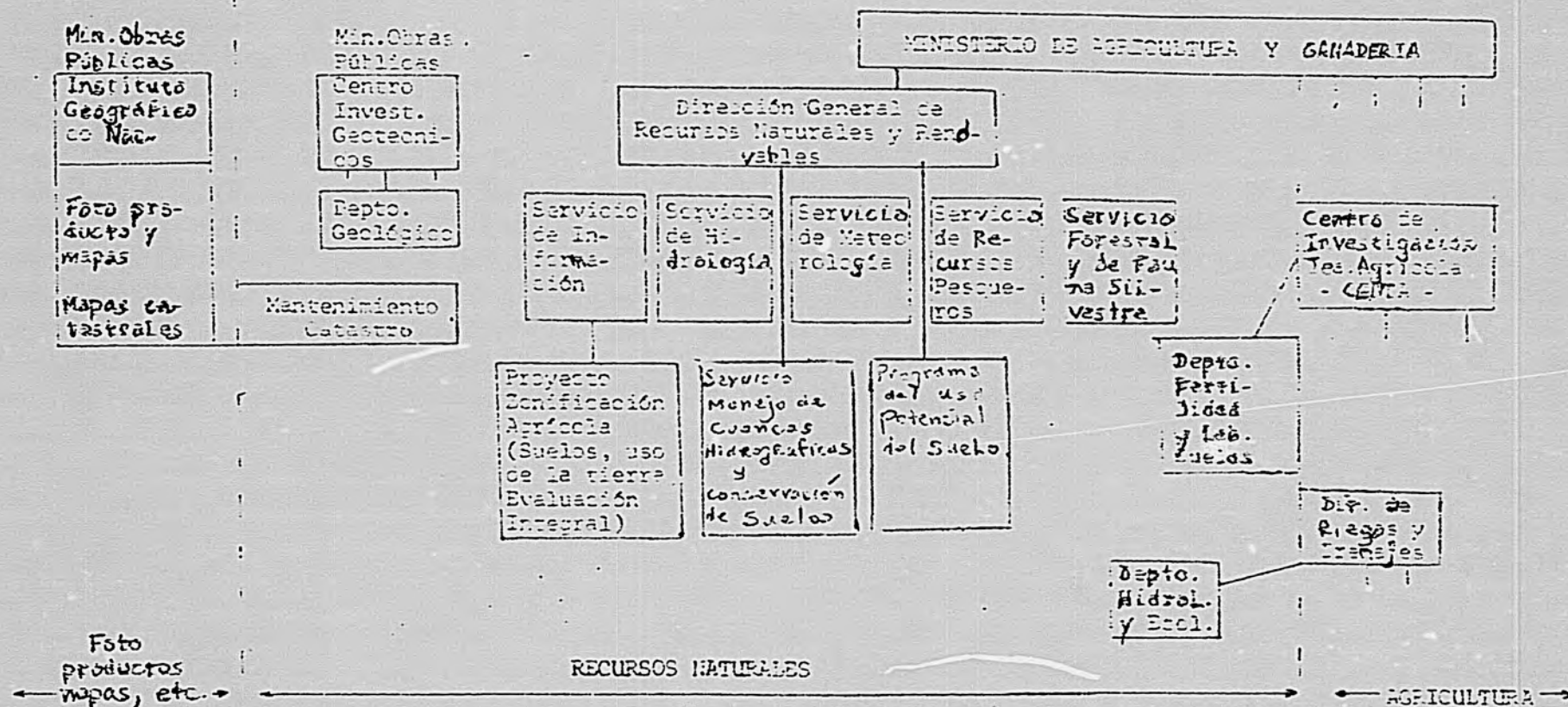
The National Cataster was begun in 1962 using difficult and slow methods. In 1970 it was replaced by use of 1:5,000 and 1:10,000 orthophotos and the property identification was complete in a few years and is being maintained by the CATASTRO.

In 1974, the country was photographed at 1:20,000. These photographs are being used by the "Dirección General de Recursos Naturales Renovables" for the computerized resources inventory. The IGN is also producing all the natural resources maps resulting from the project.

Figura 3

EL SALVADOR

Organigrama preliminar para Recursos Naturales



NOTA: Se debe ampliar y corregir este diagrama, pero el concepto global es lo importante.

Borrador
10-63

31

The IGN is engaged in the third revision of the General Inventory of Physical Resources, which constitutes a national map at small scale with 20 or more overlays of natural resources, cultural and economic subjects. This GIPR was produced through an AID/ROCAP contract for all Central American countries about 1965, but only El Salvador has tried to keep it up to date.

The IGN does service work under contract for a number of governmental agencies. Included in its recent printings are a national geology map for the "Centro de Servicios Geotécnicos" and a national soils map for the "Dirección de Recursos Naturales Renovables".

B. Consejo Nacional de Planificación y Coordinación (CONAPLAN)

El Salvador is elaborating a national plan for the 1978-82 period and the sectorial planning office has a key role. The importance of computerized resources information from the Servicio Informático of the Direction of Renewable Natural Resources is recognized by this office. They furthermore have started a new phase with OAS advisors to identify and elaborate definite projects, using the computerized information as much as possible.

C. Centro de Investigaciones Geotécnicas -
Ministerio de Obras Públicas

This agency seems largely a service group for the Ministry of Public Works and contains a laboratory of soil mechanics as well as a laboratory of construction materials. In addition it contains sections

on seismology, geology and mining. The agency has 4 geologists, 8 engineers, and 2 chemists in a total staff of about 250.

Geology seems to have been an active independent agency between 1955 and about 1962. Four volumes of a Salvadorian journal of geology were published which can be found in the Center's library. In recent years, a German geological mission has given technical assistance. This collaboration has resulted in the first national geological map published in 1973 by IGN and a larger scale expanded version published in Germany. A more detailed series at 1:100,000 is now in press in Germany.

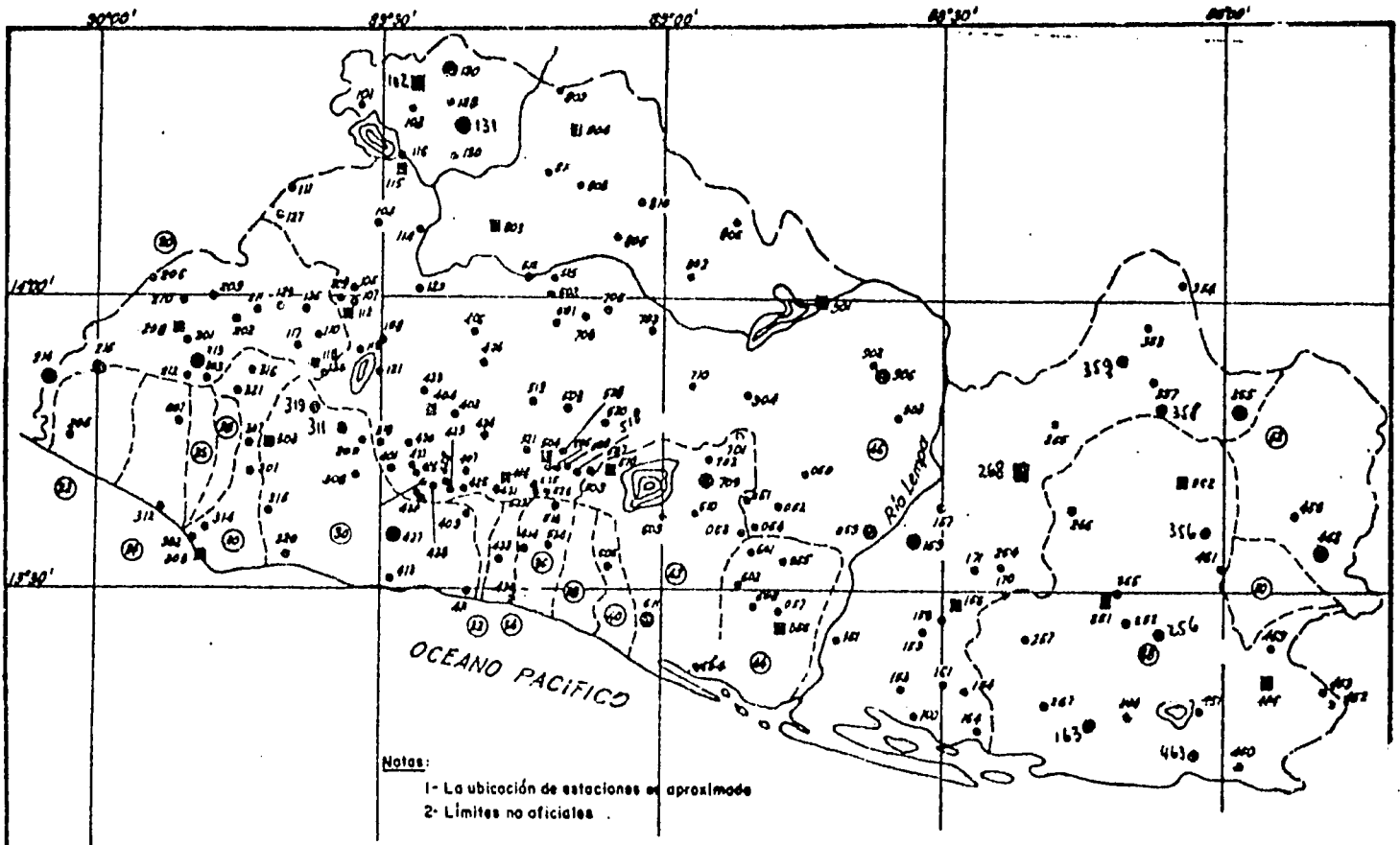
D. Servicio Meteorológico and Servicio Hidrológico (DRNR)



1. Meteorology

These offices are part of the Direction of Renewable Natural Resources but are discussed here because they produce basic non-soils data. El Salvador has 23 type A (Complete) meteorological stations; this averages out to one station for every 900 Km². Thus El Salvador has by far the highest density of such stations of all of the Central American countries. The lowest density being in Nicaragua (11,000 Km²) and Honduras (10,500 Km²) with Costa Rica and Guatemala being intermediate in their density. It has to be kept in mind that El Salvador is the smallest country of the five with the greatest population density. See Fig. 7.

The "Servicio Meteorológico" publishes an "Anuario Meteorológico", which gives the complete data from all the stations, including precipitation wind data, air temperature, soil temperature, vapor tension, relative humidity, sunshine and radiation data, cloud cover, Evaporation,

FIGURE 7



<p>NACIONES UNIDAS · PROGRAMA PARA EL DESARROLLO ORGANIZACION METEOROLOGICA MUNDIAL GOBIERNOS DE COSTA RICA, EL SALVADOR, GUATEMALA, HONDURAS, NICARAGUA Y PANAMA</p>		
	<p>Proyecto de Ampliación y Mejoramiento de los Servicios Hidrometeorológicos e Hidrológicos en el Istmo Centroamericano</p>	
<p>ESTACIONES METEOROLOGICAS DE EL SALVADOR</p>		
<p>Dibujó:</p>	<p>Verificó:</p>	<p>Aprobó:</p>
	<p>Escala:</p>	

atmosphere pressure, etc. on a daily basis and by monthly averages. It also gives maximum rain intensities for the different areas of the country.

Furthermore climatic data is computer processed for the Meteorological service by the Servicio Informático to obtain evapotranspiration data according to Penman's formula and evapotranspiration potential and water balance according to Thornwaite's formula.

In 1971, Hargreaves produced a series of monthly national maps giving isohyets of moisture deficits based on rainfall probability. In 1977, K. Hancock, his assistant analysed the data and produced a computer printout of Hargreave's Moisture Availability Index.

2. Hydrology

The Hydrology Service is also part of the Direction of Renewable Natural Resources and this agency archives the data on computer. However, the Direction of Irrigation and Drainage operates some hydrologic stations.

In 1975, El Salvador had 58 recording stream flow stations and determined sediment on 18 and water quality at 40 points.

VII. COMPILATIONS OF SOILS REFERENCES AND MAPS

- a. Bibliografías Agrícolas de América Central: El Salvador. IICA/CIDIA, Turrialba, Costa Rica. 1974.
- b. Índice de Mapas de América Latina y el Caribe existentes en IICA/CIDIA. IICA/CIDIA, Turrialba, Costa Rica. 1975. Lista de Mapas de El Salvador.