SDSU-RSI-83-02

Land Classification/Soil Survey Project of the

SYRIAN ARAB REPUBLIC

VOLUME 1

Introduction, Summary and Recommendations

October 1982

Prepared for

United States Agency for International Development
and the
Syrian Arab Republic

Prepared by

Louis Berger International, Inc.
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Remote Sensing Institute
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and the
Ministry of Agriculture and Agrarian Reform
Directorate of Soils

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1. Introduction, Summary and Recommendations
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volume 1

Introduction, Summary and Recommendations

1 INTRODUCTION AND SUMMARY *

1.1 JUSTIFICATION FOR THE LAND CLASSIFICATION/SOIL SURVEY PROJECT

Throughout large portions of the world, land areas exist which may or may not have the potential to provide the food, fiber and space requirements of the indigenous human population. In view of these requirements and especially with the knowledge of the nutritional inadequacies which these populations are confronted with, efforts have been directed on a worldwide basis to identify areas which do have the potential to provide the basic requirements of life.

Among the primary considerations involved in an assessment of the agricultural development and expansion potential of any area are the spatial distribution and quality of the involved natural resources. These resources include, but are not limited to, climate, geology, hydrology, vegetation and soils. Obviously, other regional characteristics such as the social and anthropological nature of the population and the economic situation must be considered in feasibility planning.

When natural resource information is not readily available, the formulation of effective development and management programs cannot proceed in an efficient manner. The initial step then in the derivation of an agricultural development and expansion program must be the acquisition of required natural resource data. Concurrently, attention should be given towards development of institutional capability for the continued, long-term, accumulation and refinement of knowledge concerning the nature and distribution of the natural resources upon which agricultural development is vitally dependent.

(*)Prepared by B.K. Worcester, Project Manager in Syria from November 1, 1979 to February 12, 1982 for the Remote Sensing Institute, South Dakota State University, Brookings, SD, U.S.A.

This project was undertaken to assist the Syrian Arab Republic Government (SARG) in fulfilling some of the informational and institutional needs of which they were cognizant in relation to their desire to intensify agricultural production in selected areas of the Syrian Arab Republic (SAR). The SARG is expanding and accelerating its program of land classification and soil survey in an effort to increase both agricultural output and income through appropriate use of its limited land resources. Although many sectors of the Syrian economy are growing in importance, agriculture still contributes a large share of the national income and affords employment to a considerable portion of the rapidly growing labor force.

Prior to the initiation of this project, inadequate knowledge concerning the soil and land resources of the SAR was available to permit national level, long-range development planning. Past efforts of the Directorate of Soils (DOS) of the Ministry of Agriculture and Agrarian Reform (MAAR), with some outside assistance, have produced general soil maps of small, isolated areas and special use maps of other small selected areas. However, these efforts were not undertaken utilizing a modern, uniform and systematic approach to correlation and interpretation of the accumulated data. As a result, the soils have not been identified, correlated and interpreted in the consistent manner required for comprehensive agricultural planning. In addition, no useful, nationwide inventories of soil and vegetation resources was available. A previously produced general soil map of the SAR has been found unsuitable as a basis for planning because accompanying information was insufficient for estimating soil potentials for cropland or other uses.

The Directorate of Soils of the Ministry of Agriculture and Agrarian Reform is the principal governmental agency responsible for conducting and coordinating agricultural soil surveys and for collecting, compiling and analyzing the attendant soil data. To achieve the objectives of a modern soil survey, coordinated systems of soil correlation and interpretation are essential, the relatively small staff of the DOS was neither trained nor equipped to implement accepted concepts and methods of soil surveys.

Although the soil laboratory was adequately staffed and sufficient space was available, some methods and much equipment in use were outdated or inadequate. The laboratory was unable to perform several analyses required for complete soil characterization because of those deficiencies or the lack of some essential equipment. As a result, interpretation of the available data often led to inaccurate correlations and interpretations or, because of a lack of essential data, they were impossible to achieve.

A large number of the staff of the Directorate of Soils are involved with irrigation related research projects. A major thrust of this research at the time of the project was in the area of water use by various crops in various parts of the SAR. This type of research is needed and the data can be used to develop irrigation management programs. However, no method was available within the Directorate which permitted consistent evaluation of irrigation suitability of the soils. This is probably the result of having no correlated soil survey data on a nationwide basis. Specific irrigation suitability surveys have been performed, for example, by a consultant working in the Akar Plain area. The project addressed this need by developing and testing a system of evaluating the suitability of a soil for irrigation which was based on soil properties measured

during standard soil survey procedures. The evaluation criteria were defined for three types of irrigation; surface, high-rate sprinkler and low-rate sprinkler application. Attention was also directed towards preparation of a system of water management guidelines. These are presented in detail in the appropriate chapter on irrigation.

At the initiation of the project, the DOS had no institutional capability for appraising present land use patterns on a nationwide basis. No capability existed for evaluating the rangeland conditions. Present land use patterns are an important consideration in planning activities. A large portion of the land use in the SAR is as rangeland which supports the large and important grazing animal herds.

In addition to the needs discussed relative to the acquisition of data, the SARG had no capability for data storage, manipulation or retrieval. When a program is actively undertaken to locate and evaluate the natural resources of an area the size of the SAR, massive amounts of data are generated. This includes maps, associated characterization data and the various interpretations and interactions of resources. To render this mass of information readily useable, a system must be available to accomplish this in a timely manner. In addition to the data provided to the SARG by this project, it is to be anticipated that continued activities by DOS personnel after the project termination will produce newer and more detailed data. It is obvious that a system was needed to rapidly accommodate these data in a form and format appropriate to the myriad needs of the user community.

Data included in the system should not be limited to that generated by the project or similar data generated by the DOS as an extension of the project. Data from other studies and projects could and should be included. Site specific studies could be included to assist with nationwide correlation efforts. Data other than physical resource data should be included such as socio-economic and demographic data. The inclusion of this would contribute greatly towards establishment of a national data archive and retrieval system which would have wide use for planners and could be enlarged and updated.

1.2 GENERAL APPROACH TO THE PROJECT

In general, the project addresses the generation, analysis and compilation of soils, rangeland and land use data in a form and format which can be useful to planners and decision makers in the SARG. In addition, procedures are also developed for interpretation of past, present and future resource data for irrigation suitability rating by three methods of water application. The project considers institutionalization of the DOS by providing training and by procuring needed equipment. These activities are of a nature sufficient to permit continued soil survey and land classification activities in a systematic manner after the project is terminated and the contractor personnel have departed. Agricultural development planning is not a direct output of the project. Soil potential interpretations are made, but feasibility recommendations are beyond the scope of the project activities.

The project can be viewed as having three distinct but inseparable aspects:

1. Production of resource maps and data.

2. Provision of advanced, discipline-oriented training for DOS personnel.

3. Procurement and delivery of equipment to modernize the soil laboratory and the DOS.

The various parts of these three objectives will be discussed in general in the following sections and in detail with results in the respective volumes of this report.

The resident project staff was composed such that each aspect of the project was under the direction of a competent professional in the respective fields (Table 1-1). The staff members were assigned and in residence during the period, as much as feasible, when their respective activities were underway as scheduled in the contract. These time periods, however, required modification as situations occurred and changed during the project. Budgeting considerations during the project also forced modification in scheduling of professional staff residence periods.

The resident staff of experts was supported by the activities of the home office staff. This included administrative, fiscal, training, photo lab and computer personnel. Aside from general administrative and supervisory roles, the administrative and fiscal home office staff were responsible for organization and procurement. They were closely involved in all project evaluations held in the SAR. The entire organization and administration of the training program, a major component of the project, was under the direction of the RSI training section personnel. The acquisition, processing, printing and handling of all Landsat imagery was the responsibility of the photo lab and the computer personnel. The computer staff had the additional responsibility of selecting, recommending, processing, programming, delivering and installing the minicomputer system and training of the Syrian computer scientist. Many individuals were involved in these support activities, but the principals are listed in Table 1-2.

1.2.1 PRODUCTION OF RESOURCE MAPS AND DATA

Part of the project products were the production of several resource maps and resource data. Soils maps were produced for the entire SAR at a reconnaissance scale of 1:500,000. Present land use maps were also produced with the same coverage and scale. Reconnaissance soils maps were also produced at a scale of 1:100,000 for the First Settlement Zone; that part of Syria receiving greater than 350 mm of annual precipitation. Present land use maps were produced at this scale and for the same area also. Semi-detailed soil maps were produced for an area within the First Settlement Zone at a scale of 1:25,000, as part of an exercise to provide training in semi-detailed soil mapping for the SARG personnel. This area was selected jointly by the contractor and the SARG. Each of these maps is discussed in detail in the appropriate volume of this report.

All 1:500,000 and 1:100,000 scale maps were produced using false color composite (FCC) and black and white Landsat satellite imagery as base maps. This

imagery had been digitally enhanced to maximize interpretability. The 1:25,000 scale mapping utilized black and white aerial photography provided by the SARG. The photographic coverage was acquired in 1958 and the actual scale was approximately 1:36,000. Topographic maps were supplied by the SARG at various scales.

It is important to understand what the terms "reconnaissance" and "semi-detailed" encompass before this report and the maps and data included can be fully and meaningfully utilized. The mapping methods used in reconnaissance soil mapping differ considerably from those used in semi-detailed mapping. The scale of the base maps, and consequently the intensity of observations is the basic determining factor, and in turn dictates the types of uses and decisions which can be made based upon the maps. The soil surveys at 1:500,000 and 1:100,000 are reconnaissance scales and are appropriate to new and undeveloped areas, such as the SAR, where very little is known about the soils which exist. These scales are also desirable for mapping when consideration is given to the limits of manpower, time, financing and the large area of the SAR.

Remote sensing technology is very appropriate under these constraints. Landsat satellite imagery provides synoptic, near-orthographic, multi-spectral and multi-temporal coverage. The imagery is readily available and can be used to update and refine data involving such variables as land use changes, rangeland trends and erosion. Degradation of natural resources can be effectively monitored as well as the progress and impact of agricultural development projects.

At the 1:500,000 scale, the minimum practical mapping unit size is 1,000 ha. At the 1:100,000 scale it is 40.5 ha. Mapping units of this magnitude and much larger do not permit representation of pedologically uniform individuals. In fact, at these scales of observation, the mapping units represent associations of related soils. The mapping units of semi-detailed surveys represent pure or nearly pure, carefully defined and characterized soil individuals or mapping complexes and can be as small as 4 ha. As a consequence of these differences, reconnaissance survey results can be used only for broad regional planning and management decision making and to identify areas of apparent high potential to be investigated in more detail when time and cost effective detailed surveys can be conducted.

The most recent imagery possible was used in all cases. This is particularly significant when mapping present land use. Whereas soil patterns are a relatively permanent feature of the landscape, land use patterns change rapidly in response to many factors such as precipitation amounts and distribution, economic conditions and government programs. The spatial resolution of the imagery, 80 m, must be borne in mind as well as the cartographic resolution, 1,000 ha, when reviewing the land use data. Field measurements of the area included in each land use category may differ somewhat from the area tabulation from mapping because of these resolution characteristics.

Eight general land use categories were mapped at the 1:500,000 scale in accordance with the terms of the contract. The increased cartographic resolution, 40.5 ha, at the 1:100,000 scale permitted more details to be included in mapping the First Settlement Zone and, as a result, land use categories were

used. The land use categories used at each scale are fully defined in the appropriate volume of this report.

One of the categories involving field studies was rangeland. No rangeland map was produced, however, because SAR did not provide available background rangeland data and older maps as requested. No description of the inputs and outputs of this particular activity were included in the contract. It was, therefore, at the discretion of the resident project team to derive a definite work plan coordinated with the DOS and AID personnel. Since no range management specialists were present in either organization, the project teams of contractor personnel arrived at a job description which was presented to and accepted by the DOS and AID. The program included extensive field review of rangeland condition. There was a paucity of historical information available. After review of present rangeland environments in the SAR, many recommendations were put forth concerning information needs and methods of acquisition plus a discussion of range management options.

The irrigation specialist's position, with respect to inputs and outputs, was the same as the range management position . After review and discussion with the DOS and AID, it was determined that a need existed for establishment of a uniform method of evaluating the irrigation potentials and limitations of the soil survey operations, which permitted evaluation of soil potentials. Sixteen soil and landscape properties were used to arrive at the final irrigation suitability rating. Different interpretations were required for surface and high-rate and low-rate sprinkler application or irrigation rate. Assistance was also provided to DOS personnel in design and installation of irrigation research field plots. The use of the data gathered was interjected into a system of water management guidelines which were produced as part of the project.

1.3 APPLICATION OF REMOTE SENSING TO SYRIA

Remote sensing has been defined by the American Society of Photogrammetic Engineering as:

> imagery acquired with a sensor other than (or in addition to) a conventional camera through which a scene is recorded, such as by electronic scanning, using radiations outside the normal visual range of the film and camera microwave radar, thermal infrared, ultraviolet, as well as multi-spectral. Special techniques are applied to process and interpret remote sensing imagery for the purpose of producing conventional maps, thematic maps, resources, surveys, etc., in the fields of agriculture, archeology, forestry, geology and others.

The Syrian Land Classification/Soil Survey project has utilized this technology in its mapping and in this manner has introduced it to the SARG.

Remote sensing has been demonstrated to be an effective approach to acquire resource information for a multitude of problems, not the least of which are natural resource oriented activities. Space technology can play a significant

role in the development and management of the natural resources of Syria.

The major emphasis in collecting earth resources data should be to provide a basis for resource development and management. Progress is being made in many parts of the world in a methodical, conventional manner towards completing natural resource surveys in considerable detail at large scales. However, completion of these surveys is generally programmed over a period of many years. A practical approach to the acquisition of resource data is to place priorities on areas where development is most likely to produce desirable results. This approach will maximize benefits derived from expensive ground surveys. This requires a reconnaissance scale inventory, which can locate these high potential areas, and can be readily accomplished using space technology. These technologies have flourished since the launch of Landsat 1 into orbit on 23 July 1972.

The cost and time involved in conventional surveys, the limited amount of resource data available and the lack of current base maps for data compilation all point toward remote sensing as a viable approach toward the development of natural resource plans and management.

The use of Landsat data provides a unique view of Syria. The entire country may be viewed simultaneously by the preparation of a mosaic of all or parts of 17 Landsat scenes. A synoptic view of this magnitude is nearly impossible with conventional aerial photography. In addition, Landsat coverage is available at nominal cost and during various seasons with annual climatic fluctuations. This multidate advantage can be used effectively to record current changes on the land surface and to monitor changes as they occur in the future as the Landsat program continues. The Landsat or other forms of remotely-sensed data do not replace existing survey methods but can be used as a tool to augment survey methods to derive maximum information at less cost in time and manpower.

The first earth resources satellite, named ERTS-1 and renamed Landsat 1, was launched 23 July 1972. Landsat 2 was launched 22 January 1975 and Landsat 3 followed on 5 March 1978. The Landsat 1 system, which had a projected life of one year, was terminated in 1978 after lasting more than five years. At an altitude of 920 km, these sun synchronous, orbiting sensor platforms pass over each and every spot on the earth's surface every 18 days at the same time of day for each successive 18-day interval. This provides the multidate coverage mentioned earlier.

The Landsat satellite systems utilize multispectral scanners (MSS) to provide imagery in four regions of the electromagnetic spectrum. These are referred to as MSS bands 4, 5, 6 and 7. The spectral regions of these bands are 0.5 to 0.6, 0.6 to 0.7, 0.7 to 0.8 and 0.8 to 1.1 micrometers, respectively. Bands 4 and 5 are in the visible green and red portions of the spectrum and bands 6 and 7 are in the near infrared (reflective) portion of the spectrum. The instantaneous field-of-view of the MSS is approximately 0.45 hectares.

This multispectral nature of Landsat has been found to have advantages for specific types of interpretations. For example, the spectral sensitivity of MSS 4 has the best depth penetration of clear water, MSS 5 has use for soil and geology mapping while MSS 6 and 7 are responsive to the presence of actively growing vegetation. Therefore, spectral indications, as seen in MSS data, as

well as spatial and temporal indicators can be used for interpretation of land surface features with possible inferences to the subsurface when made by experienced resource scientists.

The multispectral scanner data are sent to earth receiving stations, processed and made available to the user in two basic forms. One form is digital spectral information on computer compatible tapes (CCT). The digital data are recorded for every 0.45 hectare picture element (pixel) and can be used to rapidly extract statistical information if the radiance values recorded can be related to the composition of the land surface for the particular theme to be mapped. The second product is in an analogue of grey levels represented on an image similar to a photograph. This product is available as film transparencies at scales of either 1:3,300,000 (70 mm) or 1:1,000,000 (18.5 cm). Photographic prints are available from the transparencies at a variety of scales. The individual MSS bands may be acquired as a black and white product with each scene providing coverage of an area 185 km by 185 km, 34,225 km2.

The Landsat data can be and are being used for mapping at relatively large scales (1:24,000 or 1:50,000). This requires extensive digital processing equipment in contrast to the use of simplest but standard photo interpretation equipment for standard image analysis. The data are recorded and can be spectrally analyzed as 1.1 acres (0.4 hectare) picture elements. This type of approach allows maps to be produced at scales of 1:24,000 or smaller. This approach is worthwhile considering that the SAR future efforts will not only serve this specific project but can be of advantage either for future larger scale mapping efforts or for change analysis.

Another standard product is a false color composite (FCC) image produced by combining the various MSS bands of black and white imagery. These appear on the blue, green and red film layers, respectively. Commonly, bands 4, 5, and 7 are combined in this false color composite. As an example, vigorously growing vegetation with high infrared reflectance (MSS 7) and low reflectances in MSS 4 and 5, will appear bright red on the FCC. The combination of the MSS data into a single photographic product often increases the interpretability of land surface features.

Satellites provide a synoptic view. Where small scale maps are required covering areas as large as the SAR, image map base costs are dramatically reduced by acquiring the few Landsat images rather than hundreds of aerial photographs necessary for coverage of the area. Spatial integrity is maintained with the standard product satellite images in that the mapping features are within most mapping standards at the 1:1,000,000 or 1:500,000 scales. Aerial photography must be mosaicked using expensive procedures and surveys for ground control. This advantage of large scale coverage with near precision geometry by each satellite scene (185 km x 185 km) offers a unique cost and time savings.

Satellites provide a repetitive source of data such that changes in land surfaces occuring over time, (i.e., during droughts, seasonal differences, solar illumination changes, with land or water development programs) can be efficiently monitored. Therefore, even after the survey of the SAR associated with the present project is completed, the technology will be useful in future efforts. These may include larger scale surveys, continued monitoring of change, use of computerized storage and analysis of the data by automated techniques, as well as

other programs requiring repetitive and recent information. These as well as other characteristics of satellite technology offer a unique data source which is being used for various mapping and monitoring activities in most parts of the world. The technology is appropriate for the range from developing countries to highly developed countries when a need exists to acquire resource information over large areas quickly. Even for countries as established as the SAR, an appropriate resource map was evidently not available as evidenced by the need for mapping as defined in this project.

1.4 LANDSAT COVERAGE OF SYRIA

The entire SAR is covered by all or parts of 17 individual Landsat scenes arranged in rows and paths (Figure 1-1). For purposes of the project, only those scenes with less than 10 percent cloud cover were selected and in most cases, no cloud cover existed. Only high quality imagery was selected.

Complete coverage of the SAR was provided for two seasons of the year and, as much as feasible, the most recent, 1979, imagery was used. One set of coverage was selected to represent the end of the dry season when vegetation coverage was minimal; this occurred around September. The second set of imagery represented the end of the wet season when vegetation coverage was minimal; this occured around May. The purpose for selecting the two season coverage was to maximize interpretability by taking advantage of the natural relationships which exist between soils and vegetation.

All Landsat data are received from the satellites in digital form and are stored on magnetic tapes. These computer compatible tapes (CCT) were purchased from Telespazio, Rome, where recent data from the Middle East area is received and stored. These CCT's were received by the Environmental Resources Institute of Michigan (ERIM) for digital image processing. This included geometric correction of the tape sets on a 50 m grid by image restoration resampling techniques. It also included a linear contrast stretch on a per scene basis and a linear contrast stretch across all 17 scenes with color balance for image mosaic purposes. The ERIM delivered to the RSI:

1. Raw CCT's from Telespazio
2. Individual scenes 1:1,000,000 scale FCC transparencies and prints
3. Copies of histograms and stretch parameters
4. Geometrically corrected tape sets.

The 1:1,000,000 scale FCC transparencies were processed in the RSI photography lab. Prints of each scene were prepared at 1:500,000 scale for per scene contrast stretch imagery, used for field work, and for between scene stretch for mosaic purposes. One to one hundred thousand scale prints were prepared for the First Settlement Zone for field work only from the per scene stretch transparencies.

1.5 THE RESOURCE DATA BASE APPROACH

Mapping basic information is only an intermediate step to reaching the final objective. Use of the data for management of natural resources often requires an analysis and synthesis of map information relating to many aspects of natural resources. A data management plan can be implemented to efficiently and accurately derive maximum benefit from the maps in computer form to quickly extract information from combinations of the various data sets.

One approach used is in computerized geographic information systems which have resulted from interaction between data analysts and resource scientists. Compilation of land use, soil, hydrology, and other resources of a region often creates numerous and large data sets. In order to simplify data presentation, tabulation, multiple theme overlays and temporal change analysis, Area REsource Analysis System (AREAS) has been developed at the RSI to alleviate the handling of large data sets and to improve the interpretive capability of the resource analyst.

AREAS represents a flexible computer processing system which has the following primary analysis functions: (1) Map interpretation - an option which allows selection of a particular theme from the input data, e.g., from a soil resources map display at the desired scale the limitations for irrigation; (2) Map overlay - an option which allows computer compilation of several themes, e.g., display land use on a fragile soil per watershed and one step further what changes have taken place in the past; and (3) Map inventory - tabulation of the extent of each class of data, e.g., a table which indicates hectares of land use A per soil B on watershed C. Data resulting from AREAS can be displayed by a line printer or computer plotter. AREAS allows the operator to select the proper display scale. Also important to future use, AREAS stores data on magnetic tape for quick access at any time.

The AREAS system integrates technology of computers with the natural resources fields to yield a powerful tool for use in analyzing, compiling, tabulating, and storing resource information. When an appropriate computer is available, this approach can be readily implemented.

The project required survey, recommendation and acquisition of a minicomputer system (processor, storage, input and output peripherals, etc.) to accommodate the AREAS software. Initial contacts describing the project objectives and approximate budget dollars were made with IBM, Hewlett Packard, Prime Computer, and Digital Equipment Corporation. With the exception of IBM, these vendors are regarded as "traditional" minicomputer vendors.

Representatives from each of the four vendors made initial model recommendations as follows:

IBM	Series Model 4955/E
Hewlett Packard	Series 1000 Model 45F
DEC	PDP11 Model 44
Prime	Model 250

1.5.1 SURVEY CONSIDERATIONS

The following considerations were made in the equipment acquisition: (1) the specific Syrian application requirements, (2) the market environment, and (3) the transferability of the Area REsource Analysis System (AREAS). Present geographic information processing software capabilities include map entry, edit, storage, retrieval, structure analysis, and product generation. The selection of modules and priority of conversion to operate on the minicomputer were to be decided based on Syrian project requirements.

The minimum data base to support the project includes a detailed soils data set at 1:100,000 scale for the First Settlement Zone, a present land use data set at 1:100,000 scale for the First Settlement Zone, a general soils data set at 1:500,000 scale for the entire country and a present land use data set at 1:500,000 scale for the entire country. Direct mapping of these data sets in their entirety would result in maps approximately 9 meters (30 feet) square, 3.6 meters (10 feet) square and 1.8 meters (6 feet) square, respectively. Present plotting software in AREAS is drum plotter oriented with paging of plots. The map width is along the paper length axis and map length is segmented to 62.5 cm (25 inch) pages to fit within the drum width. The program simply steps further down the paper stock to produce the added segments necessary to plot the requested map length. Map production is then limited by the area of the paper/mylar stock.

In a practical sense, it is more manageable to produce map sets for these data. If a 75 centimeter window (30 inch square) is utilized, the three basic data sets would yield approximately 180 maps. Within the AREAS storage/retrieval there would be 180 data files. Hence plotter capacity dictates to a degree the complexity of file management and and map cataloging tasks which will accompany the project.

A 1979 DATAQUEST survey of users of mini and micro computer systems found user satisfaction was greater with PRIME than any other major general purpose minicomputer supplier (16 covered) in the survey. PRIME rated first in categories of Product Line Compatibility and CPU Performance, and second in categories of Software Support, Operating System, Reliability and Price. Neither Hewlett Packard nor DEC outscored PRIME in these areas for end-users surveyed.

PRIME's commitments to support end-users and keep "software first", i.e., total compatibility of programs throughout systems, has probably contributed significantly to the reported user satisfaction.

The technical differences between PRIME and Hewlett Packard for project purposes favored PRIME and therefore, the PRIME 250 was recommended to the SARG. This was selected and acquired. A Houston Instruments DP8S3 drum plotter would provide 92 cm (36.5 inches) by 45 meters (150 foot) capacity. This would accommodate software to accomplish the 75 cm window previously discussed. This plotter was recommended, selected and acquired for the project. The combination of the equipment recommended and acquired meets present project requirements and provides opportunity to expand the resource data base in the future.

1.6 PARTICIPANT TRAINING PROGRAM

1.6.1 GENERAL DEFINITION OF PROGRAM

Since the project represented an integrated approach to an analysis of existing natural resources in the SAR, several disciplines were required. The project was defined under the assumption that a certain minimum number of staff would require training in their respective disciplines and, since the project was remote sensing oriented, in understanding the applications of remote sensing technology. It was therefore, deemed necessary to send a multi-discipline team of Syrian scientists to the U.S. for non academic training in their respective disciplines for periods ranging from six months. A brief introducion to the basis of remote sensing would be presented during this period. The training would continue as much as possible after the scientists returned to the SAR through involvement in related project activities as guided by the resident U.S. experts.

Discipline training was to emphasize those practical activities required for the survey. Theory would not be emphasized except for that required to fulfill survey needs. Such topics as the use of the U.S. system of soil or plant taxonomy, typical U.S. manufactured equipment, U.S. quality standards, and U.S. accepted mapping methodologies should be addressed. Secondly, the development of professional contacts for future reference was to be emphasized. Since resources in South Dakota do not exactly parallel those in the SAR, these additional contacts should emphasize professionals from the arid west of the U.S.

Since remote sensing is a practical mapping tool, the most appropriate training is "on-the-job" while the survey is being conducted. A brief introducion to Landsat technology basics (note that this is only a small portion of the technology of remote sensing) should be provided. Laboratory image interpretation of data covering the SAR should be emphasized and preliminary maps for field checking produced. The training should continue as field efforts in the SAR for analysis of the images and correlation to ground features.

A total of 18 SAR natural resource scientists were determined by the contract to be sufficient to provide adequate input to program activities. The disciplines suggested in that document are presented in Table 1-3. It should be noted that this group composition was provided in the project paper prior to implementation by the RSI.

A program was defined for each discipline group as a general monthly outline in "Proposed Training Summary for Syria". That program defined that all 18 SAR scientists should be in residence in the U.S. at the same time. This would allow maximum efficiencies in use of facilities and personnel. Office space would be in apartments in the City of Brookings. All but one scientist would stay in Brookings during the major activity. Due to the availability of professional university staff, the hydrogeologist would reside in Rapid City at the School of Mines and Technology (approximately 650 km from Brookings).

The core curriculum would include a one week orientation, two weeks of remote sensing, and the remainder as laboratory, classroom, or field activities in their respective disciplines. Outlines of training topics and anticipated

schedules were documented in the December 1979 report to identify those areas that the university professional staff felt most appropriate for training topics. These were discussed with the SAR scientists prior to their departure for the U.S. Timing was critical such that the field efforts in training could be accomplished during the warm period in South Dakota.

1.6.2 IMPLEMENTATION OF THE PROGRAM

The initial phase was the selection of potential participants for the training program. This began as soon as the project manager arrived in the SAR. Although the proposed program required all 18 individuals in the U.S. at one time, this became impossible. An initial group of ten was selected. A second group of seven underwent English language training by USAID/Damascus and, upon successful completion of that training and receiving a satisfactory examination grade, followed the first group to the U.S. The final participant was not available until late in the project and was, in fact, also a participant in the first group. The trainees are listed in Table 1-4. The composition closely parallels that in Table 1-3.

A program of study was specifically designed for each group of trainees. Program duplication resulting from splitting the group presented some problems and some advantages. The manpower requirements for any specific training activity was doubled. However, within the scope of resources available, the best program possible was offered. As a result of the first group's experience, the program was altered for the second group to more exactly reflect their desires. The first group concentrated on discipline training and devoted two weeks to an intensive remote sensing training, and as a result, the program was modified to include four months of discipline training and two months of remote sensing training.

Field trips and guest lecturers provide a mechanism for trainees to become acquainted with the varied terrain and resources of the U.S. Trainees can draw parallels to their similar resources in the SAR. Future reference to advanced research or technique applications in the U.S. can U.S. can be better understood as to its adaptability in the SAR if the trainees have seen the facilities for research and have personally become acquainted with the investigators. Continuing contacts, if at a minimum through published literature, offer a unique resource to the SAR on fully utilizing academic understanding of resource development and preservation as gained by U.S. scientists.

Each trainee was required to participate in the generation of at least one report. The objective of this was to provide a period of reflection of the activities pursued during training. Certain procedures presented to the trainees are applicable to SAR and certain are not. It was the task of the trainee and his/her advisor(s) to determine which of the techniques was more applicable to the SAR needs. Certain reports present results of the photo-image interpretation. These products were made available such that field checking and updating at later phases could be completed.

1.6.3 EVALUATION OF THE PROGRAM

As evaluated by the U.S. advisors, the group was rated from average to good. Several factors entered this rating. As discussed previously, splitting the trainees into two groups and altering the program of study complicated the evaluation. Since most of the advisor's work was oriented towards field activities, it was difficult to evaluate those individuals trained in soil laboratory procedures. Since there was no soil fertility aspect to the project, that individual was difficult to evaluate. Some of the individuals were not stationed in Damascus and were, therefore, not utilized full time and some did not remain in the Soils Directorate after completion of their training.

Some areas such as discipline understanding, use of instrumentation, mapping and surveying procedures and acceptance of remote sensing applicability to the SAR showed great improvement. These are areas which were stressed during U.S. training and involvement in project activities upon return to the SAR. Changes in attitude are very difficult to evaluate on short-term basis.

The RSI considers that a substantial gain in experience level and technical understanding was provided to the SAR. The participants in this training provide the MAAR and DOS with a nucleus of scientists who are fully cognizant of remote sensing technology and its application to their respective disciplines in the SAR. Given adequate administrative direction and supervisior this core of scientists should be capable of continuing the activities of the project after its termination.

1.7 PROCUREMENT

Part of the institutionalization of the DOS involved procurement and delivery of equipment and supplies to replace, modernize and provide that available or not available at the beginning of the project. The earliest procurement and delivery was the Landsat satellite imagery as previously discussed. It also involved mobilizing a soil laboratory specialist to the SAR to review laboratory procedures, space, staff and facilities and to recommend needed items for procurement.

It was found that, whereas the laboratory was quite well equipped, much of the equipment was outdated and could not perform the required analyses of a modern soil laboratory. The laboratory building had sufficient space and staff. The facility was best equipped for routine soil chemical analyses but was nearly void of physical analysis capabilities. Such analyses are extremely important when considering irrigation development. Very limited equipment was available for field research on soil-water relationships or irrigation. The equipment procured to remedy these deficiencies is listed in Appendix A.

Acquisition of new equipment and implementation of new procedures required purchase of laboratory chemicals to support these activities. These are listed in Appendix B.

The DOS, while being adequately staffed, was very deficient in dependable field vehicles. Those acquired are listed in Table 1-5. The Chevrolet Blazers, being 4 x 4 vehicles, which hold five passengers, were used as vehicles for field

crew transportation. The Chevrolet sedan was used for administration transportation. The three Chevrolet 4 x 4 pickup trucks were equipped with Giddings Machine Co. hydraulic soil probes, model GSRB-S, for soil sampling and examination during soil survey field work or for sampling for analyses for any purpose. They were capable of sampling to a depth of two meters, sufficient for most purposes.

Several pieces of hand equipment were purchased in support of the soil survey fields activities. These are listed in Table 1-6. The final item of procurement was the computer and its peripherals as discussed previously and again in detail in the appropriate volume of this report.

1.8 PROJECT SCHEDULE

The project contract was signed in Washington, D.C. on 10 October 1979 by Mr. F.H. Moulton, USAID, and Mr. G.P. Shea, Louis Berger International, Inc.,for a 36 month project duration. Project mobilization activities were begun at this time by review of historical data, acquisition of preliminary Landsat imagery and by meeting with professionals familiar with the natural resources of the SAR. Dr. Bruce K. Worcester, the project manager, arrived on post in Damascus on 10 December 1979.

The immediate activities concentrated on three components of the project where timing was judged to be critical. The most pressing was the training component of the project. It was essential that this begin immediately because of its duration and the need to involve the returning trainees in the ongoing project activities in the SAR. This was considered an extension of training received at the RSI and it was the labor force required for timely project scheduling and completion. A total of 23 candidates were nominated by the SARG and were interviewed by the project manager. Seventeen of these were tentatively selected and were nominated to USAID and the SARG. A problem immediately arose when the Syrian State Planning Commission rejected seven of the nominees because of weakness in language. Ten were eventually approved and they began their training at the RSI in May, 1980. The remaining seven were enrolled in full-time intensive language training supervised by USAID and finally achieved acceptable language competence in July, 1980, but actually were approved by the SARG and began training in November, 1980. The original 10 completed their training and departed the RSI at the same time. The second seven completed their training and departed the RSI in May, 1981. The final trainee, in computer science, began training in March, 1982, 18 months behind schedule. All trainees were supposed to be prepared to begin training immediately after initiation of the project according to the contract. This was not possible because of inadequate English language training and the inability to identify a technically competent computer science trainee.

The second major thrust was for procurement, processing and delivery of Landsat imagery. Selection of the multi-season imagery was finalized in January, 1980. It was purchased from Telespazio, Rome in April, 1980 as computer compatible tapes for computer processing prior to delivery. All processing was completed and the final imagery delivered in April, 1981.

The third immediate area of concern was initiated at the request of the SARG, for rapid procurement of vehicles. In response to this urgent request, four Chevrolet K-5 Blazers and one Chevrolet Caprice sedan were purchased in January, 1980 at the duty free zone in Adra. The four Blazers were ultimately used as field vehicles by project staff. The sedan was provided to the Directorate of Soils and it was never used for any project related activities. These vehicles were eventually licensed by the SARG in November, 1980. The ten-month field season was lost because of this and subsequent unavailability of acceptable transportation.

The laboratory expert, Dr. W.H. Dahnke, arrived in April, 1980 for one month. He reviewed the existing laboratory facilities, equipment and procedures with the director of the laboratory. They jointly prepared lists of needed equipment and supplies. These lists were submitted to the SARG for concurrence and USAID for approval. Procurement began immediately. Delivery to the Directorate of Soils laboratory was delayed by slow receipt of duty-free customs from the SARG.

In April, 1980 a review of minicomputers and recommendations were presented to the SARG. The recommendation was for a Prime model 250 minicomputer and a Houston Instruments plotter were made and accepted. USAID authorized purchase in September, 1980. The equipment was delivered and installed at the RSI in January, 1981. It was packaged for shipment to the SAR in June, 1982 and at the time this report was prepared, is scheduled for shipment in late August, 1982.

The 1:500,000 scale soil survey began with the arrival of the soil scientist, Mr. Haluk Yuksel, in June, 1980. The survey was completed in June, 1981. This exceptionally long time for a reconnaissance survey was partially due to the unavailability of transportation until November, 1980. Also, it was decided to increase the amount of ground truth and sampling to improve the map accuracy. In addition, much of the detailed data were intended to be transferred to the 1:100,000 scale survey. The 1:100,000 scale survey was originally to have been conducted by Bruce Worcester; however, he was removed from the project for health reasons and that survey was conducted by Fred Westin from March to June, 1982.

Mapping of present land use was begun in March, 1981 when Mr. Dominique Durlin arrived as the land use specialist. Personnel problems caused this activity to be reduced from 12 to 9 months duration with no change in performance requirements. The tasks of mapping the entire SAR at 1:500,000 scale and the First settlement Zone at 1:100,000 scale were completed on schedule in November, 1981.

Range management studies were conducted by Dr. G.K. Eulert from April, 1981 until January, 1982. This represents a reduction from 12 to 9 months also. The task was completed on schedule. Mr. Fred Bergsrud was in residence from September, 1981 through September, 1982 as project irrigation specialist. His tasks were accomplished on schedule. Each of these specific activities is discussed in detail in the respective volume of this report.

Periodic project reviews were held in accordance with contract requirements. A first annual review was conducted in March, 1981. Included were representatives of Louis Berger International, Inc., RSI, USAID and SARG. A

second annual review was held in November, 1981 at the end of the field season.

1.9 ACKNOWLEDGEMENTS

The Land Classification/Soil Survey Project was conducted jointly by Louis Berger International, Inc. and the Remote Sensing Institute, South Dakota State University, cooperating with the Directorate of Soils, Ministry of Agriculture and Agrarian Reform, Syrian Arab Republic. The project was funded by U.S. Agency for International Development, project number 276-0020.

Many people participated in the various aspects of the project and they are acknowledged in the following list:

A. Resident Staff:
- Bruce Worcester, Project Manager/Soil Scientist 11/79 to 2/82
- Haluk Yuksel, Project Manager/Soil Scientist 2/82 to 10/82
- Frederick Westin, Soil Scientist
- Dominique Durlin, Land Use Expert
- Gene Eulert, Range Management Expert
- Frederick Bergsrud, Irrigation Expert
- William Dahnki, Soil Laboratory Expert

B. Directorate of Soils:
- Jouma Abdl Karim, Director
- George Somy, Assistant Director, Chief of Irrigation Drainage, and Reclamation Section
- Moudehean Taha, Chief of the Soil Survey Section
- Ilyas Jabour, Chief of Land Use Section
- Taha Dolamey, Chief of Laboratory
- Hashem Slayme, Chief of Central Laboratory
- Riad Rizik, Soil Scientist/Administrative
- Inam Al Daya, Soil Scientist
- Hana Al Deiri, Soil Scientist
- Said Sheikh al Shabab, Irrigation Speciali
- Adib Jabr, Soil Scientist
- Ayman Jabri, Land Use Specialist
- Adib Safi, Soil Fertility Specialist
- Imad Hassoun, Range Management Specialist

C. Home Office Support Staff and Specialists:
- Gerald P. Shea, Vice President, Louis Berger Int. Inc.
- Victor I. Myers, Director, Remote Sensing Institute
- Nancy Dameron, Staff Assistant
- Mary Buckmiller, Graphic Designer
- Darrell Hause, Computer Expert
- Mike Wehde, Computer Expert
- Kevin Dalsted, Soil Scientist
- Jan Griesenbrock, Photo Specialist
- Janet Gritzner, Geographer

2 RECOMMENDATIONS

An excellent beginning has been made in the Land Classification/ Soil Survey Project to inventory the resources of Syria and to highlight limitations that adversely affect the environment. Preliminary efforts have been made to outline improvements needed to overcome the limitations and reduce the hazards and also a beginning has been made to assess the impact of selected land uses on the environment. These beginnings need to be expanded into a long-range plan.

This long-range plan should include the following parts. First, a coordinating group should be designated to oversee the activities that deal with land classification and soil survey. The tasks of this group would be: 1) to establish priority areas in Syria for future study; 2) to plan special studies, investigations and laboratory activities that contribute to the problems of the selected areas; 3) to plan a training program for staff; and 4) to develop guidelines for use of land classification and soil survey information.

To establish priority areas in Syria for study, it is necessary to set guidelines for area selection. Some of these guidelines include selection of areas having rapid land use changes, and those areas with critical soil and water problems. Information included in the volumes of this project can be the basis for area selection.

Special studies, investigations and laboratory activities include characterization data (organic matter contents, cation exchange capacities and the like) for soils having unique problems such as salinity, vertisolic soil heaving, mineral deficiencies, etc. These studies help scientists understand genetic soil relationships as well as provide guidelines for such practical operations as herbicide and fertilizer application rates. Other special studies include the continued use of remote sensing to speed up resource surveys without reducing survey quality and to monitor land use changes. Plans should be made to evaluate Landsat D and imagery from the French SPOT satellite in Syria for resource inventories. Landsat D will bring additional channels of data and improved resolution. The Thematic Mapper and Landsat D will provide improved spectral resolution. Both the Landsat D and the SPOT satellite will provide improved spatial resolution. Other special studies will be to continue analysis of maps and images to generate useful products to assist with problem solving.

Studies needed in the area of range science include the continued accumulation of a comprehensive body of basic data. These data are needed to estimate carrying capacities of the range units and to form a basis for monitoring changes. Aerial photos of scales of 1:12,000 to 1:20,000 are needed for range management. This scale is required, if small but important vegetation types are to be located and mapped. These small scale aerial photos also can be used to record the location of highly palatable plants to use as future seed sources. Improvement of degraded rangeland should have a high priority in Syria. To accomplish this, grazing pressure must be reduced or in severe cases, land should be left idle until vegetation is established. Permanent study sites should be established by constructing exclosures for demonstration and research purposes in the major vegetation types in different rainfall belts. Development of Hema - cooperatives may be helpful to establish grazing control if they are based on an ecological foundation. All segments of the population must be educated in the social, economic and cultural aspects of range science. Unless

the population of Syria is stabilized, continued pressure on the grazing lands will inevitably result in desertification.

Increased resources are needed in the area of irrigation agriculture. This increased effort is needed to determine consumptive use requirements and to determine crop coefficients used in calculating crop consumptive use. There are needed major empirical, theoretical and correlative methods for calculating crop consumptive use of water. In addition, a joint study needs to be undertaken by all the government agencies involved in the management and control of project water delivery systems. A field management education program should be started based on a moisture accounting approach and also a research program initiated on how to best use the limited amount of water available for irrigation and to determine the evaporative and wind drift losses in sprinkler irrigation.

A training program for student trainees should be established. A steady supply of field-trained scientists and computer specialists is essential for the success of this program. In addition, there should be special training of present staff in manuscript writing, management training, soil correlation and training methods. Use of land classification and soil survey data depends in part on clearly written manuscripts. Management training is necessary if resource survey party leaders are going to efficiently use personnel and equipment assigned to projects. Soil correlation involves comparing local classificational units with those already named and defined in a general system of classification. It also includes grouping of soils into higher categories and arranging the unit into groups needed to bring out relationships among soils. The ultimate usefulness of soil mapping depends upon accurate soil correlation. The most efficient method to train soil correlators is through a well conceived training program.

The Data Base Information System with its capacity for producing thematic maps and tabular data has almost unlimited potential for expansion. Much additional resource information can be entered for the cellular areas, such as geology, forestry, hydrology, and others. Also, demographic and economic data can be included to make it possible to combine social and economic data with resource data in making management decisions.

The size of cells in the present system were selected on the basis of the satellite reconnaissance imagery used in the resource survey. As higher resolution imagery becomes available and as more detailed ground investigations are carried out, the present cells can be subdivided and the more detailed data entered in the computer data base to provide improved information.

The thematic maps produced in Volume 9 of this report are only typical examples of such products that can be produced with the information system. Numerous other map products, at various scales, can be produced for use in making management decisions.

Table 1-1
U.S. STAFF COMPOSITION

POSITION	NAME	ORGANIZATION	RESIDENCE PERIOD
Chief of Party	Dr. B. Worcester	RSI	12/79 - 2/82
	Mr. H. Yuksel	LBII	2/82 - 10/82
Soil Scientist	Mr. H. Yuksel	LBII	7/80 - 10/82
	Dr. B. Worcester	RSI	12/79 - 2/82
	Dr. F. Westin	RSI	3/82 - 6/82
Irrigation Specialist	Mr. F. Bergsrud	RSI	9/80 - 9/81
Land Use Specialist	Mr. B. Miller	LBII	5/80 - 7/80
	Mr. D. Durlin	LBII	2/81 - 10/81
Lab Specialist	Dr. W. Dahnke	LBII	4/80 - 5/80
Range Specialist	Dr. G. Eulert	RSI	3/81 - 1/82
Computer Specialist	Mr. D. Hause	RSI	

* RSI - Remote Sensing Institute
LBII - Louis Berger International, Inc.

TABLE 1-2
PRINCIPAL HOME OFFICE SUPPORT STAFF

NAME	TITLE
Mr. V.I. Myers	Director, Remote Sensing Institute
Mr. G.P. Shea	Vice President, Louis Berger International, Inc.
Dr. D.G. Moore	Head of Training, RSI
Ms. N. Dameron	Administrative Asst., Training, RSI
Mr. J. Griesenbrock	Head, Photo Lab, RSI
Dr. F. Schmer	Head, Fiscal Section, RSI
Mr. M. Wehde	Computer Specialist, RSI
Ms. A. Veen	Graphic Artist, RSI
Mr. D. Hause	Computer Specialist, RSI

TABLE 1-3
SAR TRAINING PROGRAM PARTICIPANTS AS DEFINED IN THE PROJECT PAPER

Discipline	Months of Training	Number of Participants	Participant Months
Range Management	12	1	12
Soil Mappers	6	5	30
Soil Lab Technicians	6	1	6
Plant Ecologist/Agronomist	6	2	12
Irrigation Specialist	6	3	18
Hydrogeology	6	1	6
Soil Fertility	6	1	6
Soil Technicians	6	3	18
Mini Computer Specialist	6	1	6
TOTALS		18	114

Table 1-4

TRAINEES IN-RESIDENCE IN SOUTH DAKOTA

	NAME	TRAINING DISCIPLINE	DATES OF ATTENDANCE	MAJOR PROFESSOR
1.	Inam El Daya*	Soil Mapping	May 5 - October 31, 1980	Dr. F.C. Westin
2.	Hana Al Deiri	Soil Mapping	May 5 - October 31, 1980	Dr. F.C. Westin
3.	Aiman Hassani	Soil Mapping	May 5 - October 31, 1980	Dr. F.C. Westin
4.	Kheira Al Khatib	Soil Technician	May 5 - October 31, 1980	Professor Paul Carson
5.	Said Sheikh Al Shabab	Irrigation	May 5 - October 31, 1980	Dr. L.O. Fine
6.	Sabah Al Baba	Soil Lab Technician	May 5 - October 31, 1980	Professor Paul Carson
7.	Adib Jaber	Soil Mapping	May 5 - October 31, 1980	Dr. F.C. Westin
8.	Bassam Al Sarraj	Soil Mapping	May 5 - October 31, 1980	Dr. F.C. Westin
9.	Samir Ismayel	Irrigation	May 5 - October 31, 1980	Dr. L.O. Fine
10.	Hassan Terchahani	Hydrogeology	May 5 - October 31, 1980	Dr. Perry Rahn
11.	Hashem Salaymeh*	Soil Lab	October 27, 1980-April 27, 1981	Professor Paul Carson
12.	Khaled Al Shari	Irrigation	October 27, 1980-April 27, 1981	Dr. L.O. Fine
13.	Elham Tu Ameh	Soil Lab	October 27, 1980-April 27, 1981	Professor Paul Carson
14.	Widad Chihadeh	Agronomy/Fertility	October 27, 1980-April 27, 1981	Dr. R. Vigil
15.	Ayman Jabri	Agronomy/Land Use	October 27, 1980-April 27, 1981	Dr. R. Vigil
16.	Adib Safi	Soil Fertility	October 27, 1980-April 27, 1981	Professor Paul Carson
17.	Imad Hassoon	Range Management	October 28, 1980-July 25, 1981	Dr. J.K. Lewis
18.	Said Sheikh Al Shabab	Computer Science	February 3, 1982-September 1, 1982	Mr. Mike Wehde

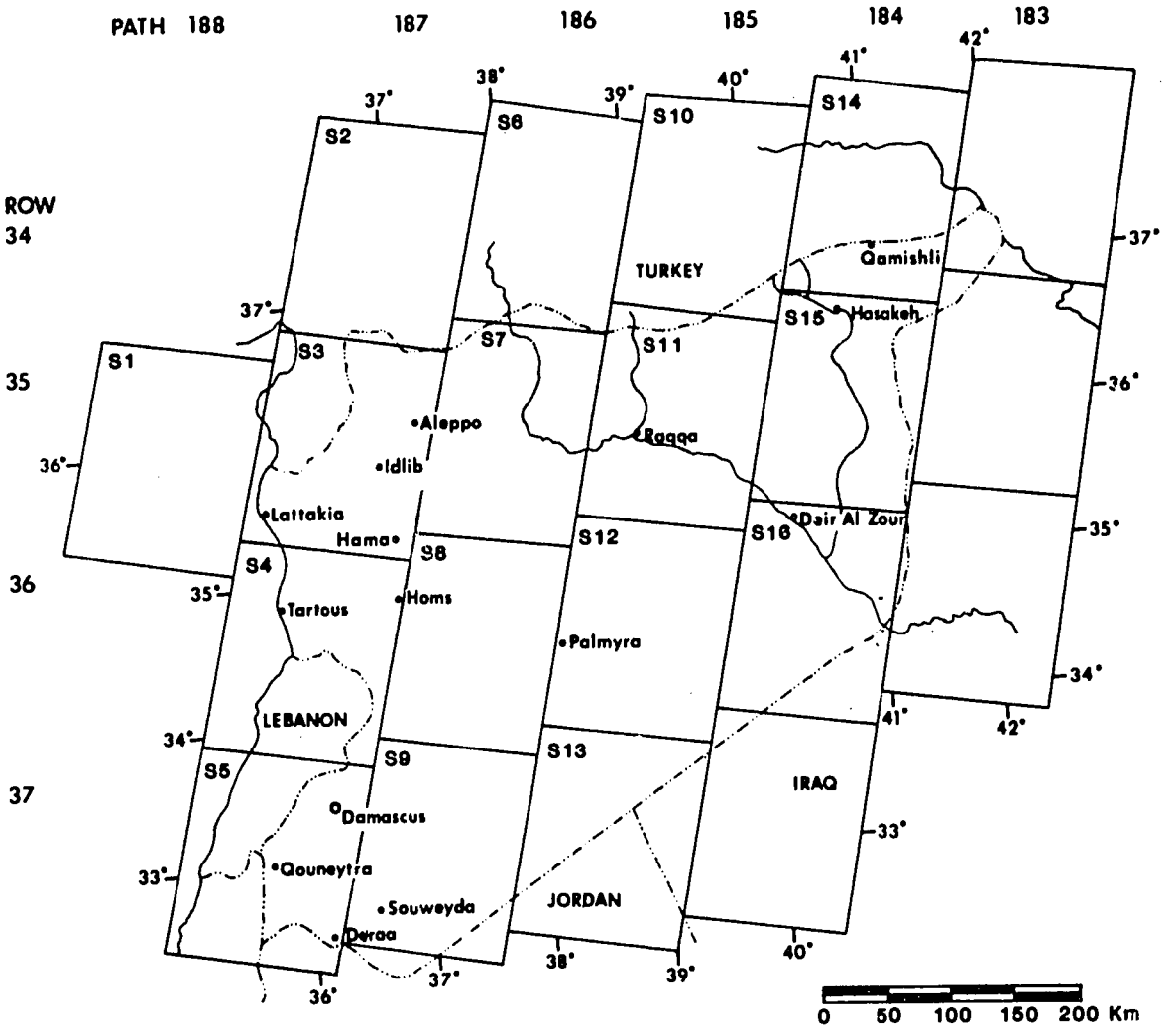
* Denote the leaders for groups 1 and 2, respectively.

TABLE 1-5
VEHICLES PRUCHASED FOR DOS

NO.	YEAR	MODEL
4	1979	Chevrolet Blazers
1	1980	Chevrolet Sedan
3	1981	Chevrolet 4x4 Pickups

TABLE 1-6
HAND EQUIPMENT PURCHASED FOR SOIL SURVEY

NUMBER	DESCRIPTION
10	Folding pocket stereoscopes
10	Field knives
10	10x magnifying lenses
5	Buckets
5	Oakfield soil probe kits
5	Compasses and cases
5	Abney levels
5	La Motte soil test kits
4	Mirror stereoscopes



S1 •21221-35067
27-5-78
•21653-35091
2-8-79
•1163-07471
2-1-73 (B5,7)

S2 •21220-34067
26-5-78
•21670-34092
19-8-79

S3 •21220-35067
26-5-78
•21670-35092
19-8-79

S4 •21220-36067
26-5-78
•21670-36092
19-8-79
•1162-07420
1-1-73 (B5,7)

S5 •21220-37067
26-5-78
•21670-37092
19-8-79
•1162-07422
1-1-73 (B5,7)
•3030-70731
6-1-79 (RBV)

S6 •21561-34086
2-5-79
•21687-34093
5-9-79

S7 •21219-35067
25-5-79
•21687-35093
5-9-79
•2391-07210
17-2-78 (B5,7)

S8 •20677-36048
17-6-79
•21687-36093
5-9-79

S9 •21219-37067
25-5-79
•21687-37093
5-9-79
•3093-607130
26-9-80 (RBV)

S10 •21560-34086
1-5-79
•21686-34093
4-9-79

S11 •21560-35088
1-5-79
•21686-35093
4-9-79

S12 •21560-36088
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•21686-36093
4-9-79

S13 •21560-37086
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S14 •21559-34086
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30-4-79
•21703-35094
21-9-79

S16 •21559-36086
30-4-79
•21703-36094
21-9-79

Figure 1-1

Landsat imagery coverage of the Syrian Arab Republic.

APPENDIX A

EQUIPMENT LIST

ITEM NO.	DESCRIPTION	QUANTITY
1	Soil Hydrometer	10
2	Hydrometer Jars	10
3	8"STO Brass Sieve, 50mm	1
4	" " " , 25mm	1
5	" " " , 8mm	1
6	" " " , 4mm	1
7	" " " , 2mm	4
8	" " " , 1mm	4
9	" " 500um	4
10	" " 250um	4
11	" " 125um	4
12	" " 106um	4
13	" " 53um	4
14	" " 138um	4
15	8 " Brass Pan	2
16	8 " Brass Cover	2
17	Sieve Shaker (220 V, 50 cycle)	2
18	Volumease	2
19	Ballons	2
20	Cylinder	2
21	Calibration Data Sheets	2
22	Density Test Data Sheets	5
23	Gasket Set	2
24	Bulb Assembly	2
25	15-Bar Ceramic Plate Extractor	1
26	Sample Retaining Rings (12)	5
27	"O" Ring Extractor Lid Seals	5
28	1-Bar Low Pressure Plate Cell	2
29	3-Bar Low Pressure Plate Cell	2
30	15-Bar Ceramic Cup	1
31	Electrical Lead	1
32	Ceramic Plate Cell	2
33	Manifold	2
34	Manifold	2
35	Cellulose Casing (50 ft)	5
36	Std. Liquid Limit Set	2
37	Spare Cup and Holder	2
38	Dial-Type Tensiometer	5
39	" " "	5
40	" " "	5
41	" " "	5
42	" " "	5

Equipment List (Continued)

ITEM NO.	DESCRIPTION	QUANTITY
43	Insertion Tool	2
44	Soil Benetrometer	10
45	Two-Stage Vacuum Pump	2
46	Epoxy dip Conducting Cell	5
47	Glass Micro Dip Conductivity Cell	5
48	Sodium Hexa-Meta Phosphate	25 lbs.
49	Diluter	2
50	Three Volume-one Aliquot Dispenser	2
51	Dyna Crush Soil Crusher	1
52	Sample Screening Pan 80 mesh	1
53	Nitrous Oxide Burner	1
54	Iron Lamp	1
55	Zinc Lamp	1
56	Manganese Lamp	1
57	Coppet Lamp	1
58	Molybdenum Lamp	1
59	Boron Lamp	1
60	Block Digestor (220v/50 hz)	1
61	Digestor Stand	2
62	Digestion Tubes	200
63	Retainer Plate	1
64	Side Plates	1
65	Centrifuge	1
66	8-Place Head (IEC 240)	1
67	Trunnion Rings (IEC 366)	10
68	Shields (16)	2 (pk)
69	Tubes	2 (cs)
70	Buchner Funnels	2 (cs)
71	Wrist Action Shaker	2
72	Lindberg Box Furnace	1
73	Central Control for 10-549-110C	1
74	Combustion Crucibles	2 (cs)
75	Dispenser (5ml)	10
76	Dispenser (10ml)	20
77	Dispenser (25ml)	10
78	Adapter Set	10
79	Magnetic Stirrer	4
80	Magnetic Stirring Bars	50
81	Spectronic-20, Spectro-photometer	1
82	Extra Phototube	2
83	Glass Electrode (rugged)	10
84	Reference Electrode	5
85	Accumet 750 pH-Ion Meter	2

Equipment List (Continued)

ITEM NO.	DESCRIPTION	QUANTITY
86	Nitrate Electrode	1
87	Replacement Module	2
88	Nitrate Activity Std.	1
89	Double-Junction Reference Electrode	5
90	Chloride Solid State Electrode	1
91	Reference Electrode Fiuing Solution	1
92	Chloride ppm Std.	1
93	pH 4 Buffer	6
94	pH 7 Buffer	6
95	pH 10 Buffer	6
96	Metal Combination Electrode (OM titration)	1
97	Analdg pH/mu meter (OM titration)	1
98	Class S-1 set of wts	2
99	Electrical Glasswate Druyer (220v/50hz)	5
100	Mercury Barometer	1
101	Spatula	12
102	Weighing Spatula	12
103	Erlenmyer Flasks	10 (cs)
104	" "	10 (cs)
105	" "	5 (cs)
106	Beakers	8 (cs)
107	"	8 (cs)
108	Graduated Cylinders	1 (cs)
109	" "	1 (cs)
110	" "	1 (cs)
111	" "	1 (cs)
112	" "	2 (cs)
113	" "	3 (cs)
114	Funnels	8 (cs)
115	Volumetric Flasks	10 (cs)
116	" "	5 (cs)
117	" "	5 (cs)
118	" "	2 (cs)
119	" "	3 (cs)
120	Burets	2 (cs)
121	Burets	2 (cs)
122	Buret Support	10
123	Liquinox	1 (cs)
124	Warburg Manometer	2
125	Manometer Stand	2
126	Reaction Vessel	5

Equipment List (Continued)

ITEM NO.	DESCRIPTION	QUANTITY
127	Springs	2 p
128	Two-stage Vacuum Pump	1
129	Eberback Shaker (220v/50hz)	3
130	Shaker Carrier Plate	2
131	Flask Holders	20
132	Flask Holders	20
133	Shaker Carrier	1
134	Timer	1
135	Vacuum Tubing	50 ft.
136	Soil Resistance Cup	2
137	59 " Fume Hood (220v/50hz)	1
138	70 " Fume Hood (220v/50hz	1
139	Flexible Exhaust Tubing	3
140	Nitrous Oxide Regulator	1
141	10 ft. connecting hose	1
142	Hot Plate (31x76)	3
143	Automatic Titrator	1
144	Chloride Titration System	1
145	Phenylarsine Oxide Sol.	1 (cs)
146	Potassium Iodie Sol.	1 (cs)
147	Buffer Solution, pH 4	1 (cs)
148	Buffer Solution, pH 7	1 (cs)
149	Conductivity/salinity meter	3
150	Conductivity Probe	5
151	Replatinizing Kit	1
152	Patinizing Solution	2
153	Microscope	1
154	Conductivity Meter	2
155	Fume Hood	1
156	Motor-Blower (220v/50hz)	1
157	Stainless Steel Perchloric Acid Fume Hood (220v/50hz)	1
158	Motor Blower (220v/50hz)	1
159	Fume Exhaust for AA	1
160	Stainless Steel Ducting	1
161	Stainless Steel Coupling	1
162	Atomic Absorption Spectrometer	1
163	Turbidimeter	1
164	Spare Lamp Source	5
165	Timer	6
166	Color Charts	10
167	Gley Charts	10
168	Orion Field pH Meter and Spare Electrodes	6

APPENDIX B

CHEMICALS

ITEM NO.	DESCRIPTION	QUANTITY
1	Boron Std. Solution	500 ml
2	Calcium Std. Solution	500 ml
3	Copper Std. Solution	500 ml
4	Iron Std. Solution	500 ml
5	Magnesium Std. Solution	500 ml
6	Manganese Std. Solution	500 ml
7	MolybdnemumStd. Solution	500 ml
8	Potassium Std. Solution	500 ml
9	Sodium Std. Solution	500 ml
10	Zinc Std. Solution	500 ml
11	Ammonium Acetate	10x10 kg
12	Ammonium Oxalate	6x500g.,cs
13	Ammonium Molybdate	12x500g.,cs
14	Ascorbic Acid	6x100g., cs
15	Barium Diphenylamine sufonate	6x5g., cs
16	Boric Acid	500 g.
17	Bromcresol Green	10x5 g.
18	Calcein Indicator	12x5 g.,2cs
19	Calcium Nitrate	6x500 g.,1cs
20	Calcium Oxide	500 g.
21	Activated Carbon	6x500g., cs
22	Ferrous Sulfate	12x500g.,2cs
23	Eriochrome Black T	500 ml
24	Hydrochloric Acid	12x2.5 L,2cs
25	Hydroxylamine Hydrochloride	12x100 g.,2cs
26	Magnesium Chloride	6x500g., cs
27	1 N Hydrochloride Acid, Std. Solution	500 ml
28	Nitric Acid	12x500 ml, 2cs
29	Methyl Orange	4x25 g.
30	Methyl Red	10x10 g.
31	Methylene Blue	100 g.
32	Phenol	6x500 g., cs
33	Phenolphthalein	4x25 g.
34	1, 10-Phenanthroline Ferrous Sulfate	6x100 ml, cs
35	Phosphoric Acid	24x500 ml, 4cs
36	Potassium Dichromate	6x500 g., cs
37	Hydrogen Peroxide	24x500 ml, 4 cs
38	Potassium Permanganate	6x500 g., cs
39	Potassium Sulfate	6x500 g., cs
40	Sodium Acetate	6x500 g., cs
41	Sodium Dithionate	2x100 g.
42	Sodium Citrate	2x500 g.

CHEMICALS (Continued)

ITEM NO.	DESCRIPTION	QUANTITY
43	Sodium Tetraethylene Diamine Tetraacetate	6x500 g., cs
44	Silver Nitrate	4x25 g.
45	Silver Sulfate	4x25 g.
46	Stannous Chloride	500 g.
47	Sodium Hydroxide, 2 N	1 Liter
48	Triethyanolamine	6x500 ml
49	Thymol Blue Solution	500 ml
50	Diethylenetriaminepentaacetic Acid	5 kg.
51	Sodium Salicylcate	12x500 g., 2 cs
52	Sodium Nitroprusside	12x100 g., 2 cs
53	Sodium phosphate	6x1,kg., cs
54	Sodium Thiosulfate	2x10 kg.
55	Sodium Chloride	2x10 kg.
56	Ammonium Vanadate	12x100 g., 2cs
57	Ammonium Molybdate	2x3 kg.
58	Barium Chloride	6x1 kg. cs
59	Cupric Sulfate	6x500 g., cs
60	Sodium (di ethylenediamine Tetraacetate	2x3 kg.
61	Ferrous Sulfate	10x1 kg.
62	Sodium Potassium Tartrate	6x500 g. cs
63	Potassium Sulfate	8x3 kg. 2 cs
64	Antimony Potassium Tartrate	6x500g. cs
65	Phosphoric Acid	12x1 L, 2 cs
66	Polyvinylpyrrolidone	10x500 g.
67	Salicylic Acid	10x 1 kg.
68	Sulfuric Acid	18x2.5 L, 3 cs
69	BRIJ-35, 30 Solution	2x1 L.
70	1-Octanol	6x1 L, cs
71	Parafin Oil	6x1 L, cs
72	Aluminium Std. Solution	500 ml
73	Silicon Std. Solution	500 ml