Iran. Jour. Agric. Res. Vol. 2, No. 2, March 1974

OPPORTUNITIES FOR SOILS STUDIES IN IRAN

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(Invitational Paper[3])

ABSTRACT

This paper briefly outlines some of the opportunities for pedological cooperative soils studies in Iran, using the area around Gorgan and Gonbad-e-Qabus east of the Caspian Sea as an example. Significant soil features at seven specific sites are described; the features show ecological shifts caused by environmental changes and effects of human activities. To understand effects of land use changes and physical resource inventories, detailed pedological examinations such as those done at these sites are necessary. For the future, this paper urges closer cooperation between universities and the Soil Institute in detailed investigations relating to soil genesis and soil properties affecting future uses of soils of Iran.

INTRODUCTION

Soils of Iran are briefly outlined by M.L. Dewan and J. Famouri in a chapter on soils in the classic Volume I discussing the land of Iran in "The Cambridge History of Iran" (5). More details about soils of the country are presented in the book on "The Soils of Iran" (2), with maps of geology, soils, and soil potential at a scale of 1:2,500,000.

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3. As with all invitational papers, this article has been subjected to a minimum of change.

General information on land resources and potentialities of the Gorgan region is given in a report by Mahler (7) accompanied by a map at 1:250,000 scale. Soil maps in more detail have been made for parts of the irrigated or irrigable valley plains, and considerable data on soils and agronomic practices are being accumulated through work of the Soil Institute experiment station staff at Gorgan (4). A report by Banai (1) gives characteristics of some of the soils of the area. The specific seven sampling sites were described in detail by M.H. Banai and G.W. Olson in a series of reports and data (10). Photographic views of the seven sampling sites are given in a publication by Olson (11). The purpose of this paper is to summarize some pedological studies east of the Caspian Sea, using these data to illustrate the utility of such studies in understanding the environment and using it more effectively.

MATERIALS AND METHODS

During soil survey activities in the Gorgan river valley, special soil samplings and descriptions were made to demonstrate the value of more detail in soil and geomorphology studies along with routine survey investigations. The area is outlined and the sampling sites located in Fig. 1. Specially-selected soils at seven points (Fig. 1) were described according to procedures of the "Soil Survey Manual" (13) of the Soil Conservation Service of the U.S. Department of Agriculture and later revisions, collected in a document by Olson (8). Samples were collected and analyzed in laboratories of the Soil Institute of Iran at Gorgan and Tehran and in the soils laboratory at Cornell University, according to procedures of those laboratories (6, 12); most of the results presented in this paper are based on the data from the Cornell laboratory.

RESULTS

Soils described, sampled, and analyzed were classified (according to the data) in the Iranian, FAO, and USDA soil classification systems (3, 4, 14). These classifications for the soils are given in Table 1. General correlations of the three classification systems have been summarized (4). Table 2 is a list of some selected data from "lowland" soil sites 1, 2, and 3 (Fig. 1) which are affected by mottling in the soil profiles; Table 3 gives data for the "upland" soils at sites 4 - 7, which are in generally well drained topographic positions.

DISCUSSION

Lowland sites 1, 2, and 3 near the Caspian Sea (Fig. 1) have soils formed in strati-

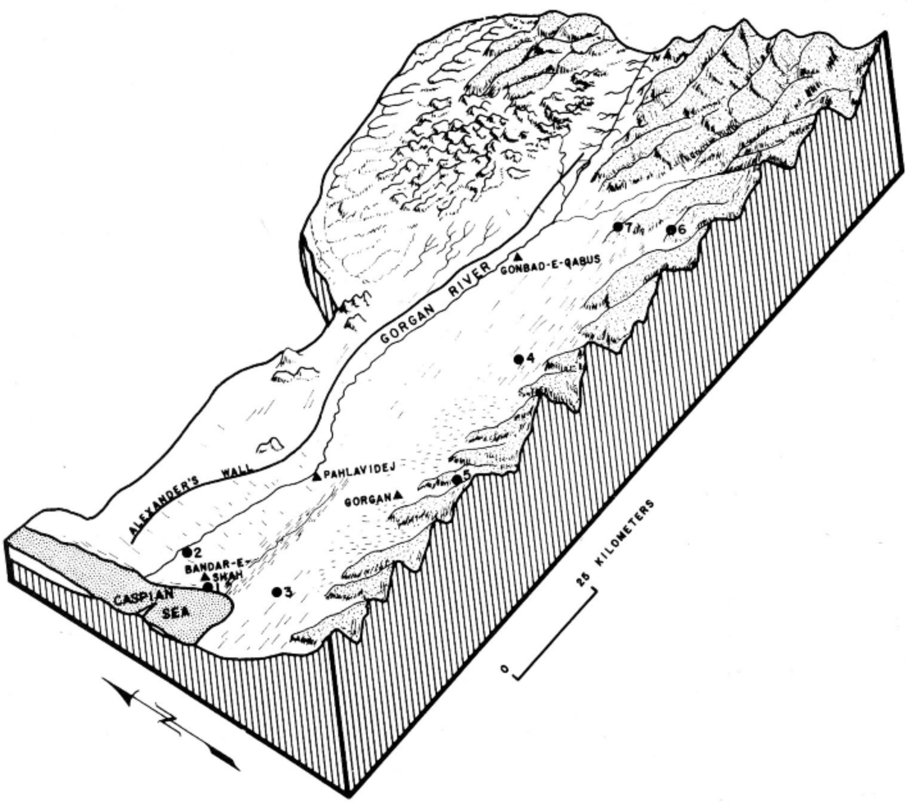

Fig. 1. Block diagram of study area east of the Caspian Sea. Soil sampling and description sites are located in the area by dots and numbers. Most of the soils sampled are formed in loessial materials, but variable bedrock geology is important to soils at sites 5 (schist) and 6 (limestone). Important towns are located by triangles. Alexander's Wall is a defensive embankment built probably during the Sassanian period A.D. 224 - 651. This area was densely settled in the second millenium B.C. and during the Sassanian period. Current land use is mostly forest in the steeper Elborz mountains (at south edge), grazing (in the eastern hills), and irrigated cotton and wheat (in the valley).

Table 1. Soil names and classifications of soil profiles at the seven sampling sites located in Fig. 1.

Site number	Series name	Iranian classification	FAO classification	USDA classification
1	Khazar	Solonchak	Gleyic Solonchak	Aquollic Salorthid
2	Pahlavidej	Brown	Haplic Xerosol	Typic Camborthid
3	Kordkuy	Low Humic Gley	Eutric Gleysol	Typic Haplaquept
4	Tappeh	Unclassified	Unclassified	Unclassified
5	Nahar Khoran	Brown Forest	Eutric Cambisol	Typic Eutrochrept
6	Nowdeh	Brown Mediter-ranean	Orthic Luvisol	Typic Haploxeralf
7	Emamzadeh	Chestnut	Calcic Kastanozem	Typic Calcixeroll

Table 2. Selected analyses of soil samples collected from lowland sites near the Caspian Sea (Analyses performed by Cornell Soil Fertility Laboratory, Department of Agronomy, Cornell Univ., Ithaca, N.Y., USA).

Soil and site	Horizon	Depth (cm)	Organic matter(%)	pH	kg/ha plow layer				Soluble salts
					P	K	Ca	Fe	K X 10^5
Khazar - 1	A12	3 - 20	6.1	7.6	10	950	130,000	14	>1,000
Khazar - 1	C1(B)	20 - 40	7.6	7.9	10	1,100	135,000	37	>1,000
Khazar - 1	C2g	40 - 60	5.2	7.8	10	825	175,000	132	>1,000
Khazar - 1	C3g	60 - 85	2.6	7.8	15	550	150,000	280	>1,000
Khazar - 1	C4g	85 - 140+	2.6	7.7	10	675	127,500	200	>1,000
Pahlavidej - 2	Ap	0 - 15	1.9	7.8	10	350	120,000	25	260
Pahlavidej - 2	A12	15 - 25	2.2	7.8	5	275	130,000	23	400
Pahlavidej - 2	B2	25 - 50	1.7	7.9	5	250	122,500	18	380
Pahlavidej - 2	C	50 - 80	1.0	7.8	5	150	125,000	45	660
Pahlavidej - 2	IIA'b	80 - 90	1.9	7.7	5	125	130,000	33	850
Pahlavidej - 2	IIB'b	90 - 130	1.0	7.8	5	100	132,500	140	520
Pahlavidej - 2	IIIA"bg	130 - 140	2.0	7.8	5	225	117,500	18	560
Pahlavidej - 2	IIIB"bg	140 - 160+	1.2	7.8	5	250	145,000	20	680
Kordkuy - 3	Ap	0 - 15	2.5	7.9	25	250	127,500	3	32
Kordkuy - 3	B2	15 - 35	1.6	8.1	4	50	117,500	5	44
Kordkuy - 3	A'2g	35 - 55	1.0	8.1	1	50	27,500	12	32
Kordkuy - 3	B'g	55 - 75	1.4	8.0	4	90	16,250	9	46
Kordkuy - 3	C1g	75 - 100	0.8	8.0	2	90	41,250	18	32
Kordkuy - 3	C2g	100 - 130+	1.0	8.0	3	115	42,500	17	40

Table 3. Selected analyses of soil samples collected from upland sites near Gorgan and Gonbad-e-Qabus (Analyses performed by Cornell Soil Fertility Laboratory, Department of Agronomy, Cornell Univ., Ithaca, N.Y., USA).

Soil and site	Horizon	Depth (cm)	Organic matter(%)	pH	kg/ha plow layer				Soluble salts
					P	K	Ca	Fe	K X 10^5
Tappeh - 4	Ap	0 - 15	3.5	7.9	155	600	51,250	1	28
Tappeh - 4	A12	15 - 28	1.6	7.9	115	350	117,500	3	24
Tappeh - 4	B2	28 - 50	1.2	8.0	200	300	145,000	2	20
Tappeh - 4	C1	50 - 65	1.5	7.8	155	400	172,500	1	24
Tappeh - 4	C2	65 - 80	1.6	8.0	200	450	142,500	2	24
Tappeh - 4	C3ca(Bb)	80 - 95	1.7	8.0	250	500	145,000	2	24
Tappeh - 4	C4(B3)	95 - 140+	1.1	8.0	180	625	122,500	5	24
Nahar Khoran - 5	A11	0 - 6	13.2	6.8	45	375	9,000	5	28
Nahar Khoran - 5	A12	6 - 21	1.4	5.9	2	60	3,750	18	5
Nahar Khoran - 5	B1	21 - 61	1.3	6.2	2	60	3,500	30	<5
Nahar Khoran - 5	B21	61 - 101	1.1	6.0	2	60	3,250	28	36
Nahar Khoran - 5	B22	101 - 136+	1.3	6.5	3	60	7,500	24	<5
Nowdeh - 6	Ap	0 - 15	5.6	7.2	2	220	3,500	2	<5
Nowdeh - 6	B1	15 - 35	1.9	7.7	5	150	22,500	16	32
Nowdeh - 6	B21t	35 - 55	1.2	7.5	1	125	8,750	14	5
Nowdeh - 6	B22t	55 - 100+	1.1	7.5	1	100	10,000	10	5
Emamzadeh - 7	Ap	0 - 28	0.7	7.8	5	150	28,750	2	24
Emamzadeh - 7	B2ca	28 - 50	1.8	7.9	4	75	155,000	3	28
Emamzadeh - 7	B3ca	50 - 100	1.0	8.0	3	50	187,500	7	20
Emamzadeh - 7	C	100 - 140+	0.7	8.0	4	50	175,000	12	20

fied alluvial and marine sediments derived principally from loess. Textures range from loam to loamy sand in profile 1, from silty clay to very fine sandy loam in profile 2, and from silty clay loam to loam in profile 3. Soluble salts decrease in the profiles with distance from and elevation above the receding Caspian Sea (Table 2); salts in the soils are also related to the annual rainfall which ranges from 680 millimeters in the foothills of the Elborz mountains to 340 millimeters in the valley plain.

The Khazar soil at site 1 was exposed by the receding waters of the Caspian Sea less than 20 years ago. Since exposure, this young soil has developed an Al horizon 20 centimeters thick. An incipient B horizon appears to be developing at 20 to 40 centimeters. Cracks about five millimeters wide extending to 40 centimeters segregate weak coarse prisms which break into weak thick stratification plates; the faces of the cracks have dusky red (10R 3/3) mottles contrasting with the prism interiors of light gray (5Y 7/1) color. Deeper than 40 centimeters, the soil is not cracked and has gray (N 5/0-N 6/0) gleyed colors. No water table was observed when the pit was dug to the depth of 140 centimeters on 30 August 1972, although the pit was dug only about 50 meters east of the shoreline at that time. White salts were visible on the soil surface. Soluble salts, iron, calcium, and potassium are very high in this soil (Table 2). Organic matter is high in the upper part of the profile - probably the cracking of the soil carries organic materials to greater depths than would be expected in soils that do not crack. Sparse emergent vegetation at this site is much affected by salts; the area is occasionally used for grazing.

The Pahlavidej soil at site 2 has had a complex history. It consists of three separate profiles, one on top of the others, each with A and B horizons and with degrading clayskins in the B horizons. Each A horizon is verified by the data in Table 2, showing accumulations of organic matter. The upper profile extending to 80 centimeters has formed in alluvium derived from loess. The profile from 80 to 130 centimeters developed in marine sediments, identified by the presence of marine shell fragments. The bottom soil profile also developed in marine sediments, and has pieces of black charcoal from wood in the III A'' bg horizon. Although the charcoal was not of sufficient quantity to be sampled for radiocarbon dating, it could possibly represent remnants from human clearing of the forest in the area. The 80 - centimeter thick alluvial deposit on top could have been deposited from accelerated erosion influenced by intensive land use in earlier times. Since clayskins do not appear to be forming in most soils of Iran in comparable climates at the present time, relict clayskins in these B horizons may be remnants from earlier wetter climatic periods. This soil profile with its trisequal development indicates that the sea receded long enough for a soil to form at this site, then advanced long enough for 50 centimeters of marine sediments to be deposited in this place (in which another soil formed), then retracted further in a period of accelerated erosion in which the upper alluvial deposits were laid down. This soil has high content of soluble salts, but not as much as profile 1 nearer the Caspian Sea (Table 2). Crops (wheat, cotton) in this area nevertheless appeared to be considerably affected by salts in the soil.

The Kordkuy soil at site 3 has a finer textured horizon at 55 to 75 centimeters that is only slowly permeable. Seepage water moves downslope above and below the layer. Grayish brown (10YR 5/2) colors predominate in the B2 horizon, but gray and grayish (2.5Y 5/2 - 6/2) colors are dominant in the lower horizons. Wood charcoal fragments were discovered in the Clg horizon; possibly also these could date from the time when humans cleared the original forest. When the pit was dug on 30 August 1972, groundwater rose to 130 centimeters below the soil surface - analyses of the water showed much less salt (2 meq/l Na^+) as compared with analyses of water from the Caspian Sea (154 meq/l Na^+). Soluble salts in the soil (Table 2) are much less than in profiles 1 and 2. Excellent cotton crops in the area indicate that the soil characteristics are favorable for plant growth. The slowly permeable layer and seepage in the soil probably improve the moisture relationships for plants and have a favorable effect upon irrigation management at this site.

Upland sites 4 - 7 near Gorgan and Gonbad-e-Qabus (Fig. 1) are all loess-influenced, but to varying degrees. Profile 4 has formed on a mound from debris of an ancient town or village, and has developed mainly in earthen construction materials built up from a nearly level alluvial plain formed from eroded loess hills. Profile 5 developed in colluvial materials from schist on steep slopes (under forest), with some loessial material mixed with the weathered schist. Profile 6 formed on foothills in weathered limestone, with some loess mantling which was probably at least partially eroded. Profile 7 formed in deep loess on hilly topography. Textures vary from clay loam to loam in profile 4, from channery clay to loam in profile 5, from clay to silty clay loam in profile 6, and from silty clay loam to silt loam in profile 7. Profile 7 has the most uniform loessial materials; profiles 4, 5, and 6 have been considerably affected by disturbances of human activities, colluvial actions, and erosion, respectively.

The Tappeh soil at site 4 has formed entirely in earthen building materials, taken originally from the alluvial valley floor. The sampling site was located on an artificial mound of at least one hectare, rising 10 to 15 meters above the nearly level surroundings. Probably the mound dates from Sassanian times; other mounds are numerous in places nearby. Many pieces of pottery and other artifacts are on the soil surface of the mound and in the soil profile. Since the mound was abandoned as a habitation, the soil has developed an A horizon of 28 centimeters. An incipient B horizon is forming at 28 to 50 centimeters; structure of the B is weak coarse angular blocky breaking to weak medium and fine angular blocky. At 80 to 95 centimeters, parts of a B horizon appear to have been deposited with the construction materials. Probably the most remarkable part of the data from profile 4 (Table 3) is the high content of phosphorus, apparently residue from human activities which has remained in the soil over a long period of time. Potassium and calcium are also unusually high in this soil, as compared with the rest of the upland profiles. When sampled on 1 September 1972, the mound had wheat stubble with some melon patches on the sides; most of the surrounding valley was occupied by irrigated cotton.

The Nahar Khoran soil at site 5 formed under Hyrcanian forest on steep slopes mainly in colluvium from weathered schist, but probably some loessial deposits have influenced the upper horizons. With depth, flat schist fragments increase and occupy about 30 percent of the soil volume at 130 centimeters. Schist outcrops, boulders, and stones are visible around the sampling site. Due to the forest vegetation, the schist parent materials, and a more humid climate, this soil profile is more acid than the rest of the soils, and the All horizon to a depth of six centimeters has an organic matter content of 13.2 percent (Table 3). Above the mineral horizon is a six-centimeter thick litter layer of tree leaves and twigs; the forest furnishes good protection for this soil against erosion and helps protect the watershed and irrigation installations below.

The Nowdeh soil at site 6 appears to have formed from clay residue from weathered limestone, on footslopes where loess was probably deposited and then eroded. Soil material at 100 centimeters is dark brown (7.5YR 4/4) clay with only a few fine faint mottles. A few pottery fragments were observed in the soil. The B21t horizon had good structure classified as moderate coarse and medium angular blocky. Clayskins on the ped surfaces in the B21t and B22t horizons indicate considerable pedogenetic weathering of this soil; possibly the clayskins are relicts from an earlier wetter warmer climatic period. The sampled site was in pasture that appeared to have been plowed several years ago. A small plowed field a few meters upslope has the same soil; the dark brown color and good structure was very evident in the plowed furrows.

The Emamzadeh soil at site 7 was sampled on rounded hills where the loess deposits are very deep. The soil is a good example of Chestnut, Calcic Kastanozem, Typic Calcixeroll soils (Table 1; 3, 4, 14) with B2ca and B3ca horizons. At the site, a recent road cut showed excellently the variable thickness of the mollic epipedon - some areas appear to have lost much of the surface layers through erosion. Low organic matter in surface horizons (Table 3) probably indicate some erosion at this site; the slope is about 20 percent. The area had wheat stubble with a few weeds; grass was probably the native vegetation here.

ACKNOWLEDGEMENTS

The authors are grateful for assistance and advice from many colleagues and counterparts in the Soil Institute of Iran, the Food and Agriculture Organization of the United Nations, the Department of Agronomy of Cornell University, and the Soil Conservation Service of the U.S. Department of Agriculture. Without cooperation in these efforts, the data could never have been collected and analyzed. Special appreciation is extended to A.F. Mahdavi, Director General, and M. Farmanara, Head, Soil Survey Division, Soil Institute of Iran in Tehran for administrative assistance ; T. Greweling, Director of Laboratories of the Department of Agronomy of Cornell University, supervised analysis for most of the data on the soil samples. The manuscript was reviewed by A.J. Smyth, Technical Officer (Land Classification), Soil Resources Conservation and Development Service, Land and Water Development Division, Food and Agriculture Organization of the United Nations in Rome and by M.L. Dewan, Project Manager, United Nations Development Programme in Bulgaria (formerly Project Manager of FAO project in Iran).

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