REPORT

OF THE

RECONNAISSANCE

SOIL & LAND CLASSIFICATION SURVEY

OF

KARKHEH WEST AREA

KHUZISTAN - IRAN

PREPARED FOR THE

KHUZISTAN DEVELOPMENT SERVICE

BY THE

FOOD & AGRICULTURE ORGANISATION

OF THE

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IN COOPERATION WITH THE

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1959

TEHERAN

SOIL, LANDCLASSIFICATION AND LAND USE

RECONNAISSANCE SURVEY

OF

KARKHEH WEST AREA

Khuzistan - Iran

Prepared by:
M.F. Farmanara and Dr. J.S. Veenenbos

Food and Agricultural Orgnization
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PREFACE

On request of the Khuzistan Development Service, agent of the Plan Organization of the Government of Iran, a reconnaissance soil, land classification and land use survey is made of the western part of the Khuzistan plain in Iran, west of the river Karkheh.

The area is surveyed within the scope of an agreement between the Khuzistan Development Service and the Food and Agriculture Organization of the United Nations on soil surveys to be carried out in the Khuzistan plain and the Headwater areas of the rivers draining into this plain. The work of the FAO-Khuzistan Soil Survey Group for this purpose is done in cooperation with the Irrigation Bongah of the Government of Iran.

The survey was started in November 1957 by Engineer M. Farmanara under the guidance of the FAO Expert Dr. J.S. Veenenbos. Most of the actual fieldwork was performed by Engineer Farmanara who was assisted alternately by the junior engineers N. Samai, N. Eshaghian and E. Kuhistani. In May 1958 all fieldwork was finished. Time-taking have been the problems of transport, food, water and fuel supplies as the area is difficult to access and the fieldparty could not rely on an organization to take care of that. Engineer M. Farmanara wrote also part of the report, which has been edited by Dr. J.S. Veenenbos.

The participation of the Irrigation Bongah in providing the engineers to carry out the fieldwork is most appreciated as also are the laboratory facilities in the Central Soils Laboratory in Teheran.

SUMMARY

The isolated part of Khuzistan plain west of the river Karkheh (about 540.000 ha) has been studied in a reconnaissance soil, landclassification and land use survey. Much of the area consists of sand dunes and ranges of hilly to mountainous terrain, resp. 98000 ha and 114500 ha.

The soils are mapped and classified in geomorphological terms as soil formation is very immature. The study of the deposition of the soil material, in particular the development of the sand dune areas has thrown new light on similar formations in other parts of the Khuzistan plain.

Several plains of alluvial soils occur in the southern part at the base of the Zagros Mountains foothills, in the eastern part of the area all draining to the river Karkheh and further in the southern part along the river Karkheh. The best plains are those of the northern part (ha), not so much as the result of a different physical condition of the soil material or the topography, but more because soil salinity is practically absent; this in contrast to the other plains of which the soils to relatively high extent are effected with harmful amounts of salts. Imperfect drainage conditions have greatly caused the salinity of these soils. In some parts even large intermittant lakes have developed. Ancient towns and works for watersupply suggest that formerly these plains were not saline and therefore better drained.

Erosion is not an active factor with the exception of sloping sandy parts. Serious erosion features (badlands, etc) present in the area date back to former other climatologic conditions.

At present the climate is semi-arid and the vegetation steppe-like. There are many indications however that the original vegetation was more of the type of an open park landscape. The original tree vegetation however is practically completely destroyed by men.

Land use is mainly grazing. Recently large parts of the plains are brought under cultivation. Wheat and some barley are the main crops. The original cultivation by the Arab tribes was restricted to subsistence cropping of wheat and barley.

Of the total about 540.000 ha, at present about 81.500 ha is cultivated; of this area only about 10.500 ha is supplemented by irrigation. About 196.000 ha is classified as waste land; the remaining about 262.500 ha is classified as pasture. Grazing however is mainly restricted to winter and spring time when large herds of Iraqi owners are brought to this area. (see table VII)

As to the classification of the land for the suitability of irrigation, about 56.500 ha is classified as class I and II land and about 25.000 ha as marginal (class III land). About 46.500 ha is

occupied by soils of the plains, saline to such an extent, that their suitability for the moment had to be left as undetermined (class V land). Further investigations and future works on drainage and leaching might turn these into good irrigable lands. About 95.000 ha is unsuited for irrigation under normal conditions (mostly pure sand soils with nearly level topography) and about 317.000 ha is positively unsuited for any development of irrigation. (see table VI)

Chapter I: INTRODUCTION

This report records the result of a reconnaissance soil, landclassification and land use survey made in an area of about 540.000 ha in Khuzistan plain covering the territory between the Iraq border and the river Karkheh.

The purpose of this survey is to provide the necessary data about soil conditions in the area in order to enable the pertinent authorities further planning on the agricultural development possibilities. The extent and regional distribution of the various soils, their suitability for irrigated farming and their present land use are represented on maps of a scale of 1 : 250.000 in:

Appendix I - soil map
Appendix II - landclassification map
Appendix III - land use map

As the area is difficult to access and as a result little known, a separate geographical map on the same scale, indicating names of regions and plains as well as villages names or names of sheiks living in these villages, is made:

Appendix IV - geographical map

For this study aerial photographs of a scale of about 1 : 60.000 were available of nearly all of the areay available only for the eastern part were also photo mosaics on a scale 1 : 50.000. The aerial photographs were studied under the stereoscope and fully analyzed. All observable differences in topography, land pattern, colour tones, etc, escarpments, drainage ways, roads, villages, remnants of ancient towns, etc. were delineated on the photographs. As far as photo mosaics were available, the photo data were transferred to them. These mosaics and for the rest of the area the photographs, were used for fieldwork. Before actual fieldwork started all photo-analytical data were transferred to a map cf the final scale made from a transparent overlay on the 1 : 250.000 Aeronautical Approach Charts of the area. This photo-analytical map served as an overall reference during fieldwork to which all changes, additions and deletions were transferred within the possibilities of the scale.

The first part of the report gives a general description of the area. Chapter II gives geographical and physiographical descriptions. Chapter III records the geological knowledge of the area, its formation in tertiary and quarternary periods. Chapter IV deals with the historic developments, climate and vegetation. In chapter V present agriculture, and population, the landrights are discussed.

The second part of the report gives descriptions of the soils in the area; in chapter VI the soils of the area are discussed in general, chapter VII gives the character of the mapping units, the bases of separation of soil, the legend of soils distinguished in the area, and a description of the soils of the plains.

The last part of the report deals with the classification of the land for irrigation development, present land use and laboratory methods used in soil sample analyses.

Chapter II: GEOGRAPHY AND PHYSIOGRAPHY

2.1. Location

The surveyed area forms the western part of Khuzistan plain and is situated between 31°28' - 32°25' north latitude and 47°30' - 48°36' east longitude. From north to south the area extends over a distance of about 100 km and from west to east over a distance of about 50 km. Total area is about 540.000 ha.

Geographically the area lies between the river Karkheh and the Iraq border (fig 1). In the south it is bounded also by the Karkheh where this river takes a west-northwestern course after passing Hamidieh and finally discharges in the Havizeh marshes. The northern boundary is formed by the foothills of the Zagros Mountains.

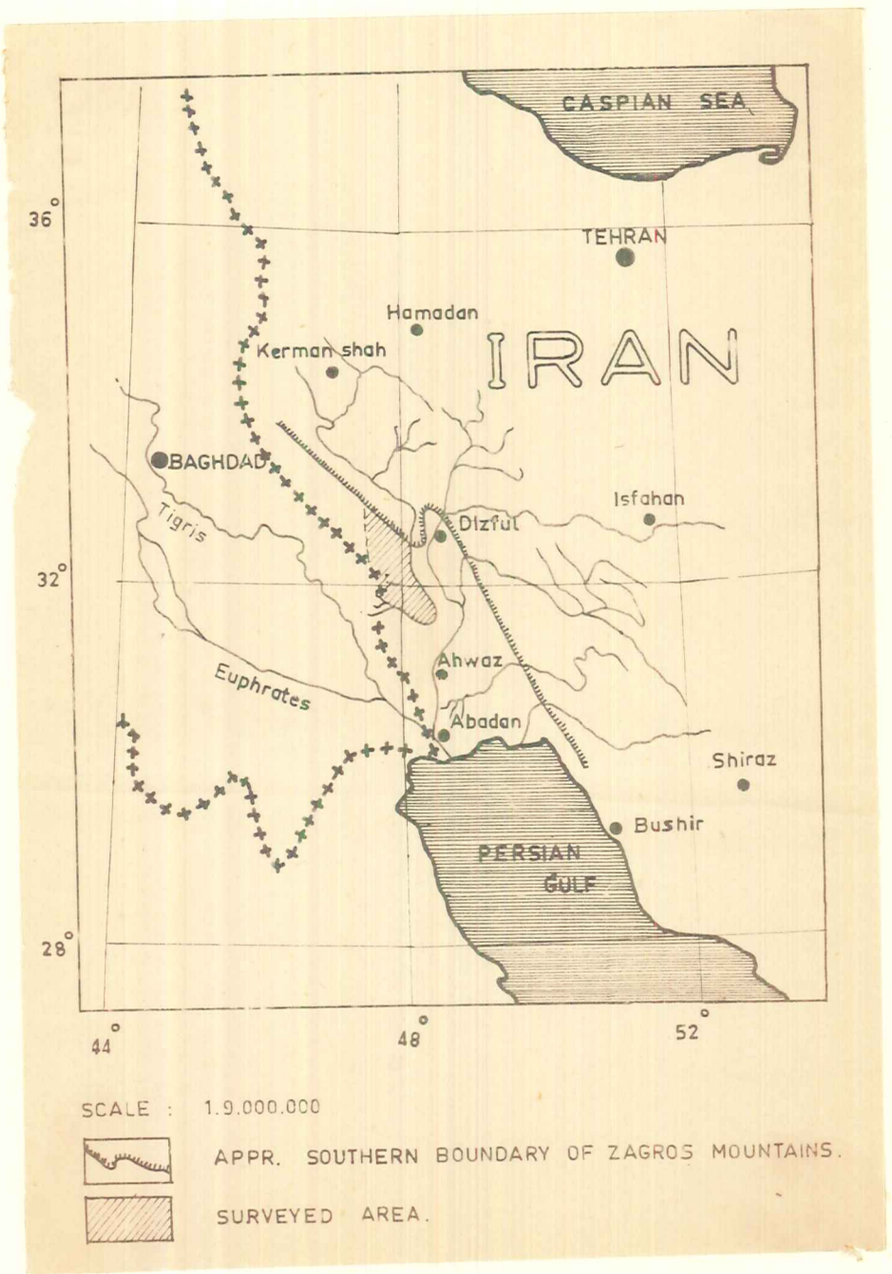

Fig 1: Location of surveyed area in Iran.

Between the sand dune desert of Dasht-e-Mishan and Ommeddebès is located the mountainous Kuh-e-Mosdagh. To the south of the Dasht-e-Mishan dune part exists further a level, completely sandy plain with an elongated intermittant salt lake in it. This plain is known as Hofal. The small cultivable plain at the western tip of Hofal bordering the Havizeh marshes is called Abarfush.

Sorgheh, nearly all of Chenaneh and the eastern part of Dasht-e-Abbas fall under the jurisdiction of the administrative centre of Dizful; Robut and Musia under Deh Luran. The plains along the Iraq border including the Someideh plain and Abu Ghowair as well as the Dasht-e-Mishan are in the jurisdiction of the administration of Susangird. The Khasradj part and the area near the Karkheh dam are under Ahwaz.

2.3. Physiography

For the greater part the area is occupied by windblown sand formations partly represented by dunes, partly by areas with rolling undulating or nearly level topography (fig 2).

Fig 2: Nearly level sand area.

The dune formations show two main different characteristics. There are real living dune parts practically without any vegetation and built up to relatively high elevations (fig 3) and other parts with a more regular dune topography with some vegetation growing in the depressions (fig 4). The rolling, undulating or smooth sand areas in winter and spring are completely grown with grass and form extensive grazing grounds in that time of the year.

2.2. Geography

This part of Khuzistan plain is more or less isolated from the rest of Khuzistan plain. Therefore and also because of its terrain conditions little is known of the area. The northern part is accessable by a motor ferry at Pa-i-Pol over the Karkheh from where a motor track leads westward to the frontier near Deh Luran. This town and Musia are the only places of settlement in the region of some importance; they lie outside the surveyed area. The recently constructed Karkheh diversion-dam north of Hamidieh gives access to the southern part. Between both places, which lie about 100 km apart, there are a few fordable places in the river a.o. at Shush, which serve access to the area only by foot or horse. A private ferry recently was brought into operation at Abdul Khan.

From the places of access a few trails lead resp. southward and northward into the area (see appendix IV). A connection between both systems only exists along the Iraq frontier between Subleh and Fakkeh. Still, apart from rainy periods, with knowledge of the terrain and the help of aerial photographs the passage from north to south can be made with jeeps. A few of these trails form the main lines of traffic for the supply of the few small places of settlement.

The only river is the Dawairij which enters the area from the northwest. After joining up with an intermittant stream also coming from the Zagros foothills, the Dawairij follows a southerly course till the frontier post Fakkeh, where it flows westward into Iraq under the name of Kharkhara, to loose itself in the Hour al Lazime or Hour Sanaf marshes. The river Karkheh, forming the eastern and southern boundary of the area looses itself in the Havizeh marshes, through which the frontier between Iran and Iraq runs roughly north-south.

Geographically the area can be divided into five parts, indicated by names of Arab tribes living in the area. The boundaries between the different parts are not always clear as influence spheres are variable.

The northeastern part is known as Sorgheh. This area is entered by crossing the river Karkheh with the ferry of Pa-i-Pol. The first plain to be met here is indicated as the Dasht-e-Ewan named to the ruins of an old building in the remnants of the ancient Sassanide town of Kut Kapu. The southern part of this plain (south of a somewhat eroded area) is known as Malheh.

The northwestern part of the area is known as Robut. The boundary between both parts is not clear, as following the track from Dasht-e-Ewan westward through a hilly terrain first the large plain Dasht-e-Abbas is met. This plain is named to the Immamzadeh Abbas found in the centre part. The western part of this plain and the hilly sandy part between this plain and the tributary of the Dawairij river is known as Enekhosh and in the far northern part as Khersan.

These areas are part of Robut together with Abu Ghowair, the sandy plain south of the village of Enekhosh and the Dasht-e-Ali opposite Enekhosh to the west. The last plain is called after the Immamzadeh Ali Nair, found after crossing the tributary of the river Dawairij.

The region westward: the plain of Dasht-e-Patak and south and west of the river Dawairij (Dasht-e-Ambar, Cham Sarim, etc.) is known as Musia.

The central part of the area from the Iraq border till the river Karkheh is known as Chenaneh. The boundary in the north again is not clear as Chenaneh also is a tribal name. The southern and western part of the Dasht-e-Abbas (called Thal) is already the domain of the Chenaneh tribe. The southern part of the plain of Abu Ghowair again already is part of Chenaneh. Also west of the Dawairij river near Fakkeh the plain of Someideh is part of Chenaneh. The small plain on the eastside of the river called Ghobed Hashal should be incorporated in the Chenaneh part though the tribe living there is not part of the Chenaneh family.

The plain between Fakkeh and Subleh, west of the dune area, known from north to south as Ghenamieh, Tawusi and Rosheideh is part of Chenaneh as also the plains draining to the Karkheh east of this dune area and the mountain chain. In the centre is found the plain called Dosalagh; the sandy plain just west of Dosalagh is called Tapeh Gorg. To the east the Dosalagh plain narrows along its drainageway and there is called Khèzèr. The more or less level plain along the river Karkheh east of Khèzèr is known as Tapeh Tup. The strongly undulating and partly badland part north of Tapeh Tup is known as Abu Gharab and till Malheh as Abu Amood.

The large plain running northwest-southeast south of the Dosalagh and Khèzèr plain is called mainly Erayez; the lower part near the Karkheh together with a weakly undulating sandy area north of it is known as Moder'reh. The higher weakly undulating part between Erayez and Dosalagh is known as Tapeh Hachem. All these are parts of Chenaneh.

The southwestern part of the region is known as Khasradj. To this part belongs firstly the plain south of the Erayez and Moder'reh plains again draining into the Karkheh. This plain is known as Bag'eh. On the southern side this plain is bounded by fairly high mountainous terrain in which again plains occur. That region is known as Ommeddebès. A fairly large intermittant salt lake is found there. Further south along the river Karkheh is located another plain beloning to Khasradj, called Khomsieh.

The great dune area west of the main part of Chenaneh and Khasradj is known as Dasht-e-Mishan. The region called Dasth-e-Mishan however extends further south than just the sandy desert part. Also the irrigated parts near Susangird are part of Dasht-e-Mishan.

Fig 3: Living dunes.

Fig 4: Dune topography with vegetation in the depressions.

A further characteristic of the area is the presence of a number of anticlinal hill or mountain ranges which cross the area in northwest-southeastern direction as common in the Khuzistan plain. These ranges are physiographically of various character. Coinciding with the stratigraphy of the tertiary layers outcropping in these ranges, usually the southwestern sides of these ranges are of a steep, rocky and rugged topography (fig 5). The northeastern sides occupy the largest parts of the ranges and in principal are gently sloping. Numerous natural drainage channels have developed along these sides, forming an undulating, rolling hilly or locally deeply dissected topography. Some of these areas are difficult to access.

Fig 5: Rough rocky land on Middle Fars rock formations (Miocene)

East of the hilly or mountainous ranges and more or less protected against the windblown sand which occurs mainly west of these ranges and moves in eastern direction, are found a number of level to nearly level plains. Parts of these plains are covered already by the eastward moving sand, as in particular seems clear, where the dunes reach uptil the very borders of the floodplain of the river Karkheh; only locally small plain remnants are left uncovered.

Nearly all plains are draining in southeastern direction, partly to the Dawairij river, all other plains to the river Karkheh. The eastward slope however of these plains is so little, that no deep natural drainage channels have developed. In times of heavy rains therefore the bottompart of the plains may become wholly covered by a sheet of water for a few days. In some plains groundwater tables occur in these parts on depths of about 1.50 - 2.50 meter and saline soils have developed. In two cases intermittant lakes have developed (fig 6).

Fig 6: Intermittant salt lake in the plain of Hofal.

The Dawairij river and tributary and the Karkheh river lie deeply incised in fairly wide floodplains, which for the greater part are covered with floodplain forests. Only very close to these rivers a marked erosion and incision of the drainageways has occured, locally even resulting in the formation of typical badland areas. The strongest this is found in the northeastern part of the project along the Karkheh, where former parts of plains by erosion have been transformed to utterly valueless badland (fig 7).

Fig 7: Badland along the Karkheh floodplain.

In some cases the erosion of former land has developed to such an extent, that only isolated remnants are left in newly formed plains. Fig 8 illustrates the story of development of such areas.

Fig 8: About 20 m high erosion remnant near Fakkeh.

These witnesses of tremendous erosion activities date back from former times. The erosion active to day is much less important, and is limited to some gully erosion in the badland areas and windblown sand areas (fig 9).

Fig 9: Recent gully erosion in badland area.

Chapter III: GEOLOGY

3.1. Tertiary formations

The geology of the area is marked by a number of hilly to mountainous ranges, crossing the area in northwest-southeastern direction. These are the anticlines of folded tertiary formations formed mainly during the orogenesis of the Zagros Mountains in late Pliocene times (Lees and Falcon 1952). As such these ranges run more or less parallel to the Zagros Mountain ranges.

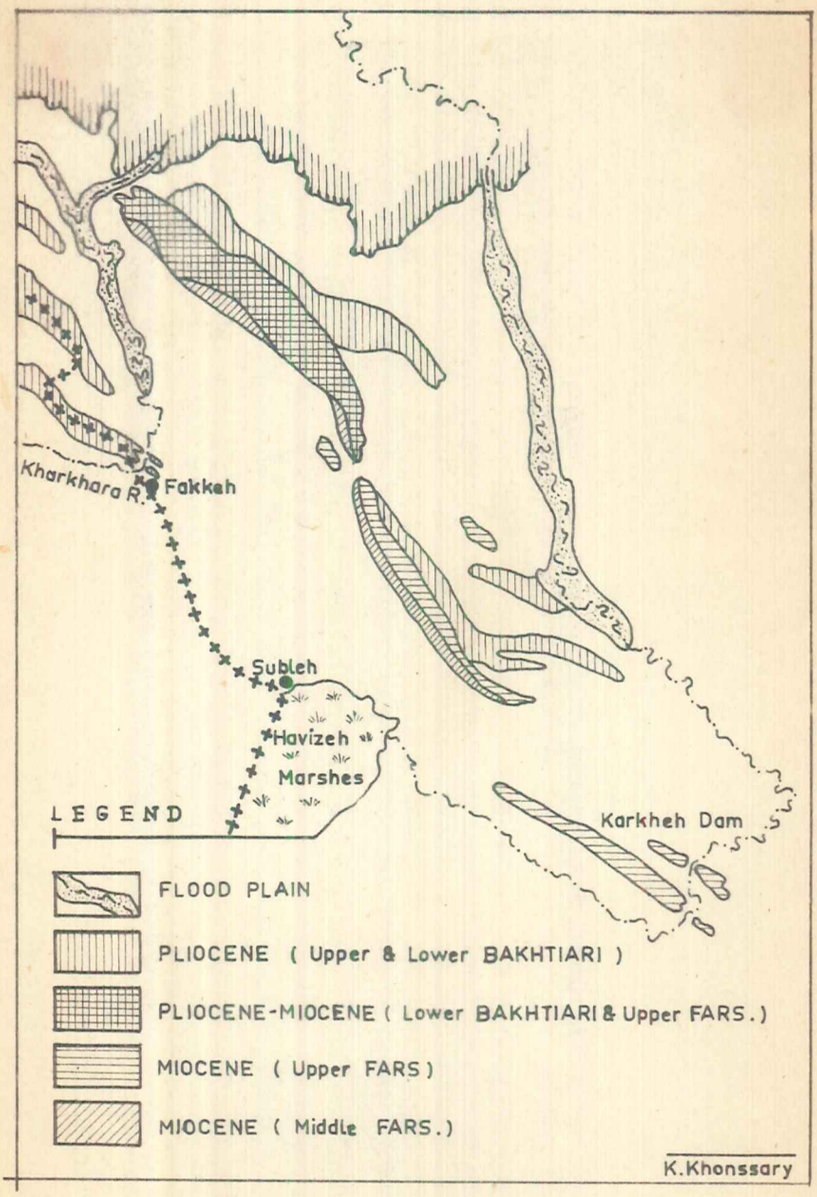

FIG. 10 : GEOLOGICAL SKETCH MAP Interpreted to the B.P.C map 56
SCALE 1:1.000.000

Boundary to ZAGROS foothills

In many cases could be observed that the hill or mountain ranges represent overthrusted anticlines. The layers dip only northeastward with about 10 - 30 degrees or even stronger as is the case with the main mountain chain dividing the area roughly into a western and a eastern part. In particular along its western fringe the layers sometimes are more tilted or in a nearly vertical position, giving the area a very rough topography (fig 5). Also the layers in the foothills of the Zagros Mountains along the northern boundary are dipping northeastward.

Fig 11: Sandstone and shale layers dipping with about 30 degrees to the northeast.

In other cases as between the Moder'reh and Erayez plains and near the Karkheh dam, it appeared that the outcropping layers in the northern side dip northward and on the southern side southward, representing the two sides of one anticline. Generally again the northeastern dip is less steep than the southeastern.

The general tendency of the anticlines to be more or less overthrusted to the southwest causes the northeastern slopes of the hill or mountain ranges to be less steep than the southwestern slopes. Geologic erosion generally is stronger on the southwestern sides.

For the same reason the tertiary layers coming to or close to the surface on the northeastern slopes are in most cases younger than in the southeastern slopes. This is most evident in the main mountain chain, where on the western side the for the region oldest Middle Fars formations crop out. The eastern slopes, like in most other anticlinal ranges,is formed by Upper Fars or Pliocene Lower Bakhtiari formations.

There exists no great petrological difference between the different tertiary formations. Sandstone of varying hardness, mostly soft shale layers and more or less cemented gravel layers prevail in all of them. In the Middle Fars formations, some quartside and marly layers were observed. The stratigraphy of the younger layers is often difficult to recognize and separation on the basis of composition problematic (fig 10).

The youngest tertiary Upper Bakhtiari formations occur mainly in the footslopes of the Zagros Mountains and according the geological map (B.P.C. Ltd. 1956) also in the hilly ranges northwest of Fakkeh.

3.2. Pleistocene and holocene formations

Mainly south and west of the hill or mountain ranges are found large windblown sand deposits. Apparently the mountainous ranges have been serious obstacles for this sand to move further northeastward with the prevailing westerly winds. On several places can be seen how the sand creeps over the ranges and penetrates into the plains beyond.

It is not clear from where the sand originates. As weathering of sandstone formations is not a very quick one, it is not likely, that these great quantities of sand find their source in the tertiary rocks. Another possibility could be that the sand originates from Bakhtiari formations from which it is blown out by the wind leaving a gravelly residue. However in the sand area itself traces neither of gravel nor of sandstones are found. They might be fully covered up with the sand itself.

A more acceptable theory is, that the sands date back from the very dry climatic period (Butzer 1957, Bobek 1937) at the end of the Pleistocene and the beginning of the Holocene, some 9000 - 11000 years ago. During the pluvial period preceeding this dry period, many sandy water-layed deposits will have been sedimented in the Upper Terrace deposits of the rivers in the Mesopotamian plain, which were blown by the prevailing winds east-northeastward and accumulated before the hill and mountain ranges. Also in other areas of the Khuzistan plain (f.i. east-northeast of Ahwaz) such windblown sand accumulations in front and equally to lesser extent just over the hill ranges are found.

The theory that these sand formations are coastal marine deposits, is left out of consideration as there is no prove up till now that the Persian Gulf even extended further inland than it does now. As a matter of fact, Modern studies about tectonic movements in the region (Lees and Falcon 1957) and the rising of the sealevel after the Pleistocene point to the contrary.

The local character of these windblown deposits is a striking feature. In the surveyed area it occurs only in the Iranian part of the plain, the frontier with Iraq following about its western extremity. This can be explained by on one side accumulation in front of the mountain ranges and on the other side by a renewed discharge of drainageways at the end of the dry period in the fundamentally fluvial area more westward, creating somewhat wetter conditions and bringing in heavier textured deposits which together put a stop to further winderosion. Nowadays to the west (in Iraq) large parts are marshy and on other places soils with high groundwater tables occur.

As to the sand deposits and their geomorphology some typical characteristics are observed. The sand is transported constantly in east-northeastern direction by the prevailing western or west-southwestern winds. Where fully exposed to these winds, dune formation occurs, they are covered with a kind of weed and bush vegetation in particular in the low spots. There are only small places, where sand accumulates to higher and bare living sand dunes. Such high dune parts are found however in particular just in front of the most western mountain range.

When sand is transported by wind, the different grain sizes will be taken up into the air to corresponding heights. The coarser sand will stay near to the ground, only the finest sand particles will be taken up to greater heights. The coarser sand in general is not transported over large distances through the air and will repeatedly be settled. Thus the regular dune formations are formed in a kind of equilibrium with average wind velocities.

However in front of the mountain ranges the winds will be forced up. The result is that the transporting capacity near to the ground decreases, and the coarser sand grains will settle. In this way there the higher bare dune formations are formed. Generally they are situated somewhat in front of the mountain range with finer textured deposits in the lee spot between them and the mountains. However with the building up to higher elevations of these dunes, they gradually will fill up the depression between them and the mountains till finally the coarse sand flanks the mountain slopes and eventually will be able to creep over it.

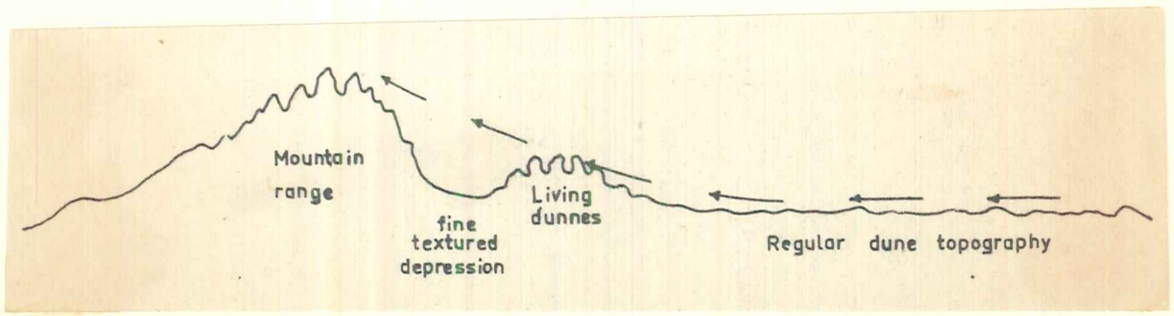

Fig 12: Dune formation in front of mountain range.

The more rolling and level sand deposits are deposited in areas which lie somewhat protected against the wind, usually behind the main mountain range; the rolling parts again in front of other hilly or mountainous ranges. As they are fully grown with a grass vegetation it is likely that these formations date back to former climatologic periods.

On the eastern boundary the dune formations of the Dasht-e-Mishan reach till the very border of the floodplain of the river Karkheh. A further move of these formations is checked as the eastward creeping sand is carried away by the flowing water of this river. As dune formations are also found on the eastern

side of the Karkheh it stands to reason that formerly the Karkheh did not flow where it flows now, but more to the east (see Dizful unified report).

For the greater part between the hilly or mountainous ranges and protected by them against the moving sand are found a number of plains. These plains are nearly level in topography. The soil material is medium to heavy textured, forming an alluvial fill in the former anticlinal basins.

With probable exception of some parts near to the river Karkheh, all these plain sediments are pedimental alluvial formations originating from the adjacent tertiary ranges. Their sedimentation is entirely connected with floodwater streaming down the hills and spreading over the plains during and after torrential rains; they bring in soil material in thin layers and gravelly deposits along gullies penetrating over some length into these plains. The main part of this valley fill will date back to pluvial Pleistocene periods, but the topparts are certainly of Holocene age as flooding occasionally still occurs in this era.

Apart from some gravelly deposits mainly occurring in the plains bordering the vast foothill areas of the Zagros Mountain, these pedimental formations are very uniform in composition. Only locally sandy subsoils at about 70 - 85 cm depth are found. These may indicate stronger movements of the floodwater in former times either dating back to the Pleistocene pluvial period or to times that these plains had stronger natural drainage possibilities to the river Karkheh.

A remarkable characteristic is, that though most of the plains drain in southeastern direction to the river Karkheh, no distinct natural drainage channels usually exist; in fact drainage of the plains mostly is so poor that after heavy rainy spells parts of the plains get inundated. The more this is astonishing as the river Karkheh lies well below the general level of these plains. With respect to the findings in the Dizful project east of the river Karkheh, this might be an indication that also in this area tectonic movements occur, tilting the area northeast-southwest, dipping to the southwest. The plain of Dosalagh in fact only has a man-made drainage channel to the river Karkheh.

Chapter IV: HISTORY, CLIMATE AND VEGETATION

4.1. Ancient settlements and irrigation works

Little is known of the historic development in this area, but the hummocky remnants of many ancient towns or villages, tapeh's, ancient canals and qanats occur in various parts. From the pottery found is concluded that in Islamitic times and later the area was still densily occupied by men. Several of the remnants of old towns show the traces of surrounding earth walls, sometimes two or even three. The tapeh's usually are not high, though two very high specimen are seen near Enekhosh and the village of Sheikh Mohammed Shaghati.

The most striking remnants are found in the Dasht-e-Ewan. There the traces are present of the ancient town of Kut Kapu. A rectangular lay-out of ancient earthern city walls, divided by ditto walls into three compartiments forms the reminiscens of the settlement of Roman prisoners of war during the time of the Sassanid kingdoms (Shapur II). The ruins of a building, partly restored and preserved are still to be seen (fig 13).

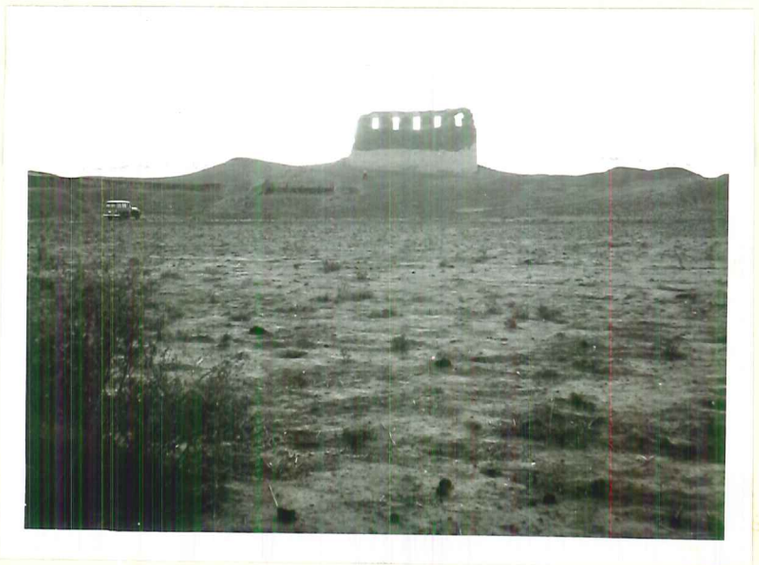

Fig 13: Ruin Ewan-e-Karkhah in Kut Kapu.

The hummocky remnants of ancient canals leading to this ancient town from the river Karkheh near Pa-i-Pol ferry illustrate the mode of water supply. A dam-cum-bridge existed at the place of the ferry. However the impression is given that at least one major canal was not fed by this dam, but took off more upstreams. The bottom of this canal lies too high for this. North of the ferry site the area through which this canal once must have crossed, now is completely eroded by the river and forms part of the Bottom Lands.

South of the ruins of Kut Kapu are found the hummocky traces of another large town. This town is situated in an area severely influenced by erosion. No traces of canals or qanats for water supply are observed in this area. Here also a ruin exists of a brick building, probably of a kind of tower (fig 14).

Fig 14: Ruin of tower south of Ewan-e-Karkhah.

The ancient canals leading to Kut Kapu have served both the water supply of the town as well as the irrigation of the surrounding land. Partly the canals lead into the rectangular; on places there are also outlets. Other canals pass along the rectangular. Soil conditions in the neighbourhood illustrate the deposition of irrigation material. There certainly will have been an active agriculture in this plain during intensive settlement, as also traces of canals further away from the town of Kut Kapu are found, partly fed by the aforementioned main canals, partly by canals constructed to collect and distribute floodwater from gullies. They have been extending quite far southward, right through the eroded area which now is found west of Kut Kapu. It is not unlikely that this erosion has been initiated by the excess of water draining through this area. On several places the direction and pattern of the erosion gullies point to the presence of former canals of which the very vague traces also are found south of the eroded part in the area called Malheh.

In the western part of Dasht-e-Abbas several medium high tapeh's occur, on one of which the tomb of Abbas is built. The remnants of an ancient town which has been surrounded by an earthern wall are found also in this area (Khersan). Near Enekhosh a remarkable high tapeh exists.

Also south of Enekhosh in the plain of Abu Ghowair traces of ancient settlement and irrigation works are found. This is a nearly level sandy area, but bundles of qanats are found in it, laid deeply in the gravelly subsoil. Though not completely clear, it seems that these qanats start on the point where the tributary of the Dawairij river coming from the north stops to carry water during the summer. Apparently underground water there was tapped and leaded southward by qanats. A remarkable feature is that the hummocky remnants of the town in this plain is on quite a distance from these qanats, which moreover lead to the river Dawarij.

The conclusion might be that irrigated agriculture here was the main object of the qanats.

Further south in the plain of Abu Ghowair the traces occur of a town, which originally was protected by three walls with moats in between. This must have been quite an important place in the area. Great amounts of brick stone pieces cover the hummocky remnants. A km long, now on most places practically extinguished canal served together with a local natural drainage system the watersupply of this centre with floodwater. Also the traces of ancient qanats occur in this area. Somewhat to the west the rather high remnants of another old town was seen (fig 15).

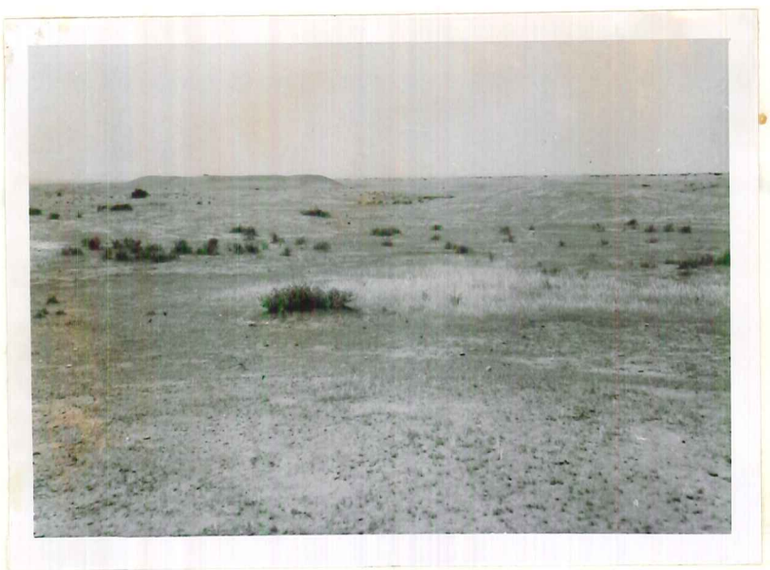

Fig 15: Remnant of an ancient town in Abu Ghowair.

In plain of Dosalagh,apart from less important traces of ancient settlement, an extremely high tapeh is present, dominating the whole scenery. Intriguing are the remnants of settlement in the centre of the area about 30 km south of this tapeh in the plain of Erayez. The remnants of a large town are found, surrounded by an earthen wall and served by qanat systems for its water supply. A deeply cut in and obviously much used road leads in southern direction.

The remnants of another big place of settlement further south in Hofal at the edge of the dune sand area and near the large intermittant lake tells an interesting story about developments in the area. Traces of old canals are found there too. This town was situated on the edge of a quite large plain now gradually merging into the intermittant lake. This plain now is severely salt. There is a good chance that it originally was not, and served the agricultural production of this centre.

4.2. Historic developments of agriculture

Though few data are available about the age of the various settlement places, it is quite obvious that in former times a more permanent occupation of the area existed where now only nomads and some local tribes

live in small tent villages. The position of the ancient towns only in or predominantly along the periphery of the plains point to agricultural activity. They are located on the somewhat higher terrain around the plains, either because the plains occasionally were inundated by floodwater or because along the edges during rainy spells flooding occurred more frequently, but less severe, giving better possibilities in dry farmed agriculture.

Irrigated agriculture for sure was practized in Sassanian times in the Dasht-e-Ewan. In how far and to what extent the ancient canals and qanat systems found in other plains served irrigated farming is not known. They may have served predominantly the watersupply of the townships.

However finding these systems and the relatively large amount of ancient places of settlement, we cannot but escape the idea that formerly agricultural activities and may be possibilities in the area were considerably greater. Now considerable parts of the plains are just severely saline, in which agriculture under present conditions is of no use. It is quite likely that these plains in former times had a better natural drainage to the Karkheh. Tectonical movements, as mentioned in chapter III, may be the reason for this deterioration.

During the reign of Shah Rezah,efforts were made to transfer the population to a sedentary existance. Villages were built, tents burned and people had to settle. Apart from their natural inclination as herdsmen, the Arabs however took again to their nomadic existance as soon as the possibility offered itself. The ruins of the former villages tell the tale of this development. It is quite understandable that even if they wished to settle, the saline soils of some of the plains did not offer fair means of existance.

4.3. Climate

No climatological data are available for the region. However it may be expected that the climate will not considerably deviate from what is known about Khuzistan plain in general.

Average annual rainfall in the south will be about 250 mm and about 350 - 400 mm in the north at the foot of the Zagros Mountains. The summer is long (about May through October) and dry, with practically no rainfall at all after April. In November the first rains will come again. Rainfall is very erractic and often occurs in heavy showers. Air humidity during summer is low and medium during winter. In December periods of heavy fog occur.

Mean annual temperature as measured in Ahwaz is about 25.6° C with average variations in January of 13.6° C till 38.5°C in August. Day temperatures during summer are very high reaching maxima till and over 50° C. Between April and June a sharp rise of average temperatures sets in.

Winds are predominantly westerly, occasionally blowing from the north, the south or the southeast. Northerly winds bring low humidity and clear fresh weather, southerly winds bring high air humidity and as a result oppressive weather. Winds are strongest during summer, sometimes causing serious sand or dust storms; in particular during day-time strong westerly winds can persist over longer periods.

4.4. Vegetation

The vegetation is scanty and steppe-like. Annual grasses form the main vegetation cover, in particular in the sandy parts with smooth relief. They develop after the first rains in November/December and come to full growth in Janary and February, forming a fine natural pasture of short grasses. During the last part of April and the beginning of May the grass dies down, leaving the land bare during the summer.

Fig 16: Dense Artemisia vegetation on sand soil.

The monotony of the grass areas is locally broken by low shrubs of Artemisia species (fig 16). Locally this vegetation may be very dense. Other typical plants in these sandy grazing areas are scarce. Here and there a Cucurbitaceae which spreads radially from its roots producing small round melonlike fruits is found. (Citrullus colocynthrus)

Fig 17: Radial growth of Citrullus colocyntrus.

In the non-saline parts of the plains some Camelthorn (Alhagi maurorum) may be found, but there the low woody perennial shrub locally known as Kavireh(Prosopis stephaniana)is more typical, in particular in those parts, which are or have been under cultivation.

Fig 18: Kavireh vegetation.

In non-cultivated parts some wide-spread high bushes and a few trees mainly consisting of Konar (Ziziphus Spinachristi) can be seen. For the greater part these bushes or trees have been removed by the population in their need for wood for building and fuel; or they have disappeared out of the natural vegetation type as the result of grazing and burning which is practized in the grazing areas during May nearly every year. These bushes are the remnants of a former more dense Konar tree vegetation. Numerous are the shallow holes where trees or bushes have been dug out with trunk and parts of the roots. It may be safely assumed that originally the vegetation was more of a park-type than of the steppe-type as it appears now.

Fig 19: Scattered Konar bush vegetation.

In the low parts of the dune areas some grasses and different kinds of shrubs are found, as well as Artemisia and some Tamarix trees. Their presence also indicates that this area climatologically is not a steppe area

Fig 20: Tamarix trees in dune part.

In the river floodplains of the Karkheh and the Dawairij a typical flood forest has developed consisting of a variety of species (Tamarix, Alnus, Salix).

For the saline areas the most striking vegetation is a Salicornia species. This plant indicates salinity over about 3 % salt in the topsoil. Several halophytic grasses are typical for the less saline parts, where also again Kavireh and Camelthorn thrive in soils with less than about 1 % salt in the topsoil. The Kavireh growing on saline soils is less well developed than on non-saline soils.

Chapter V: AGRICULTURE, POPULATION AND LANDRIGHTS

5.1. Grazing

Agricultural activity in the area till recently was restricted to grazing and the typical arabic dry land-farming of wheat and barley.

All tribes keep large herds of sheep and goats, few donkeys and very few camels. In winter and spring time there is an abundance of grass for the cattle, in particular in the non-cultivated non-saline parts of the plains and on the sandy soils with smooth topography, so much so large herds are brought in the area by owners of animals from Iraq. During three or four months the grass on these soils thrives well, also feeding great quantities of gazelles. Grazing possibilities stop first on the sandy soils due to their low waterholding capacity. That is the time that the herds from Iraq are withdrawn (before 15th of April). What is left of the grassplains since the increase of cultivation serves for some time after that period as the main grazing grounds, before the herds are spreading over the larger hilly terrain to find enough food.

5.2. Non-irrigated agriculture

Farming was restricted to dry land farming, known as "Deym". As the habits of the Arabic population do not include agriculture on larger scale, but require just enough production of wheat and barley to feed the families during the year, only small spots are normally cultivated.

Small scattered fields are plowed and sown to wheat or barley. Wheat is the dominant crop, also grown on slightly saline soils. Barley is found less but usually occupies the more saline spots. The fields are plowed in irregular forms. To have maximum profit of the precipitation they are located either on places where the topography shows a depression, how weak this may be, or on weakly sloping areas subject to flooding during rainy spells (fig 21). These are the more densily cultivated parts.

Though the annual quantity of rainfall in principle suites dry landfarming in this region, the need to secure yields by making maximum use of the rainwater is quite evident. The incidentally added extra water during flooding apparently gives more advantages than it causes damage to the crop. In the depressional areas water is accumulated from the surroundings; for this purpose auxiliary ditches are dug to lead water from not cultivated parts to the plowed fields. This need to augment the watersupply of the crops is one of the reasons that from origine nowhere large fields are cultivated by the local population.

Never the fields are cultivated continuously. The rotation seems to be one year grain, two or three years fallow. In particular in the erratically scattered fields it is difficult to discover a

Fig 21: Flood debris caught in camelthorn shrubs growing in fallow land.

rotation system. After fallow newly plowed fields often are laid out in different sizes, forms and direction as to topography. These fields are plowed with horses, seldom with donkeys. The grain is put on the land before plowing and thus worked under.

Only recently under the influence of Persian farmers hiring land in this area, dry landfarming in the last few years has developed on larger scale. Large parts of the plains are worked with mechanized tillage and harvesting implements.

5.3. Irrigated agriculture

Irrigated agriculture is very local. In Dasht-e-Ambar a small area is irrigated by gravity as also along the river Karkheh near the village of Sheikh Ali Zamel. Some vegetables etc. are grown near Enekhosh, where water from a spring is available.

Further irrigation activity is found along the river Karkheh supplied with water by motorpumps a.o. at Pa-i-Pol, and further south near the places of Sheikh Kazem and Sheikh Tahimeh and west of Hamidieh near the places of Sheikh Seyed Ali, Sheikh Zamel and the village of Subhaneh.

In the southern part west of Hamidieh a modern irrigation project is under construction. A dam built in the Karkheh upstreams of Hamidieh can provide the water for this project. The total area planned for irrigation covers about 10.000 ha; to day only about 500 ha of this project is under irrigation.

All other land lies too far away from the sources of water or topographically too high above it (Dawairij river) that irrigated agriculture could develop.

5.4. Population and landrights

The population from origin consists mainly of Arabic tribes. There are numerous small villages each with their own sheikhs. Mostly a number of these local sheikhs are under the general direction of a chief sheikh. Several of these chief sheikhs are members of one family and thus form together large tribes. The different tribes are located in different parts of the area.

The Sorgheh part is the domain of the Sorgheh tribe. The important sheikhs in this part are Sheikh Saleh Davood and Sheikh Saleh Moshat'tad. Robut is part of the domain of the Homed tribe. Dasht-e-Ali Nair, the vicinity of Enekhosh, Khersan and part of the Dasht-e-Abbas are all under the general direction of Sheikh Goayem of the Homed tribe. Musia: Dasht-e-Patak, Dasht-e-Ambar, Cham Sarim, the area further southwest of the Dawairij and the small plain of Ghobed Hashal east of this river is under the general direction of Sheikh Abdullah Hassan, Bakhsdar in Musia.

The Chenaneh area can be split into four parts. The plain between Fakkeh and Subleh is under the direction of Sheikh Dja'ehdjeh. The southern part of the plain of Abu Ghowair to the north along the eastern side of the Dawairij river and the Someideh plain, west of the Dawairij are under the general direction of Sheikh Hawi. Further eastward the northern part of Chenaneh is under the direction of Sheikh Mohammed Shaghati (the areas of Dosalagh, Tapeh Gorg, Khèzèr, Abu Gharab, Abu Amood and the southern and western part of Dasht-e-Abbas). Southward the plains of Tapeh Tup, Tapeh Hachim, Moder'reh and Erayez are under the direction of Sheikh Ali Zamel.

In the Khasradj part the plain of Bag'ch is under the direction of Sheikh Mosan and near the Karkheh under Sheikh Kazem. To the south the plain of Khomsieh and the Ommed'debès area is the domain of Sheikh Tahimeh.

All land in the area is government land, directed by the pertinent office for government land, the Khalaseh. It was brought definitely under Iranian government rules some 30 years ago after the imprisonment of Sheikh Khasal, who considered himself at that time king of Khuzistan.

The Khalaseh collects taxes from the land users. Each sheikh has to pay and does this in so far as governmental control and force is strong enough to collect adequate payments per animal grazing in the area or crops grown. Apart from this the Khalaseh office hires out land to others than the original population, who want to start cultivation of cerials. From this type of agriculture surer and larger incomes are ensured.

This causes problems. Firstly because the Arabic tribes consider themselves owners of the land, but secondly because for cultivation exactly the best summer grazing land is occupied. Naturally this is very much to the disadvantage of the herdsmen because they loose

their means of existance. To this comes that the Arabic tribes resent very much the gradually increasing influence of Persian settlers.

Persian settlers rented land in the Dasht-e-Ewan (Mr. Naderi); in Dasht-e-Abbas (several members of the Sagvand family under the direction of Gholam Khan) and in the Bag'eh plain (Mr. Dahambani). Some sheikhs have started themselves cultivation on larger scale and rented the land from the Khalaseh office for that purpose. However not all sheikhs can bring themselves to that or have the financial possibilities to buy tractors, tillage or harvesting machines etc.

An agreeable solution seems the formation of agricultural companies between the local sheikhs and persian cultivators as for instance in the Erayez plain. There, Sheikh Ali Zamel rents land and cultivates that in a company with Mr. Ghalam Zan from Dizful.

The case of the Sagvand group in the Dasht-e-Abbas is a"bit particular". The Sagvand people claim the same ownership of the land in this plain,as their ancestors like the Arabic tribes lived there before. Gholam Khan in some way or another even got a certificate of property over some 3000 ha in this plain, a right which none of the Arabic tribes have. This Sagvand family is cultivating this part and a much larger terrain hired from Khalaseh. As a result of this position there exists quite a tension between these Persian settlers and the Arabic tribes.

Chapter VI: SOILS OF THE AREA

6.1. General

On the basis of their value for agriculture and development possibilities a grouping of the soils of the area is made as follows:

a) soils of the plains
b) soils of the windblown sand areas
c) micellaneous landtypes

6.2. Soils of the plains

These are the most important soils of the area. They occupy about 172.700 ha or 32 % of the total survey. In all the plains land is cultivated to varying extent with the exception of severely saline parts.

The soils of the plains are rather young soils. Profile development is immature also because sedimentation of new soil material with floodwater occurs now and then during wet spells. Nearly all soils show gypsum mycelium in the profile below 8 - 15 cm depth. There is no distinct horizon of gypsum accumulation; only, some soils may in total be very rich in gypsum in the form of gypsum sand or crystals. These soils generally contain in the toplayers more gypsum than the rest of the profile. Such soils occur rarely in the plains and are mainly restricted to weakly sloping and undulating soils developed on material derived from tertiary Upper Fars and Lower Bakhtiari gypsiferous formations (shales, gravels and sandstones). Thin and soft layers of gypsum crust are found often a few cms below the surface.

Also distinct horizons of accumulation of lime are lacking though some visible lime in the form of nodules or powdery pockets occur in certain depths. In general the soils of the plains, with the exception of the severe saline soils, can be classified as immature Brown soils.

The soils of the plains are lighter textured (sandy loam, loamy sand, loam) nearer to the hills and mountains and heavier textured (heavy clay loam to clay) further away. There the slope of the plains becomes so much less that floodwater will run off only very slowly so that only finer material will settle. Only locally light textured (till sandy) subsoils occur.

Many of the plains have such poor drainage conditions that saline soils have developed, the most saline of which can be characterized as Solonchak soils.

floodwater comes down before spreading over the plain. To considerable extent this is only found in the lighter textured soils developed below coalescing gravelly fan areas. Such fans are only built up by the great quantities of floodwater which incidentally come down the foothills of the Zagros Mountains along the northern boundary of the surveyed area. The frequency of such gravel deposits made a special indication necessary a.o. in the Dasht-e-Ewan. The spotwise presence of fine gravel in the lighter textured soils often on considerable distance from the coalescing fans is not indicated. They are the witnesses of former gullies which penetrated further in the plains than they do to-day and which lie now completely imbedded or under the fine textured pedimental alluvium of recent times. Other soils which show gravel in the surface to some extent are derived from gypsiferous Upper Fars and Lower Bakhtiari formations. Mostly they occupy weakly sloping areas with an undulating relief.

Generally the topography of the soils of the plains is level to nearly level. Locally a weakly undulating relief (3 - 6 %) may have developed as the result of erosion action. Stronger erosion has caused in equally small areas the development of distinct gully systems. With very few exceptions the terrain features in these gullied areas are rounded and smooth and often cultivated all over. Slopes of about 6 - 9 % occur between the nearly level remnants of the original landscape. In some cases this erosion has developed to such an extent, that whole areas have developed a so-called badland topography. Although originally part of the plains, these areas are mapped separately and indicated as a miscellaneous landtype.

6.3. Soils of the windblown sand areas

Of less to no agricultural importance are the soils of the windblown sand areas. These soils all consist of practically pure sand with rapid permeability and very little waterholding capacity. As such they are too dry for the cultivation of crops, though in some parts which are nearly level, irrigation for special purposes might make cultivation possible.

The greater part of the windblown sand areas consists of dune formations, partly completely bare and constantly shifting; partly more or less fixed by a grass and shrub vegetation which thrives in the lower parts. Here and there even some Tamarix trees can be found (fig 20). These dune areas are not comprised in this group of soils but are arranged with the miscellaneous land types.

Recognized in this group as soils are only the sand soils with weakly undulating to nearly level relief (fig 2) and those with smooth undulating to rolling relief. These soils are completely covered by a grass vegetation during the winter and spring months.

As annual the grass vegetation protects these soils against further wind influences, they show an incipient profile development which appears from a very thin and weakly developed A_1-horizon and the presence of visible lime in the form of nodules in the subsoil

The features of soil formation however are not pronounced enough to call these soils anything else but Regosols. To some extent the nearly level sand soils may even be slightly loamy in the surface alyers.

Where the more level soils are distinctly loamy in the toppart of the profile deeper than 75 cm, they are grouped together with the light textured soils of the alluvial plains. This is a.o. the case south of Enekhgosh. There most likely a periodical inundation by the rivers caused this admixture with clayey material.

Here and there severe gully erosion is found in these rolling, undulating or nearly level sand soils. This is a type of erosion formed in these days and is not fossile. The gullies are mostly very steep and deep; they erode backward with great speed, every time that heavy rains occur (fig 22).

Fig 22: Recent gully erosion in sand area.

Locally these sandy soils show gravel in the surface. This illustrates the presence of gravel deposits on some depth, where they cover gravelly tertiary formations.

6.4. Miscellaneous landtypes

Grouped under miscellaneous are firstly all the hilly and mountainous parts. These soils have not been studied, being of no importance to agriculture now or in the future. Real rocky parts occur mostly on the southwestern sides of the mountainous ranges, where Middle Fars formations occur. The hilly areas are mostly characterized by gravelly and/or strongly gypsiferous soils on sloping land (more than 10 % slope) in which many incised drainageways are present, giving the land an irregular topography with slopes over 16 %. Frequently the erosion has been so strong that an original downward sloping plain is scarcely to be recognized and only hilly to very steep land presents itself to

the eye. The gravelly and gypsiferous lands mostly occur over Upper Fars and Lower Bakhtiari formations.

Also grouped as miscellaneous are the dune parts of the windblown sand areas. They have no value for agriculture and are difficult to penetrate other than on horseback, by camel or walking.

Furthermore classified as miscellaneous are all gravelly coalescing fans. The topography of these is not unfavorable, but the soils occurring in it are mostly very gravelly and thin over pure gravel. The depth of the gravel varies from spot to spot. These coalescing fan areas are regularly subdivided by gravelly gullies.

Chapter VII: THE SOIL MAP

7.1. Mapping units

The survey being of a reconnaissance type it was not possible to study and map the soils in any detail. All soils which were of no actual or potential agricultural value are grouped without further studie in various miscellaneous landtypes. All other soils are mapped on the basis of general genetic relationships, usually indicated as soil associations. The relationships mostly are geographical but over and above also may be of other character like topography, texture or salinity.

In most associations a number of soil phases have been distinguished according to deviations of the modal soil properties set for the associations proper.

Some complexes of soil associations or soil associations and micellaneous landtypes have been introduced.

7.2. Basis of separation of soils

The associations are separated on the basis of:

a) texture characteristics of the upper 100 - 120 cm of the profile
b) salinity over 0.35 % of salt in top and/or subsoil
c) main relief characteristics

The phases are separated on the basis of:

1) Shallowness due to the presence of sand in the subsoil
2) Presence of gravel in the profile
3) Topography features dissimilar from the normal relief characteristics of the association
4) Erosion features
5) Degree of salinity higher than the salt contents normal for the soil association proper.

7.3. Legend description

Soils of the plains

P_1: Association of light textured soils, predominantly sandy loam, loamy sand to loam soils both in the surface and subsoil with incipient profile development. Topography regular with 1 - 3 % slopes.

Phases:
P_1d - shallow (sand occurs at depths of 70-85 cm).
P_1g - gravelly (gravel in surface and subsoil).
P_1u - undulating (slopes vary from 3 - 6 %).
P_1ug - undulating and gravelly. These are mostly soils rich in gypsum sand.
P_1e - gullied. The terrain has many shallow gullies and some parts are deprived from the topsoil by erosion. Slopes of 3 - 6 % occur.
P_1sa - slightly saline. These soils are slightly saline (0.15 - 0.35 % of salt) in surface and/or subsoil.

P_2: Association of heavy textured soils, predominantly clay loam, sandy clay loam or clay soils both in the surface and subsoil. Weak profile development.

Phases:
P_2d - shallow (sand occurs at depth of 70-85 cm).
P_2e - gullied. The terrain has many shallow gullies and some parts are deprived from the topsoil by erosion. Slopes of 6 - 9 % occur.
P_2sa- slightly saline. These soils are slightly saline (0.15 - 0.35 % salt) in surface and/or subsoil.
P_2dsa-shallow and slightly saline. These soils overlei sand on depths of 70 - 85 cm and are slightly effected by salts (0.15 - 0.35 % salt) in surface and/or subsoil.

P_3: Association of saline soils, predominantly silty clay loam or sandy clay loam soils. The subsoil usually is of fine sandy clay loam to clay texture. Profile development is weak. These soils usually are moderately saline. Salt content in surface and subsoil varies generally between 0.35 and 0.65 %, sometimes is higher.

Phases:
P_3d - shallow (sand occurs at depths of 70-85 cm).
P_3sa- severely saline. Salt content in surface and subsoil exceeds 0.65 %.
P_3saw-severely saline and wet. This severely saline phase shows groundwater on 150 - 200 cm depths.

Soils of windblown sand areas

S_1: Association of nearly level to gently undulating sand soils, (1 - 3 % slope) These are pure sand to weakly loamy sand soils. Subsoils always are sand. Incipient profile development in the form of a weak A_1-horizon and some visible lime in the form of $CaCO_3$ nodules.

Phases:
S_1e - gullied. Gullies have developed because these soils usually are in a gently sloping position (3 - 6 % slope). Slopes of 6 - 9 % occur.
Complex:
S_1-S_3 - complex of nearly level sand soils with locally small dune areas to a maximum of 10 % of the area.

S_2: Association of sloping and rolling sand soils (6 - 9 % slopes). These are pure sand soils in surface and subsoil. Profile development is negligable.

Phases:
S_2e - gullied. The gully formation here is more active. Steep and deeply incised gullies are formed by floodwater coming down the slopes.
S_2g - gravelly. Gravel occurs in surface and subsoil.

Miscellaneous

M_1 - hilly to mountainous land with rock outcrops
M_1^2 - hilly to mountainous land over conglomerates
M_2^3 - badland. Strongly eroded land
S_3^3 - sand dunes
S_3^4 - shifting sand dunes
M_1-S_4 complex of mountainous land and sand dunes
R_1^1 - gravelly river and gully beds
R_1^2 - non-gravelly river and gully beds
F^2 - gravelly coalescing alluvial fans

7.4. Descriptions of the soils of the plains

P_1: Association of light textured soils of the plains:

These soils are light textured varying from loamy sand to loam. The median of the sand lies between 75 and 105 mu (extremely fine sand). The topography is level to nearly level. Locally these soils contain some small gravel in the topsoil; often at about 1 m. depth again a gravel admixture occurs.

The Dasht-e-Ewan shows locally some shallow erosion gullies and clearly gravelly topsoils. In the Dasht-e-Abbas plain gravelly topsoils occur mainly north of the natural drainageway, the material originating from the gravelly Upper Bakhtiari. South of the drainageway the soils usually are not gravelly; the texture in general is more sandy (loamy sand). In the plain of Ali Nair the soils are practically similar to those of the Dasht-e-Abbas. They show locally fine gravel in the topsoil. In the Abu Ghowair plain south of Enekhosh the soils of this unit are slightly different. There the sand fraction is somewhat coarser and mainly of windblown origine (median of the sand fraction about 150 mu). Probably there exists an influence of the river Dawairij and its tributary coming from the north; no gravel occurs in the topsoil except in the vicinity of some ancient qanats present in the area.

In the Erayez plain (Chenaneh-Sheikh Zamel) the topography is characterized by very slight gully-like depressions along which water transport takes place during floodperiods. These shallow depressions fan out into the plain.

In the plain northwest of Hamidieh along the foot of the hills the soils again are slightly gravelly in the topsoil; however along the river Karkheh they are not. The formations here are not pedimental but fluvial.

Scattered places of this soil association occur also in the area of windblown sands at the end of drainage systems coming from the hills and mountains. They may occur right at the foot of the hills or somewhat further in the sand area depending on the water transporting capacity of the gullies. Here the sand fraction is coarser (median about 150 mu) as a result of the mixing of dune sand with the fine textured material.

brought in by the gullies.

The soils of this association are characterized, apart from their light texture by a moist colour of the surface soil (about 0 - 20 cm) of 10 YR 4/3 - 5/3 and a subsoil colour of 7.5 YR 4/4 - 5/4. This topsoil colour occurs only in not or recently plowed soils: in the not plowed soils there is often a 10 YR 3/2 moist colour in the very toplayer (0 - 4 cm) as a result of accumulation of organic matter (2 - 3 % O.M.). In plowed soil the organic matter content of the topsoil varies from 0.4 - 1.00 %.

Generally these soils are moderate in gypsum content (5 - 10 %) and high in lime content (about 30 - 40 %). Some soils are found which are very rich in gypsum (gypsum sand), these are mostly undulating and gravelly.. No mechanical data are available as the suspensions made for the analysis do flocculate. A correlation which is often found, shows that with high gypsum content, the lime content is low. The determination of the cation exchange capacity of these soils (table I, Ali Nair 7) seems to be dubious.

On all depths the soils of this association are characterized by pores of about 0.2 - 0.5 mm diameter.

Phases:

Gravelly phase: In this phase the topsoil and the subsoil are distinctly gravelly. The size of the gravel is larger than in the typical soil. Many shallow gullies occur. This phase covers the large part of the Dasht-e-Ewan below the coalescing fans.

Undulating phase: The topography is undulating as a result of weak erosion. Slopes vary from 3 - 6 %. Over large areas the topsoil is removed as a result of erosion.

Undulating and gravelly phase: The topography is locally undulating as a result of erosion,with slopes varying from 3 - 6 %. Between the undulating part small level areas occur. All soils have gravel in the topsoil and are very rich in gypsum crystals, often showing the yellowish colour of gypsum "sand", soft gypsum crusts a few cm below the surface. These soils are derived from gypsiferous tertiary material.

Gullied phase: This phase is a more pronounced phase of the undulating phase. Stronger erosion has formed many gullies, shallow and deep. The topography is rolling; slopes vary between 6 and 9 %. The bottom parts of the gullies are rich in gravel. The original topsoil is nearly completely removed by erosion.

Shallow phase: In this soil the light textured material is only about 80 cm deep, overlying sand. This soil occurs only in the Khomsieh plain near the river Karkheh, where it is used for irrigated farming. These soils are somewhat excessively drained. Permeability is in the toppart medium and rapid in the deeper subsoil.

Profile No.	Depth cm	Texture	Sat. %	pH 1 : 5	Mechanical analyses $CaSO_4$ and $CaCO_3$ included >20 mu	2-20	<2 mu	T.N.V. as $CaCO_3$	O.M. %	T.S.S. %	$CaSO_4$. me/100 gr
4	0 - 18	FSL	41.5	8.3	56.8	26.2	17.0	37.7	0.62	0.04	9.7
Ewan	18 - 30	FSL	43.0	8.4	55.2	24.8	20.0	38.5	0.26	0.04	8.9
	40 - 55	-	66.7	8.6	58.4	22.8	18.8	37.9	-	0.04	-
7	0 - 4	FSL	68.4	8.1	-	-	-	18.8	2.64	0.06	18.7
Ewan	25 - 40	SL	33.8	8.7	65.0	18.6	16.4	34.7	-	0.03	7.4
	60 - 80	SL	34.4	8.5	59.8	21.2	19.0	34.3	-	0.05	7.9
2	5 - 20	L	44.5	8.0	flocculated			-	0.38	0.11	20.0
Ali Naer	20 - 35	L	58.9	8.0	"			27.6	-	0.13	-
	70 - 85	liSCL-SL	74.3	8.0	"			-	-	0.19	very high
6	0 - 20	SL	34.6	8.8				32.7	0.88	0.04	3.0
Abbas	70 - 100	L	40.2	8.8				39.1	-	0.03	-
8	0 - 20	LS	33.3	8.7				-	-	0.03	-
Abbas	40 - 60	SL	37.7	8.8				-	-	0.03	-

Table I: Laboratory data on the light textured soils of the plains.

Slightly saline phase: In this phase a salt accumulation occurs in topsoil and subsoil between 0.15 and 0.35 % of salt. In some cases NaCL salts are observed.

A profile of the typical association:

0 - 15	cm	Ap horizon with organic matter, dark brown to very dark gray brown 10 YR 3/3 - 3/2 moist (10 YR 5/2 dry), FSL-L, mixed with small gravel, structureless to massive, loose to very friable. Some pores. No visible lime or gypsum.
15 - 30	"	Brown to dark brown 10 YR 4/3 - 5/3 moist, FSL-L, penetration of organic matter, structureless breaking into weak subangular blocky, friable. Some pores, some gypsum mycelium and little lime.
30 - 80	"	Brown (7.5 YR 4/4 - 5/4 moist) SL-L, sometimes mixed with gravel, structureless or massive, sometimes weak angular blocky, friable to sometimes little hard or cemented. Some pores, some gypsum mycelium and some powdery pockets of lime.
80 -(130)	"	Dark yellowish brown or yellowish brown to brown 10 YR 4/4 - 5/4 or 7.5 YR 4/4 - 5/4 moist sandy loam to loam, massive, friable. Some gypsum mycelium and visible lime, sometimes with lime nodules.

Topography: These are usually level to nearly level soils with upto 2 % slope. In the undulating and gullied phase the slopes exceed 3 % varying till 6 % (topography B).

Salinity: These soils are usually not saline. However in the saline phase 0.15 - 0.35 % of salt may occur in the topsoil and/or subsoil.

Agriculture and land use: Large parts of the typical soil are dry farmed. Wheat as well as barley is grown. But in the gravelly phase cultivation occurs only in patches. In the undulating and gullied phases no cultivation occurs, because of the stronger slopes and the lack of topsoil material. Where still some topsoil is present, grass is to be found. The other parts are practically without vegetation.

Drainage: This is a moderately well drained soil. In general the internal drainage is medium, sometimes rapid. The soils have a favorable infiltration rate and a good water holding capacity. In the undulating and gullied phases external drainage is excessive with the result that these soils hold less moisture for plant growth.

P_2: Association of the heavy textured soils of the plains

These soils consist of the finer textured material as they occur on farther distances from the foot of the hilly parts; generally they occupy the centre parts of the plains with a level topography.

They occur in the Dasht-e-Ewan near the river Karkheh, further in the plains of Dasht-e-Abbas, Dasht-e-Ali Naer, Dasht-e-Ambar, along the river in Abu Ghowair, in Dosalagh and furthermore occupy large areas in the Erayez plain, the Bag'eh and Khomsieh plains,

Profile no.	Depth cm	Texture	Sat. %	pH paste	pH 1 : 5	Mechanical analyses $CaSO_4$ and $CaCO_3$ included >20 mu	2-20	<2 mu	T.N.V. as $CaCO_3$	O.M. %	T.S.S. %	$CaSO_4$ me/100 gr
7	0 - 15	liC	63.9	7.1	8.3	-	-	-	-	1.43	0.07	-
Ali Naer	15 - 56	liC	48.1	7.2	8.5	-	-	-	-	0.31	0.06	-
	55 - 120	VFSCL	47.5	7.2	8.5	60.4	20.2	19.4	43.4	-	0.21	-
1	0 - 10	CL	-	-	-	-	-	-	-	1.00	0.03	4.3
Someideh	50 - 70	CL	-	-	-	flocculated			31.1	0.34	0.08	4.6
13	0 - 10	heL	-	-	-	36.6	37.8	25.6	-	1.46	0.07	-
Bag'eh	30 - 50	CL	-	-	-	25.8	45.4	28.8	-	0.53	0.11	2.8
23	0 - 10	CL	-	-	-	38.2	25.2	36.6	-	1.08	0.04	-
Bag'eh	80 - 100	C	-	-	-	-	-	-	33.2	0.38	0.08	-
5	0 - 15	SCL	-	-	-	-	-	-	-	0.93	0.06	3.0
Ommeddebes	30-50	SCL	-	-	-	43.2	27.0	29.8	35.6	0.33	0.07	4.0
	50 - 70	SCL	-	-	-	flocculated			-	-	0.06	-
15	0 - 10	L	38.3	7.9	8.8	-	-	-	-	1.03	0.05	-
Khezer	15 - 30	SCL	33.6	7.8	8.9	-	-	-	-	0.40	0.05	-
	40 - 60	FSCL	46.2	7.8	8.9	flocculated			50.6	-	0.04	-
	80 - 100	FSCL	80.1	7.9	8.9	-	-	-	-	-	0.05	-

Table II : Laboratory data of the heavy textured soils of the plains.

and near Hamidieh and the Karkheh dam.

The textures of both topsoil and subsoil vary from sandy clay loam or silty clay loam to clay. Usually they are not gravelly. Only locally some erosion and narrow shallow gullying is observed. Where these soils occupy the centre part of a plain, a wide and shallow main drainage channel can be found. The colour of the topsoil (about 0 - 15 cm) is usually 9 YR to 10 YR 6/4 - 5/4 dry, and 5/4 - 5/3 moist. The subsoil till about 75 - 90 cm has a 7.5 YR hue, deeper the colour may change to 5 YR hues with the same chroma and value as in the topsoil. Where the topsoil is removed by erosion, the colour of this soil till about 90 cm is of 7.5 YR hue and deeper nearly always 5 YR.

Typical again for this soil is the medium presence of pores on all depths. They vary in diameter (abt. 0.1 - 0.55 mm). Usually these soils do not show visible lime in the profiles. If it occurs, then it is present between 30/40 - 75/90 cm depth in the form of powdery pockets. Gypsum in these profiles in the form of mycelium is always present but not in the topsoil (0 - 20 cm). With depth it increases and there also gypsum crystals may occur. The organic matter content generally is somewhat higher than in the light textured soils varying from about 1 - 1.50 % in the topsoil. The gypsum content in the various layers is usually lower (abt. 2-5 me/100 gr soils. Generally these soils are not effected by salts, though in a few cases slight salinity may occur in the subsoil.

Phases:

Shallow phase: In this soil the heavy textured material is only about 70 - 85 cm deep, overlying sand. Topography is regular and practically level. The permeability of the toppart of this soil is slow, but rapid in the bottom part. This soil occurs only in the western part of the Bag'eh plain.

Gullied phase: This phase is characterized by the occurrence of many steep and deeply incised gullies. Surface erosion is active, causing an irregular topography. This phase is found in the Dasht-e-Ewan near Kut Kapu and in the western part of the Erayez plain. This phase is not suited for cultivation and irrigation.

Saline phase: In this soil usually both the surface and subsoil are slightly effected by salts (0.15 - 0.35 %). In some cases the topsoil is not saline and the salinity in the subsoil also is less severe. These soils could be cultivated and brought under irrigation, but for a low permeability. They occur in the Dasht-e-Ambar, in the Ghobed Shahal plain near Fakkeh, in Dosalagh and Erayez, and along the Karkheh near Karkheh dam, Hamidieh and Subhaneh village.

Saline and shallow phase: This soil is slightly saline overlying sand on about 85 cm depth. It is a better drained soil, found in the western part of Bag'eh plain.

Profile no.	Depth cm	Texture	Sat. %	pH paste	pH 1 : 5	Mechanical analyses $CaSO_4$ and $CaCO_3$ included >20 mu	2-20	<2 mu	T.N.V. as $CaCO_3$	O.M. %	T.S.S. %	$CaSO_4$ me/100 gr
8	0 - 10	CL	41.8	7.7	8.8	-	-	-	-	-	0.07	-
Erayez	30 - 50	CL	64.7	8.0	9.0	36.4	31.4	32.2	-	-	0.06	2.6
	70 - 90	SiL	46.2	7.4	8.4	flocculated			-	-	0.17	-
11	0 - 10	SCL	36.6	7.9	8.6	flocculated			-	0.81	0.06	-
Erayez	15 - 30	SCL	43.5	7.6	8.4	-	-	-	44.2	0.40	0.32	-
	50 - 70	SCL	43.5	7.8	8.5	flocculated			42.7	-	0.37	-
16	0 - 15	FSCL	-	-	-	42.8	32.6	26.4	-	0.81	0.03	-
Bag'eh	30 - 50	SCL	-	-	-	45.2	24.2	30.6	-	0.28	0.15	2.9
21	0 - 10	SiCL	-	-	-	14.6	46.2	39.2	-	1.19	0.05	-
Bag'eh	20 - 40	C	-	-	-	-	-	-	-	0.57	0.33	6.5
4	0 - 10	SiCL	52.8	7.6	8.0	flocculated			-	1.63	0.19	-
Ambar	65 - 80	C	56.0	7.5	8.1	-	-	-	-	-	0.22	-
6	0 - 12	FSCL	49.7	7.4	8.4	51.4	28.0	20.6	-	1.73	0.21	-
Ambar	45 - 60	FSCL	42.9	7.5	8.5	54.4	23.4	22.2	-	-	0.27	-
3	0 - 10	CL	49.5	7.8	8.7	-	-	-	-	1.26	0.19	-
Erayez	20 - 40	CL	62.7	7.8	9.0	-	-	-	-	0.52	0.15	-
	40 - 60	SiCL	50.5	7.7	8.4	flocculated			-	-	0.35	-
	60 - 80	CL	66.8	7.7	8.2	-	-	-	44.7	-	0.36	-
	100 - 120	VFSCL	43.7	7.4	8.2	flocculated			45.5	-	0.28	34.6
5	0 - 30	SCL	45.3	7.6	8.9	flocculated			45.1	0.21	0.13	2.2
Erayez	40 - 90	HeCL	43.2	7.4	8.1	"			46.7	0.14	0.22	-
	90 - 120	CL	70.5	7.4	8.1	"			-	-	0.19	-
6	0 - 12	L	33.3	7.6	8.8	-	-	-	44.3	0.78	0.04	-
Erayez	30 - 60	CL	58.0	7.9	8.9	-	-	-	-	-	0.03	-
	90 - 120	C	67.9	8.0	8.8	-	-	-	-	-	0.17	-

Table III: Laboratory data of the heavy textured soils of the plains, saline phase.

A profile of the typical association:

0 - 10/15	cm	Ap horizon; light yellowish brown to yellowish brown 9 to 10 YR 6/4 - 5/4 dry and brown to yellowish brown 9 to 10 YR 5/4 - 5/3 moist SCL - CL, subangular blocky or cloddy structure, friable or little hard. Some pores. No visible lime or gypsum.
10/15 - 30/40	"	Light brown to brown 7.5 YR 6/4-5/4 dry and brown 7.5 YR 5/4-4/4 moist. SiCL or SCL - CL, structureless or massive to angular blocky, firm to hard or little hard. Some pores. No visible lime, little gypsum mycelium.
30/40 - 75/90	"	Brown 7.5 YR 5/4 - 4/4 moist CL to C, structureless or massive to angular or subangular blocky, friable to hard. Some or many pores with some gypsum mycelium and some powdery pockets of lime.
75/90 - 120/130	"	Light brown to brown or reddish light brown to reddish brown 5 to 7.5 YR 6/4 - 5/4 dry , 5 to 7.5 YR 5/4 - 4/4 moist FSCL - C, structureless to massive, little hard to hard. Some pores, much gypsum mycelium and crystals. No visible lime.

Topography: Level to nearly level regular topography, but for the gullied phase.

Salinity: The typical soils are not effected by harmful amounts of salts. Large parts indicated as saline phase are slightly effected by salts (0.15 - 0.35 %). Because permeability is low, irrigation practices in this phase will need careful management.

Drainage: This is a somewhat poorly drained soil. External drainage is very slow; also internal drainage is slow.

Agriculture and land use: Except for the gullied phase all these soils could be cultivated. Wheat and barley are grown now in large areas under dry farming conditions. Not cultivated parts show a grass and annual weed vegetation on which sheep and goats may feed.

P_3: Association of saline soils of the plains:

The soils are comparable with the non-saline association of heavy textured alluvial soils. They are strongly effected by salts both in the top and subsoil. Salt contents vary between 0.35 and 0.65 % in top and/or subsoil for the typical representatives of this association. Stronger salt influences are separated in a severely saline phase ($>$ 0.65 %). The organic matter content of these saline and severely saline soils is generally lower than in the heavy textured non-saline soils of the plains.

Topography is regular and level to nearly level and textures are heavy or very heavy. Possibilities for cultivation and development of irrigation are

limited and imply the necessity of drainage and leaching. The permeability of the soil is very low and drainage therefore difficult. Sometimes watertables between 1.00 - 2.50 m are observed.

This soil occurs in the Dasht-e-Patak and Dasht-e-Ambar and near Fakkeh; further along the Iraqi border in the plain between Fakkeh and Subleh; also it occupies large parts in Chenaneh: the plains of Dosalagh and Tapeh Gorg; Khasradj : the central and eastern part of the plain of Bag'eh and further along the Karkheh near the Karkheh dam, Hamidieh and north of Susangird.

The texture of this soil both in the top and subsoil varies from clay loam and sandy clay loam to clay. Normally the plains where these soils occur show deeply incised drainage channels with many tributary gullies.

Remarkable for this soil is a more reddish colour with depth. The colour of the typical association generally is in the topsoil (0 - 15 cm) 7.5 YR 6/4 dry and 5/4 - 4/4 moist; the subsoil is 5 YR 5/4 - 4/4 moist. This tendency is also found in the distinguished phases.

This soil is characterized by many small pores in the topsoil, also antholes etc.; the subsoil has less pores. Usually no visible lime occurs in the profile, but if present it is found in a horizon of varying thickness between 20 and 50 cm depth as powdery pockets. Gypsum in these profiles in the form of mycelium occurs not or very little in the topsoil. Below the topsoil gypsum increases with depth; in the deeper parts gypsum crystals are abundant. Sometimes the middle part of the profile has no gypsum mycelium or crystals (abt. 35 - 65 cm). $CaSO_4$ content is mostly over 5 me/100 gr soil.

Phases:

Shallow phase: In this soil of sandy clay to clay textures, sand occurs at abt. 70 - 85 cm depth. In the clayey toppart separate sandy layers may occur. This soil is found in Chenaneh, the Dosalagh plain. Topography is level; the land is nearly all dry farmed. There is no visible lime in the profile, and only a tiny little gypsum mycelium developed in the lower part of the more clayey toplayers.

Severely saline phase: This soil has a heavy sandy clay loam to clay texture mostly with moderately to high percentages of salt in the surface and high salt percentages ($>$ 0.65 %) in the subsoil. According to the taste much NaCL is present. The gypsum content in these soils is markedly higher than in the typical soil (uptil abt. 40 me/100 gr soil). Also the organic matter content is higher (1 - 2.5 %).

Topsoil colours till 10 - 15 cm depth usually vary from 9 YR to 10 YR 6/4 dry and 4/4 - 4/3 moist; sometimes these are 7.5 YR 6/4 dry, 4/4 moist. Till about 40 - 50 cm depth they are in all cases 7.5 YR 6/4 dry, 5/4 - 4/4 moist and deeper again less reddish (varying between 7.5 YR - 10 YR). Below 100 cm again stronger reddish tinges occur of the same value and chroma varying between 7.5 YR and 5YR.

Profile no.	Depth cm	Texture	pH paste	T.N.V. as $CaCO_3$	O.M. %	T.S.S. %	$CaSO_4$ me/100 gr
Typical soils							
4	0-15	SCL	7.0	-	0.84	0.48	-
Karkheh	30-50	SCL	8.0	36.6	0.28	0.57	3.3
Dam	80-100	C	8.0	-	-	0.65	6.5
9	0-10	C	-	-	1.03	0.06	-
Bag'eh	10-30	C	-	30.6	0.41	0.45	-
	80-100	C	7.5	-	-	0.65	7.6
Severly saline phase							
1	0-7	SCL	7.5	-	0.62	0.73	4.7
Karkheh	10-30	C	7.5	-	0.33	1.90	8.4
Dam	60-80	SCL	7.4	-	-	1.00	15.7
	120-190	C	7.5	-	-	2-05	15.1
2	0-7	CL	-	-	0.96	0.49	-
Karkheh	20-40	CL	7.3	-	0.41	1.10	-
Dam	100-120	C	7.5	-	-	0.65	5.0
1	0-20	SCL	7.4	-	0.33	0.71	2.0
Abarfush	60-80	C	7.8	-	0.22	2.05	3.0
3	0-20	SCL	7.6	-	0.74	0.18	8.8
Abarfush	40-60	C	7.6	-	0.33	2.05	11.0
	60-80	C	-	-	-	2.05	-
4	0-15	CL	-	-	1.24	0.05	-
Bag'eh	30-50	C	7.1	-	0.19	1.20	-
	80-100	C	-	-	-	0.07	3.9
3	0-30	C	7.4	-	0.33	2.20	42.8
Ommed-	50-70	SiC	6.9	-	0.26	2.30	-
debes	90-110	C	-	-	-	2.15	-
6	0-10	CL	7.6	-	0.33	1.15	-
Ommed-	20-40	C	-	-	0.50	0.08	4.0
debes	70-90	C	8.2	-	-	0.97	2.5

Table IV: Laboratory data of the saline soils of the plains

These soils occur near Fakkeh, the Khomsieh plain, Erayez and along the Karkheh river near the Karkheh dam and north of Susangird.

Wet severely saline phase: This clay loam to clay soil has a watertable between 1.50 - 2.50 m and is very saline. Salt content right under the topsoil (about 30 cm depth) is above 0.65 %, frequently even so in the topsoil. Values reach up till about 2 % or even 3 %. $CaSO_4$ content is very high (uptil 60 - 100 me/100 gr soil). On many spots salt efflorescence on the surface in certain times of the year is strong. The groundwater is saline.

The colours of this soil are pretty well the same all over the profile (7.5 YR) with again a tendency to more reddish (5 YR) colour below about 1 m.

This soil occur in the Dosalagh plain, along the Iraq border between Fakkeh and Subleh, in Bag'eh plain and around the intermittant lake north of Susangird.

A profile of the typical association:

0 - 10/15	cm	Light brown 7.5 YR 6/4 dry and brown 7.5 YR 5/4 - 4/4 moist SCL or C, subangular blocky or cloddy; hard and sometimes compact. Very small pores and holes, no visible lime or gypsum.
10/15 - 30	"	Reddish brown 5 YR 5/4 - 4/4 moist heSCL or C, medium subangular blocky, little hard to hard. Some small pores, some powdery lime pockets.
30 - 60/70	"	Reddish brown 5 YR 5/4 - 4/4 moist C, structureless, firm to little hard. Few small pores. Gypsum and powdery lime pockets may be present.
60/70 - 120/125	"	Reddish brown 5 YR 5/4 - 4/4 moist or dry C, structureless or massive, very hard and sometimes compact. Very small pores, many crystals of gypsum.

Topograph: Usually level to nearly level (1 - 3 %) regular topography.

Salinity: The typical association of this soil is moderately saline (0.35 - 0.65 % of salt), the severely saline or wet phases are extremely saline ($>$ 0.65 %).

Drainage: Drainage conditions in these soils are poor and complete inundation occurs during wet spells. Both external and internal drainage are slow to impeded.

Agriculture and land use: Only the typical association is spotwise cultivated, but not the severely saline phases. These phases, even under natural conditions have a very scanty vegetation mainly consisting of Salicornia or halophytic grasses.

Soils	area in ha	area in % of total
Soils of the plains		
P_1 light textured soils	30.000	5.56
P_1d -shallow phase	1.450	0.28
P_1g -gravelly phase	4.000	0.75
P_1u -undulating phase	9.000	1.67
P_1ug -undulating and gravelly phase	18.000	3.35
P_1e -gullied phase	10.000	1.85
P_1sa -saline phase	3.200	0.62
P_2 heavy textured soils	22.000	4.00
P_2d -shallow phase	350	0.08
P_2e -gullied phase	4.000	0.75
P_2sa -saline phase	15.100	2.70
P_2dsa -shallow and slightly saline phase	1.400	0.30
P_3 saline soils	9.000	1.68
P_3d -shallow phase	700	0.15
P_3sa -severely saline phase	17.000	3.15
P_3saw -severely and wet saline phase	27.500	5.12
Soils of windblown sand areas		
S_1 nearly level to gently undulating soils	39.400	7.12
S_1e -gullied phase	2.250	0.45
S_2 sloping and rolling soils	43.500	8.00
S_2e -gullied phase	9.700	1.82
S_2g -gravelly phase	850	0.17
Miscellaneous and complexes		
M_1 hills and mountains with rock-outcrops	60.000	11.12
M_2 hills and mountains without rock outcrops	25.000	4.65
M_3 bad land	25.000	4.65
S_3 sand dunes	40.000	7.42
S_4 shifting sand dunes	58.000	10.75
R_1 gravelly river and gully beds	9.500	1.77
R_2 non gravelly river and gully beds	30.000	5.55
F gravelly coalescing fans	11.300	2.12
S_1-S_4 complex	8.300	1.55
S_3-M_1 complex	4.500	0.85
Total	540.000	100.00

Table V: Areas in ha and percentage of total of the various mapping units.

Chapter VIII: THE LANDCLASSIFICATION MAP

8.1. General

The possibilities of agricultural development by the application of irrigation are illustrated in the landclassification map (appendix II). Table VI gives the extent of the areas of different landclasses. Only 81.500 ha is found suitable for irrigated agriculture without further investigations and soil improvement measurements, such as will be necessary in the more saline soils.

The classification of the land for irrigation purposes is based on the system as developed earlier in Iran and described in the "Irrigation Soil Survey and Landclassification for Iran". Criteria are the inherent and associated properties of the soils. Technical factors other than p.e, leveling, terracing, subsoiling, deep ploughing, etc. and economical factors as to the suitability for irrigation are not brought into consideration.

8.2. Factors evaluated

The following factors have been evaluated:

a) Soil characteristics

1. Surface textures
2. Depth of soil over well permeable sand or gravel subsoils
3. Soil salinity
4. Permeability
5. Depth of groundwater

b) Associated land features

1. Topography, including micro-topography (degree of single or complex slopes)
2. Erosion liability (both by wind and water)
3. Liability to damaging floodings (force or duration)

c) Drainage conditions (present and potential)
Drainage conditions depend on soil conditions and associated landfeatures, reflecting their influence on internal and external drainage conditions.

8.3. System of landclassification

In this type of landclassification and according the above mentioned factors 6 classes of land with regard to agricultural development suitability with irrigation can be distinguished:

Class I - very suitable for irrigation
Class II - suitable for irrigation
Class III - marginal suitable for irrigation
Class IV - not suitable for irrigation except under special conditions and for special purposes
Class V - suitability for irrigation undetermined
Class VI - entirely unsuitable for irrigation

Class I: Very suitable for irrigation. In general the soils in this class are deep, of medium to heavy texture, good water holding capacity and medium permeability and are practically free of salt. The topography is usually favorable, with gentle slopes; there is no erosion, the watertable is low and there is no liability to flooding.

Class II: Suitable for irrigation. Soils that are moderately suitable for irrigation, being measurably lower than Class I in productive capacity. Certain limiting factors are present: drainage may be too slow in some parts, water holding capacity may be too low, slight salinity and/or alkalinity may occur, or relief may be relatively unfavorable.

Class III: Marginal irrigable land. Lands that are suitable for irrigation development but are marginal and of a more restricted suitability than Class II because of greater deficiencies in the soil; impeded or too rapid internal drainage (light texture), appreciable surface run-off and erosion (topography), liability to damaging flooding, moderate salinity and/or alkalinity problems.

Class IV: Not irrigable except under special conditions. Land which is not generally suitable for irrigation of common tilled crops due to inhearent soil properties, but may, under special conditions or after special treatment: leveling, terracing and other, except leaching and drainage, have limited usefulness for these crops. Lands in this class are usually too gravelly, too shallow, too severely eroded, too steep, or too frequently flooded for practical and economic development as cropland.

Class V: Undetermined suitability for irrigation. Under their present conditions they appear to be unsuited and should be considered so, until future economic and engineering studies prove them otherwise. Included are lands that have severe salinity or alkalinity problems or are poorly - imperfectly drained.

Class VI: Non-irrigable land. Lands in this class are those that are considered permanently non-irrigable. Included are steep, rough, broken lands, riverwash, dune sand and highly saline land proved not to be economically reclaimable.

The principal limitations in the evaluation of the landclasses indicated, lead to a subdivision into <u>subclasses</u>.

Three subclasses are defined which may occur in combinations:

A - salinity
S - soil properties, except salinity (permeability, depth etc)
T - topography

Classes and subclasses	area in ha		area in % of total	
Class I + II	39.000		7.21	
I, II S		22.500		4.16
I, II AS		16.500		3.05
Class III	68.200		12.64	
III S		40.000		7.40
III ST		17.900		3.33
III A		9.700		1.80
III AS		600		0.11
Class IV	135.500		25.09	
IV S		59.500		11.02
IV T		12.800		2.37
IV ST		63.200		11.70
Class V	47.300		8.76	
V A		15.800		2.92
V AW		31.500		5.84
Class VI	250.000		46.30	
Total	540.000		100.00	

Table VI: Landclassification data

8.4. Special landclass features in the area

In this landclassification reconnaissance no class I land is separated. This will only be possible in a more detailed study.

Much of class I and II land is at present cultivated for dry landfarming. Parts are now and then flooded by water from the hillsides. These floods however, as they do not come down in force and occur only over short periods have no damaging effect to the crops, in the contrary. Only when irrigation is laid out in these lands some care should be taken to protect the canals.

Class III land in the area mostly is distinguished from class II and II land on the basis of salinity. Also topography or heavier textures influencing the permeability can be the limiting factors.

Class IV land covers most of the windblown sand parts with smooth relief and the coalescing fans. These lands in general are only suited for grazing. From the end of autumn till about May they are covered with grass. For irrigation either the topography is unfavorable or the texture is too light (sandy or gravelly).

Class V land is separated mainly on severe salinity. Frequently groundwater occurs at depths of 1.50 - 2.50 m. Mostly the texture of these soils is somewhat heavier than what is normal for the region. Usually they have flat topography with some deeply eroded drainage channels.

Class VI land represents the steep and mostly very stony or gravelly land, sand dune parts, etc. which with the exception of some small parts are not suited for any development of irrigated agriculture and under present conditions are only suitable for erratic grazing and dry land farming in isolated spots.

Chapter IX: THE LAND USE MAP

According to present land use the area is divided into the following land use groups:

NR - non-irrigated cropland
IR - irrigated cropland
P_1 - pasture land with closed vegetation cover
P_2 - pasture land with patchy vegetation cover
W_2^1 - wasteland without any vegetation
W_2^1 - wasteland with scanty vegetation, seldom or not used for grazing.

Table VII gives the extent of the areas falling under the different land use groups.

Land use	ha	% of total
NI	71.000	13.1
IR	10.500	1.9
P_1	152.500	28.3
P_2	110.000	20.4
W_2^1	99.000	18.4
W_2^1	97.000	17.9
TOTAL	540.000	100

Table VII: Land use data in hectares and percentage of the total.

Non-irrigated cropland:

This group of land use comprises the land cultivated on large scale with mechanized farm machinery by local sheikhs or persian settlers and the subsistance cultivation of the local population. Wheat and barley are the only crops grown.

This type of land use is nearly entirely restricted to the plains. Mostly the small areas for subsistence cropping are situated on sloping parts which are most liable to occasional flooding.

Irrigated cropland:

This type of land use is only found along the river Karkheh. Near Pa-i-Pol is found a small garden irrigated by a pump, which however was toosmall to be indicated on the map. Further south in Moderreh and the lower part of the Erayez plain some small areas are irrigated by gravity; also these parts are too small to indicate.

In the lower part of the Bag'eh plain a larger part is pump-irrigated by Sheikh Kazem, as well as further south in Khomsieh plain by Sheikh Tahimeh. Irrigation on larger scale is practized near Hamidieh. Several Sheikhs own pumps in that region and furthermore about 500 ha is irrigated with the help of the Near East Foundation. This area is part of a larger irrigation project for which a.o. the Karkheh dam was built. The dam and main irrigation canals were constructed to serve the irrigation of at least 10.000 ha, but the project is not continued.

Pasture land:

Regular pasture land is formed by the non-cultivated parts of the plains and the light textured parts with smooth topography of the windblown sand area (P_1). In winter and spring these areas are completely covered with a vegetation of fine leaved short grass. The soils may be gravelly.

Other parts are less intensively used for grazing as the grassvegetation is patchy (P_2) on land which often is of an irregular relief, dissected by deep gullies, many times gypsiferous and gravelly.

The production capacity of these grasslands is highly dependable on the rainfall during winter and spring.

Waste land:

As waste land are indicated the areas which have no value at all such as living dune parts (W_1) and the hilly and mountainous areas (W_2), where only occasionally during the summer sheep and goats may be herded when more accessable areas as the sandy areas and plains are devoid of all vegetation. Also the river floodplains are indicated as W_2. For a great part they are covered with floodplain forest.

Chapter X: LABORATORY ANALYSES

Mechanical data are available only for a few samples as in most cases the suspensions flocculated after the treatment with Calgon: Na-hexameter phosphate used as dispersion agent in the Bonycucos hydrometer method.

The soils analyzed were first ground in a mortar, then dried in the oven and weighed before being analyzed. The fractions therefore are expressed in percentages on oven dried soil. Carbonates are not removed first; no treatment is done to remove organic matter. By grinding the $CaCO_3$ particles (farigenous, nodular and concretionary) which take a large part of the total volume of soil, are disintegrated.

The fractions <2 micron and 2 - 20 micron are obtained by reading the time of differential settling velocities; the fraction >20 micron by subtraction.

Saturation percentage: This item gives the percentage of water of saturated soil paste.

pH 1 : 5 and pH paste: pH measured with glass-electrode in a 1 : 5 soil-water suspension or saturated soil paste.

T.S.S.: Total soluble salts measured from the conductivity of a saturated soil extract or in a saturated soil paste and computed into salt content of the soil.

T.N.V.: Total neutralizing value expressed as percentage of $CaCO_3$. The soil is neutralized with excess standard HCL. Then boiled, filtered and washed free of chlorides. The excess acid was than titrated.

O.M.: The organic matter content is given by determining the organic carbon content with a wet combustion method and then multiplied with factor 1.724. The factor 1.724 is based on a carbon content of organic matter of 58 %. The carbon content of organic matter however varies with the type of organic matter as well as the C/N ratio. In these climates the carbon content will be higher and therefore the factor lower. The O.M. contents given are therefore not entirely correct.

$CaSO_4$: Gypsum content determined by measuring the soluble calcium plus magnesium in a saturation extract and comparing this value with the calcium plus magnesium in an extract made with sufficient water to dissolve all the gypsum.