Soils of the Syrian Arab Republic

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Status of soil surveys in the country

Soil mapping at the national level

At this level one could mention three major soil survey projects covering the total area of the country:

1. General soil map of Syria, prepared by FAO: The map was produced in 1965 at a scale of 1:500,000. The report of the map includes 151 pages (Van Liere, 1995)

2. Soil map of Syria at a scale of 1:500,000 prepared as a technical assistance project of USAID to Syria. The project was terminated in 1982 (Yuksel, 1982). The legend of the soil map was built up with association of subgroups of the U.S.D.A. Soil Taxonomy (1975).

   The soils of Syria were grouped in 999 associations. The report of the map is entitled "Land Classification/Soil Survey Project of the Syrian Arab Republic" comprising 567 pages (Yuksel, 1982). For each soil association on the legend, the report includes the following information:

   - General characteristics;
   - Location and extent;
   - Geomorphology;
   - Climate;
   - Geology;
   - General land use;

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- Soils;
- Surface stoniness; and
- Crop recommendations.

The report also includes interpretation of limitation and potential for each soil association. The work was based on investigating 93 soil profiles and about 600 soil observations, which were performed by the Arab Centre for the Studies of Arid Zones and Dry Lands (ACSAD).

3. Soil map of Syria, prepared by ACSAD at a scale of 1:1,000,000 in 1983.

   The legend of the soil map includes 55 groups of soil associations at the subgroup level (USDA, Soil Taxonomy, 1975) with some modifications, especially in the associations of the gypsiferous soils. In addition to soil associations, the legend includes information on slope and texture of the surface layer (0-30 cm).

The description of each group include (Ilaiwi, 1983):

- Location, landscape and parent material;
- Rainfall;
- Land Use;
- Composition and soil occurrence; and
- Range in soil characteristics.

The work was based on a systematic soil survey covering the whole country. About 700 soil profiles were described, of which about 100 profiles were analysed. Mineralogical and micromorphological investigations were carried out for a large number of samples.

The map legend was recently converted according to the 2nd edition of USDA, Soil Taxonomy, 1999. In this map as well as the U.S.AID map, the mapping units were delineated on satellite data of the same map scale.

Information from both maps, as well as additional data from local soil surveys, was used to prepare the "Soil and Terrain Digital Database-SOTER). About 190 profile descriptions and analyses were used to represent soils of the 90 SOTER units of Syria. In addition to SOTER map, both USAID and ACSAD map are also digitised.

Soil mapping at the local level

Soil mapping at this level has been done either by foreigner consulting companies or by the staff of the Ministry of Agriculture and Agrarian Reform. In the first example the surveys usually covered areas chosen for agricultural development (mainly irrigation projects) with mapping scales of 1:25,000 or larger. Irrigation and drainage designs are usually included in such surveys.

Most of these studies were carried out within the Euphrates irrigation projects and to a lesser extent to the Khabour and the Al-Ghab irrigation projects. Classification systems used are dependent on the nationality of executing agencies. Examples of these studies are listed in Table 1

Soil surveys carried out by the staff of Soil Directorate within the Ministry of Agriculture cover about 40% of the country. Examples are given in Table 2. Since the beginning of the eighties, work was started in surveying areas with the highest agricultural potential.

A local methodology was followed to describe soil profiles according to the following items: Depth, Colour, Texture, Structure, Roots, Consistency, Oxides and stains, Permeability, Drainage, Cemented layers or rocks, Carbonates and Moisture.

Laboratory analyses performed in the country include the following:

ECe, pH Calcium Carbonate, Organic Matter, Gypsum, CEC, Exchangeable K, Available Phosphorous, Mechanical analyses and soluble salts.

The mapping scale was 1: 25,000. In general, where topographic maps at the same scale are not available, the mapping scale becomes 1:50,000. About 20,000 profiles were described and analysed.

Land capability of soil mapping units was evaluated according to the USDA handbook no: 210.

Major soil constraints for agricultural production and for sustainable use of land resources

Soil constrains for agricultural production in Syria could be listed as follows:

1. Shallow soil depth over bedrock: These soils are usually found in mountainous areas and commonly associated with steep slopes. Removal of the natural forest cover, in historical as well as in recent times is believed to be the main reason for soil shallowness. Rock outcrops are found in summits, and upper parts of slopes followed by Lithosols (Lithic Torri/Xerorthents).

2. Presence of cemented crust very close to the soil surface: These are the petrocalcic and petrogypsic horizons. Petrocalcic horizons prevail in three mapping units in Syria. They are mostly related to mountainous fronts and colluvial fans. Their climate is typically transitional between the arid and Mediterranean climates, with rainfall ranging from 200÷350 mm.

Table 1. Examples of soil surveys carried out by foreign consulting companies

Area	Implementing party	Submission date	Scale	Total area (ha)	Remarks
Left bank of southern Khabour and Euphrates	Techno-prom export	1963	1:25,000	38,000	Pedology, geology, hydrology, irrigation & sewage net design
Euphrate basin	Nidico	1963	1:100,000	1,759,000	Pedology, geology, hydrology
Low Euphrates	Ghisarsit	1976	1:50,000 – 1:25,000	164,800	Pedology, geology, hydrology, topography
Low Euphrates, area one	Ghisarsit	1978	1:25,000	65,450	Irrigation & sewage net design
Low Euphrates, area 1&2	Ghisarsit	1981	1:25,000	78,500	Pedology, geology, hydrology, irrigation & sewage net design, topography
Middle Euphrates	Roma ghrimex	1978	1:25,000 – 1:5,000	30,817	Pedology, geology, hydrology, irrigation & sewage net design, topography
Baliekh basin	Aleksander jeep	1966 – 1967	1:25,000	502,000	Pedology, geology, hydrology, irrigation & sewage net design, topography
Baliekh basin, sections:3,4,5,6	Soghria	1974	1:25,000	163,460	Pedology, geology, hydrology, irrigation & sewage net design, pilot project topography
Baliekh basin, sections:3,4,5,6	Roma ghrimex	1980	-	71,590	Pedology, geology, hydrology, irrigation & sewage net design, topography
Baliekh basin, sections:1,2	Techno Export strowy	1975	1:25,000	50,000	Pedology, geology, hydrology, irrigation & sewage net design, topography
Baliekh basin, Pilot Project	Aleksander jeep	1967	1:25,000	24,500	Pedology, geology, hydrology, irrigation & sewage net design, topography
Baliekh basin	General establishment for investment, Alexander jeep company	1966-1967	1:20,000	9,500	Maps are annexed
Al-Rassafa basin	Techno Export strowy	1974	1:25,000	62,000	Pedology, geology, hydrology, irrigation & sewage net design, topography
Mskanah Sharek	Nipon Koy	1977	1:25,000	56,000	Pedology, geology, hydrology,

					irrigation & sewage net design, topography
Typical Farm	Solkhoz brom Export	1974	1:25,000	4,049	Pedology, geology, hydrology, irrigation & sewage net design, topography
Maskanah Ghareb Project	Solkhoz brom Export	1975	1:25,000	24,343	Pedology, geology, hydrology, irrigation & sewage net design, topography
Maskanah Ghareb Project	Solkhoz brom Export	1977	1:100,000 – 1:25,000	174,500	Pedology, geology, hydrology, irrigation & sewage net design, topography
Aleppo plateau	Solkhoz brom Export	1980	1:100,000	385,196	Pedology, geology, hydrology, irrigation & sewage net design, topography

Table 2. Examples of local soil surveys carried out by the soil directorate of the Syrian Ministry of Agriculture

Area	**Implementing party**	**Submission date**	**Scale**	**Total area (ha)**	**Remarks**
Al Ghab	Soil Directorate, FAO	1973	1:50,000		Map annex
Taar Al-ulla Alasharina	Soil Directorate	1975	1:20,000	54,027	Soil annex (lab analyses results, soil groups diagram, soil grades diagram
Al-sen river	Soil Directorate	1974	1:20,000		Maps are annexed (pH and $CaCO_3$ data are in soil groups)
Jablah	Soil Directorate	1974	1:20,000	35	Maps are annexed
Al-Faid valley (Raqqa)	Soil Directorte, Dr. M. Shaliha	1973		4,000	
Daraa and Sowaidaa	Soil Drectorate, Soil	1980	1:25,000		Maps are annexed

	classfication and Pedological Research Section				
Al-Assi basin	Soil Directorate, Soil classification and Pedological Research Section	1980	1:25,000	60,000	Annex (lab analyses results, soil groups diagram L2L, geological diagram of the area)
Lower Euphrates, two banks	Ministry of Agriculture and Agrarian Reform	1974	1:25,000	164,000	Pedology, geology, hydrology, irrigation, & sewage net design, topography
Pilot project	Soil Directorate	1974-1978	1:5,000 – 1:25,000	24,000	Pedology
South of Rassafah	Soil Directorate	1978	1:25,000 – 100,000	20,000	Pedology
Babiri area	Soil Directorate	1976	1:25,000	5,000	Pedology
Al-Bosaira-Saadoni	Soil Directorate	1979	1:25,000	7,000	Pedology, geology, hydrology, irrigation, & sewage net design, topography
Ishbilia farm & cow station	Soil Directorate	1974	1:5,000	1,000	Pedology

3. High concentrations of gypsum and calcium carbonates: The Calcids and Gypsids are almost equally represented in the Aridisols of Syria. Together they cover about 40% of the country. The Gypsids (Gypsisols) are mainly characterised by horizons with a very high amount of gypsum, ranging between 70 and 90% and in extreme cases the percentage may reach as high as 95%. Practically such horizons form a depth-limiting layer especially when the crust caps them. Hy-

per calcic horizon is usually found in association with soils having petrocalcic horizons.

4. Both hyper calcic and petrocalcic horizons are mostly found in the Mediterranean climate, forming a white layer occurring at various depths below the red normal soils. Surface crust is usually found on the top of the lime layer.

5. To represent these particular soils, the concept of hypergypsic and hypercalcic horizons were proposed to the “World Reference Base for Soil Resources” (WRB) and already are included in the system. Another proposal was also made for their inclusion to the US Soil Taxonomy.

6. High concentrations of soluble salts: Soils with high salinity are usually found in some natural depressions that have a shallow saline ground water level. These types of soils have a limited extension in Syria.

7. Low organic matter content: This is common property for soils with arid and Mediterranean type of climate where the organic matter content seldom exceed 1%.

8. Surface crust formation: This process occurs locally in soils with high silt content and in volcanic ash soils near Raqqa.

Major environmental problems related to soils

The main agricultural practices in Syria and their environmental consequences will be discussed in the following section. Special emphasis will be given to land degradation processes in relation to the major agricultural land use types.

Major soil degradation processes in Syria are salinisation in irrigated areas, water erosion in mountain regions and wind erosion in the steppe area. These processes are discussed below.

Salinisation

In 1997 the irrigated agriculture has been practised in about 1,167,000 ha. This area forms only 6% of the total surface of the country and about 21% of the total cultivable lands. However, it plays an important role as a major key factor for agricultural development in Syria. While all summer crops, such as cotton, are produced under irrigation, production of irrigated winter crops is much higher compared to them of rainfed agriculture. Salinisation is the major land degradation process in the irrigated agriculture. Evaluation of the salinity status however, is not always the case, since this requires systematic soil surveys and sampling.

Surface water irrigation**:** The Euphrates river is the biggest source of irrigation water in Syria. Following are two examples showing the salinity status in areas irrigated by the Euphrates river water.

The Euphrates valley (lower terrace)**:** The fertile alluvial soils (Fluvents) are the prevailing soils in the valley. The Euphrates valley is the largest irrigated area in Syria. Some of the earliest human agricultural activities were started in this valley. As early as 6,000 BC, the region was inhabited by grain farmers. Irrigation became extensive between 4,000 and 3,000 BC. Evidences of historical salinisation are almost absent within the Syrian part of the valley.

Recent soil salinisation processes in the valley have started as early as the late 1940s, when large scale irrigated agriculture became possible by using diesel irrigation pumps. The process has remarkably accelerated at the beginning of the 1950s when cotton was introduced into the area as a summer cash crop. Misuse of irrigation water accompanied with the absence of any kind of drainage systems and improper management led to the upraise of the ground water level and consequently salt accumulation within the root layers by evapotranspiration.

In the middle of the 1960s, a quite large area became out of agricultural use due to extreme salinisation. The first semi-detailed soil survey for 123,000 ha of the lower Euphrates valley carried out in the late 1970s, proved that the electrical conductivity of the soil saturated paste extract was over 8 dS/m for 50% and over 16 dS/m in about 30% of the area (Abd Al-Karem *et. al*. 1984).

The Euphrates valley (higher terraces): Near Raqqa about 10,000 ha mainly located within the second Euphrates terrace were brought under irrigation in 1970. The land was prepared for a modern irrigation project therefore, a soil survey has been carried out in the year 1980. Severe salinisation with more than 16 dS/m of the soil paste extract took place in about 24% of the project area (Abd Al-Karem et al., 1984), as a result of insufficient and improper drainage system.

The salinisation processes have been remarkably accelerated due to the introduction of rice cultivation for the first time in the area. It has been estimated that in Syria about 3,000 to 5,000 ha of the irrigated lands became unsuitable for agricultural use every year, due to extreme salinisation (THF, 1994).

Ground water irrigation: In 1997 about 701,634 ha have been irrigated by ground water. This area represents 60% of the total irrigated land in Syria and it has been gradually increasing from 30 % during 1970 to 44 % in 1980 and 49 % in 1990. However drastic increase of 10 % took place in only two years (Soumi 1993).

Considering that, the total renewable ground water in Syria represents only less than 7% of the total available water resources one may notice the irrational and unbalanced policy of using water resources in the country.

According to the FAO guidelines (Ayeres and Westcot 1985) on water quality for irrigation severe restrictions for irrigation are indicated when the electrical conductivity of the water exceeds 3 dS/m.

To check on the quality of irrigation water, samples from three wells north of Deir el-zor within the steppe area have been analysed (Al-Beshi, 1995). The ECe values were ranging between 7 and 10dS/m.

Furthermore the guidelines also indicate limits for specific ion toxicity. In the analysed samples, sodium and chloride are found to be the dominant cations and anions respectively. A severe restriction degree is given in the guidelines, when the concentration exceeds 9 meq/l for sodium and 10 meq/l for chloride.

These concentrations where ranging in the Syrian samples between 35-45 meq/l for sodium and 37-52 meq/l for chloride. It is obvious that when both the total soluble salt concentration and the composition of these salts are considered, the analysed samples and similar waters are not suitable for irrigation.

Water erosion

Mountainous regions under humid Mediterranean climate are, probably the most accessible regions to water erosion due to its natural conditions, such as steep and long slopes, shallow soil cover, high rainfall average (800-1,500mm) and frequent rain storms. Rather dense forests cover much of the area. Forest fires, intentional or not, are the worse human intervention in the area. About 8,000 ha have been subjected to fire during the period 1985-1993.

Another human activity leading to water erosion is farming. About 2,440 ha of the natural forest has been converted to agricultural lands during the period 1985-1992 (MAAR-SAR, 1994).

It is obvious that in this region, the removal of the vegetative cover by any means will lead to tragic consequences as far as soil degradation is concerned.

Recent investigations within the Lattaquia province have shown that, the maximum annual soil loss under natural forest conditions ranges between 10 to 60 kg/ha per year, and from 200 to 2,550 kg/ha per year, while under burned forest converted to agriculture land the values reaching 960 to 3,280 kg/ha per year (Kebebo and Jaloul, 1993).

Wind Erosion

About 50% of the soils in Syria are Aridisols. These soils are characterised by an aridic soil moisture regime. By definition, without irrigation Aridisols are not suitable to grow small grain crops (e.g. wheat and barley) in most years. Under the prevailing climatic conditions in Syria, Aridisols occur when the annual average of the rainfall drops below 250 mm.

Water requirement for barley as the major rainfed crop in the steppe area has been computed under the conditions of the Syrian steppe. A minimum of 250 mm is needed to grow barley.

In the middle of 1980's rainfed agriculture has been seriously expanded in the country to include large areas within the steppe, where Aridisols prevail. Agricultural statistics indicate that rainfed agriculture in the Syrian steppe has been increased from 36,000 ha in 1982 to 218,000 ha in 1985 and reaching 552,000 ha in 1990.

At Deir El-Zor City, which is located within the steppe the annual average of the rainfall is about 160 mm. The climate data for 20 consecutive years show that in 2/3 of the years the actual annual rainfall was below the average, and in some years it was even below 1/3 of the average.

As a result of the expansion of the rainfed agriculture in the Syrian steppe, severe environmental consequences have been observed. These consequences are mainly related to the nature of the soils.

The soils of the steppe are mainly characterised by weak structural stability and light texture. Based on the percentage of the soil aggregates larger than 1 mm in the surface layer, it has been estimated that more than 50% of the soils of Syria are extremely accessible to erosion. A map of soil susceptibility to wind erosion has been prepared for the major part of the steppe area (MAAR-SAR, 1985). It shows that most of the area is also extremely accessible to wind erosion.

The natural vegetation cover has probably the major role in protecting the soil over the years. When rainfed agriculture was expanded in the steppe, the shrubby cover has firstly been eliminated leaving the soil particles to the action of the wind. The maximum wind speed at Der el-Zor ranges from 16 to 27 m/sec. during the year. Assuming that a minimum wind speed required to transport soil particles is 5 m/sec, it may be a considerable soil movement by wind throughout the year when the dry soil particles are subjected to the wind action.

Dust, dust storms, sand accumulation on roads, railroads, formation of sand sheets, sand hummocks and sand dunes are the main environmental consequences resulting from the introduction and expansion of rainfed agriculture in the Syrian steppe. Dust frequency and intensity have been remarkably increased during the last few years in the eastern part of the country. It is worth mentioning that rainfed agriculture was prohibited in the steppe land since 1995.

The human-induced soil degradation map of Syria has been prepared following the GLASOD guidelines and the Explanatory Note of the world map of human - induced soil degradation (Ilaiwi*, et al.* 1992).

To prepare the present soil degradation map and due to scale limitation, the 201 mapping units of the soil map of Syria, where grouped into 68 physiographic units. The units are characterised by a great degree of homogeneity of topography, geology soil, climate, vegetation and land use. All elements of the human-induced soil degradation status were evaluated for each mapping unit. The legend of the map has been prepared following the procedures of the world GLASOD map.

For each mapping unit the following elements have been indicated:

- Degradation type;
- Degradation severity;
- Affected percentage;
- Causative factors;
- Recent and past rate.

These elements are clearly shown on the map legend and the mapping units.

Results

Table 3 summarises the results of the evaluation of the human-induced soil degradation in Syria. It shows that soils affected by different degrees cover about 18% of the total area of the country. Wind erosion is the most serious degradation type. If the steppe area alone is considered, about 25% of the total area is affected by wind erosion.

Salinisation has lesser extension, however when the irrigated area is considered we could conclude that about 45% of this area is affected by different degrees of soil salinisation. Water erosion degrades about 6 % of the country.

Table 3. Relative extend of human-induced soil degradation in Syria (x 1,000 ha.)

Type	**Degree**		
	Slight	***Moderate***	***Se-vere***
Water erosion -Loss of top soil	902	127	29
`Wind erosion -Loss of topsoil	1,210	380	30
-Over blowing	11	267	130
Salinisation	15	20	90
Total	**2,138**	**794**	**297**

Specialised scientific institutions or research centres on soils

Specialised centres on soil studies and research in Syria can be listed as follows:

♦ Soil Directorate

It is one of the main directorates of the Ministry of Agriculture and Agrarian Reform. The directorate was established in 1970. The headquarters are located in Damascus, while several field offices are established in the Syrian provinces. It consists of different technical sections such as, laboratories, soil survey, soil fertility, environment, land use and GIS. It carries out also studies and research in relation to soil and land, and also participates in most projects for soil mapping in the country. Other areas of expertise are field experiments aiming at conserving land productivity and increasing production through an efficient extension service.

♦ General Organisation of Remote Sensing (GORS)

GORS is a governmental institution linked to the office of the Prime Minister, which main goal is to apply remote sensing techniques for monitoring natural resources. It was established in 1986, and it consists of four main technical directorates, which are: data processing applications, projects fulfilling, photography and photogrametry, and field studies.

GORS conducts and takes parts in soil studies and research projects in co-operation with the related national institutions. In co-operation with the Agriculture Faculty of Damascus University it has carried out studies, such as soil and forests study in the coastal area.

Other projects include preliminary study of soil water erosion in co-operation with Agriculture Faculty of Techreen University, land degradation monitoring in north east Syria in co-operation with the International Centre for Agricultural Research in the Dry Areas (ICARDA) and land use mapping of west Syria. All the GORS soil studies and mapping are fulfilled using different remotely sensed data and satellites images.

♦ Agriculture faculties

There are five agriculture faculties in the Syrian Universities:

- Damascus University in South Syria;
- Aleppo University in Aleppo (2 faculties, one in Aleppo city in the north and the other in Deir Ezzor in the Eastern part of Syria);
- Techreen University in West Syria; and
- Baath University in central Syria.

All the faculties teach soil science and related subjects, such as soil chemistry, soil physics, soil formation and genesis, soil conservation, land reclamation, soil survey and classification, soil mapping, soil fertility and plant nutrition. The main awarded degree is B.Sc.; however, post-graduate degrees (M.Sc. Ph.D.) are awarded as well for scientific research related to soil and land resources.

Soil maps available in the country

At the Soil Directorate of the Ministry of Agriculture are available the following maps:

1. Semi detailed soil survey for Syria according to the US Soil Taxonomy at scale of 1:500,000;
2. Soil survey for first, second and third level stabilisation zones at scale of 1:50,000;
3. Soil survey for irrigated areas in the steppe;

4. Land use maps of extension centres, at scale of 1:25,000; a total of 640 maps are available;
5. Soil survey and classification of Euphrates basin;
6. Soil information system database of Syria at scale of 1:500,000 (SOTER).

Map projections used in the country

The only two map projections used in Syria are:

- UTM zone 37.
- Lambert Conformal Conic/Spheroid Clarke 1880.

Conversion of national soil legends into the international systems

Due to non-uniformity it is difficult to provide a clear and sharp opinion. However it seems that in most cases, using profile descriptions and laboratory analyses, one could classify soils according to the FAO legend (1988) or at the subgroup level of USDA, Soil Taxonomy.

Laboratory methods used for soil analysis

Soil physical and chemical routine analysis are described below:

❑ Particle size analysis

The methods usually used are either hydrometer or pipette; the latter is preferable because of accuracy.

❑ pH

pH or soil reaction, is determined on soil water suspension 1:2.5 and KCl 1N 1:2.5. The more common one is the determination on saturated paste, but it is more difficult to conduct.

- Organic matter

The common method is the oxidation of organic carbon by potassium dichromate and titration by iron sulphate.

- Cation exchange capacity and exchangeable cations

These two analyses are carried out by using CH_3 COO NH_4 1N. The exchangeable cations are determined either by A.A.S or by titration for Ca and Mg, and flame photometer for K and Na.

- $CaCO_3$

Is determined usually by calcimeter or back titration, both methods are good, but the former one is faster.

- Gypsum

There are many methods or (extraction solutions), however, the most commonly used and preferable is the acetone one.

- Water extractable ions

The most common ions analysed are K, Na, Ca, Mg, SO_4, CL, HCO_3, CO_3, and NO_3. These ions are determined on water extract. K, Na, Ca, Mg are determined by A.A.S. or flame photometer for the first two elements, SO_4, by turbidity, Cl, HCO_3 by titration.

- Bulk density by wax method

- Real density by pichnometer

- Electrical conductivity

Using the conductivity meter on soil water extract. The soil water ratio depends on the expected content of salt.

Presence of international institutions doing soil studies

In Syria, there are two main international institutions working on regional levels in the field of soil studies and other related activities. They are ACSAD and ICARDA:

♦ ACSAD

The Arab Centre for the Studies of Arid Zones and Dry Lands was established in 1971 within the framework of the League of Arab States. Its headquarters are based in Damascus, Syria. ACSAD conducts research and studies in the Arab arid and semi arid environments.

ACSAD carried out several activities within the framework of soil studies and other related works such as:

- Preparation of soil maps of some Arab states;
- Preparation of desertification control action plans for some Arab states;
- Participation in the preparation of human-induced soil degradation map of the world;
- Participation in the preparation of the World Atlas of Desertification, which was published by UNEP in 1992; and
- Monitoring and combating desertification through the use of remote sensing and GIS in Al-Bishri mountain (Syrian steppe).

ACSAD has its own soil laboratory and training facilities such as:

- Remote sensing and GIS laboratory;
- Training centre for degraded land rehabilitation; and
- Experimental station for reclaiming salt affected soils.

All soil studies and other related works in ACSAD are carried out by the Soil Studies Section and Desertification project.

♦ ICARDA

The activities of the International Centre for Agriculture Research in Dry Areas (ICARDA), cover a wide range of countries of the Middle East and North Africa. Most of ICARDA's soil activities are conducted under the umbrella of the natural resources management projects, where several related activities are taking place in the field of soil conservation, rangeland management and land resources monitoring. There exist also a close co-operation between ICARDA and ACSAD in the West Asian joint programme for strategic studies, which include research and training to combat desertification.

The other related international institution in Syria are FAO and UNDP, which work in co-operation with the concerned national institutions to strengthen the national capability building in the field of soil studies and other related donor projects.

Suggestions for improving the actual soil information system

- A soil information database is available for Syria at the scale of 1:500,000. We recommend making use of this information and that of about 20,000 soil profiles, studied in the past soil surveys. However, this valuable information needs to be computerised and attributed to the Geographic Information System (GIS) in order to prepare layer scale maps (attribute maps) to be used for agricultural planning and land management;

- Staff training on soil survey and soil classification;

- Staff training on building and updating soil databases;

- Supporting Soil Directorate with related advanced software.

References

Abd Al-Kareem , J. Soumi, G., and Mardoud, T. 1994. Soil and water resources in the projects of the Euphrates basin. The Syrian Economic Journal. Vol. No. 248. P 43-70 (in Arabic).

Al-Beshi, L. 1995. Temporal succession, pedological development and classification of Lower Euphrates area soils. Aleppo University, Ms.C thesis.

Ayers, R.S. and Westcoat, D.W. 1985. Water quality for agriculture. FAO irrigation and drainage paper no. 29.

Foth, H.D. and Scher, J.W. 1980. Soil geography and land use. Wiley, New York. 484 p.

General Company for Water Resources. S.A.R. 1985. Evaluation of wind and water erosion in the Syrian steppe, preliminary map.

Haluk Yuksel. 1982. Land classification/soil survey project of the Syrian Arab Republic. Contract USAID-C-1644.

Ilaiwi, M. 1983. Contribution to the knowledge of the soils of Syria. PhD. thesis, Ghent University.

Ilawi, M., Abdelgawad, G., and Jabour, E. 1992. Human-induced soil degradation map of Syria in World Atlas of Desertification. UNEP.

Kerebo, F., and Jaloul, A. 1993. Investigation on soil erosion in the coastal area (in press).

Ministry of Agriculture and Agrarian Reform. SAR. 1994. The agricultural sector in figure (1970-1992), 127 p. (in Arabic).

Soumi, G. 1993. Measures for protection of surface and ground water resources and means for its rational use and management. 10th Congress. Arab Union of Agricultural Engineers.

THF. The Syrian Syndicate of Agricultural Engineers. 1994. The annual agricultural report. Damascus, 76p. (in Arabic).

Van Liere, W.J. 1995. Classification and rational utilisation of soils. Report to the Government of Syria. FAO, Rome, 151p.