# THE SOILS AND

# SOIL ASSOCIATIONS MAP OF ISRAEL

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# INTRODUCTION

The map of soil associations and the accompanying explanatory notes condense our accumulated knowledge of the soil resources of Israel.

The soil associations map has been prepared on the basis of the Soil Conservation Service survey carried out in the northern part of the country on a scale of 1 : 20,000 during 1949-52, and on the basis of the soil reconnaissance survey on a scale 1 : 100,000 carried out in the south by the Agricultural Research Station during 1950 to 1956. Copious use has been made of air photos in both surveys and also in the present compilation into soil associations. Often recourse was made to additional surveys or checks in the field. A map on a scale 1 : 250,000 has been prepared, which is here reduced to 1 : 1 million.

The explanatory text contains first a brief description of the 29 soil units whose array form the soil associations. The classification and its principles have been recently described. *) The units used here are all at the great soil group or subgroup level of the classification, except for the arid brown soils, where two soil families are the lowest units described.

The soil associations shown on the map are defined as geographical associations of the listed soil units which are distributed in a landscape segment according to a definite pattern related to the physiographic, lithologic and microclimatic conditions. The 17 soil associations are divided into two major groups. Those of subdued mountains and high plateaux, all of which have a high proportion of lithosols or bare rock outcrops, and those of the low plateaux and plains, which include all the major agricultural areas. This division follows that of the Soil Map of Europe which has been prepared by F.A.O. The outline used for the description of the soil associations conforms closely to the one used for the Soil Associations of Europe (2nd draft). We have therefore added a suggested correlation of the soil associations of Israel with those of Europe. Certain associations have no suitable correlatives in Europe because of the large differences in climatic conditions. For others the correlation is only tentative. The relatively large number of soil associations in Israel is due to the great variations of environmental conditions over a small area. Certain aspects of the geographical distribution of Israel soils have been discussed recently. **) This and the above mentioned publication contain references to additional studies of the soils of Israel which were of great help to us in the preparation of the present text and map.

The map and text have been submitted by the authors as a contribution to the F.A.O. Soil Map of Europe and Asia which are in preparation.

Jerusalem and Rehovot, October 1962.

The authors

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*) Dan, J., Koyumdjisky, H. and Yaalon, D.H., 1962. Principles of a proposed classification for the soils of Israel. Trans. Intern. Soil Conference, New Zealand, sect. B.

**) Dan, J. and Koyumdjisky H., 1962. The soils of Israel and their distribution. J. Soil Sci., vol. 13.

# SOILS OF ISRAEL

## A. DESCRIPTION OF SOIL UNITS

1. Hamra soils have an ABC horizon sequence. The profile has a red textural B horizon. There are continuous clay coatings on ped surfaces in the B horizon which has a strong blocky or prismatic structure. Sandy soils are single grained to massive. Organic matter content is low. The soils are formed on sandy parent material. They are slightly acid to neutral and non-calcareous.

2. Brown Hamra soils have an ABC horizon sequence. The profile has a reddish-brown or brown textural B horizon. There are usually continuous clay coatings on ped surfaces. The B horizon has mostly a blocky or prismatic structure. The soils are mostly neutral and non-calcareous. They developed mainly from mixed unconsolidated sediments, such as sandy and loamy alluvium.

3. Husmas soils have an ABcaC horizon sequence with a pronounced textural B. The A horizon is brown and calcareous, while the Bca horizon is red and contains many hard calcareous concretions though the soil matrix might be non-calcareous. These soils have developed from hamra as the result of enviromental changes and addition of $CaCO_3$.

4. Dark brown soils. These are coarse textured soils with an ABC or A(B)C horizon sequence. They have usually a textural B, but this is mostly less pronounced than in the brown hamra soils. The B horizon has a blocky or prismatic structure. The soil is calcareous and has usually a pronounced Bca or Cca horizon. They developed mainly from mixed unconsolidated sediments.

5. Grumusolic dark brown soils have an ABCca or ABcaC horizon sequence. The upper 10-20 cm. are brown medium to fine textured (silty clay loam or silt loam); downward the texture becomes finer (silty clay to clay) and the colour

darker. A ca horizon appears at depth of 0.50 to 1.0 m. or even lower. The structure of the B horizon is blocky to prismatic. Slickensides are found usually in the deeper layers and the soil cracks to some extent during the summer. The soil is calcareous throughout and developed from medium to fine textured unconsolidated sediments.

6. Psammic arid brown soils. These are coarse textured soils with an ABcaC profile sequence. The A horizon is coarse textured, brown to yellow brown; the Bca horizon is brown to reddish brown and of medium texture (loam, sandy clay loam or sandy loam). The soil is calcareous throughout and has small irregular hard lime concretions in the B horizon. The parent material is mainly sand or sandstone, but the upper layers have been supplemented, to some extent, with silty aeolian sediments.

7. Loessial arid brown soils. These soils have an ABcaC or an A(B)caC profile sequence. The A horizon is yellowish brown and relatively coarse textured (mainly very find sandy loam) while the B horizon is darker and somewhat finer (loam to clay loam) and has soft lime concretions. The B horizon has a pronounced subangular blocky or blocky structure and sometimes there are some clay skins on ped surfaces. The soil is calcareous throughout. The parent material is aeolian and redeposited loess.

8. Loessial sierozems have an ABcaC or an A(Bca)C profile sequence. The A horizon is yellowish brown and relatively coarse textured (mainly very fine sandy loam), while the B horizon is darker and finer (loam to clay loam) and contains lime concretions. The soil is calcareous throughout and saline in the deeper layers. The parent material is aeolian and redeposited loess.

9. Stony sierozem soils have an ABcaC horizon sequence. They are very stony and usually covered by a desert pavement. The A horizon is yellowish brown and coarse textured, while the Bca is darker and finer textured. Often a lime

crust is found at a depth of about 0.50 m. The soil is calcareous and increasingly saline with depth. The parent material is mainly old gravelly and stony alluvium.

10. Calcareous sierozem soils are deep highly calcareous medium to medium fine textured A(B)C or A(B)Cca soils, developed from calcareous lacustrine sediments. They are often gypseous or even saline at depth.

11. Reg (Hammada) soils are shallow desert soils covered by stony desert pavement. The A horizon is loamy, light yellowish-brown to very pale brown, vesicular, 2-3 cm. thick; the B horizon is 10-20 cm, thick, somewhat heavier in texture, light reddish-yellow, loose, and very saline. At greater depth are stones and weathering rock. These soils were formed under extremely arid conditions from various parent material, principally limestone, flint and chalk, or from coarse desert alluvium.

12. Grumusols are AC soils of heavy texture. The clay fraction consists of expanding clay minerals which causes the soil to crack badly during the alternating wet and dry seasons, and the soils show evidence of considerable churning action. The soils may contain calcium carbonate. Three structural horizons may be observed, an upper granular horizon, a prismatic horizon and a deeper "pyramidal" horizon. (The faces are mostly in an angle of about $45^{o}$ to the horizon; slickensides are seen on these faces).

13. Terra rossa soils are red brown to red, fine textured, mostly non-calcareous A(B)C soils on hard limestone, dolomite or sometimes nari lime crust. The upper horizon is granular to subangular blocky. The deeper horizon is subangular blocky to blocky. Most of the terra rossas are quite shallow and many rock outcrops appear in their area of distribution.

14. Brown rendzina soils are dark to very dark brown, fine textured, non-

calcareous to calcareous A(B)C soils on nari lime crust, hard chalk and occasionally on hard limestone. The upper horizon is relatively rich in organic matter. The structure is granular while in the deeper layer it becomes subangular blocky. Most of the brown rendzinas are quite shallow and many rock outcrops appear in their area of distribution. The transition to the underlying rock is mostly sharp. The soils have a moderately high to high content of organic matter.

15. Pale rendzina soils are brown to light grey loamy highly calcareous AC soils on soft calcareous sediments. The A horizon is crumbly; the transition to the soft rock is gradual.

16. Pararendzina soils are shallow sandy or loamy, light brown to brown, calcareous AC soils on calcareous sandstone (locally kurkar) or on hardened lime crust overlying the calcareous sandstone.

17. Basaltic protogrumusols are shallow fine textured AC soils on basaltic rocks. These soils are non-calcareous, stony and with many outcropping rocks.

18. Brown lithosol is a shallow (A)C soil. It is pale brown to yellowish-brown, loamy and calcareous. The hard parent rock or a hardened calcareous crust is found at 20-30 cm. depth or even less. The transition to the rocks is mostly sharp.

19. Rendzinic desert lithosols are shallow (A)C soils on soft marly or calcareous parent material. These soils are highly calcareous and as a rule also quite saline.

20. Regosols are (A)C soils, whose parent material includes various palaeosols and ancient alluvial and aeolian sediments. The soils are quite variable in texture and colour. They are characteristic of eroded areas and badlands.

21. Colluvial-alluvial soils are deep mostly fine textured soils which contain varying amounts of shattered stone. In most of their characteristics they resemble the soils from which they originate (mostly terra rossa, brown rendzina, pale rendzina, or basaltic protogrumusols).

22. Alluvial soils originate from recent alluvium deposited in broad valleys and flood plains. According to their properties, they are sandy, loamy or clayey soils, with a variable lime content. Alluvial deposits generally serve as a source for the development of other soils.

23. Coarse desert alluvium is the coarse material deposited in wide stream beds and in alluvial fans in various parts of the desert. These deposits are stony and contain only very little fine soil material between the stones.

24. Sandy soils are coarse sandy soils with an undeveloped profile, which were formed by aeolian and fluviatile deposition, particularly in the desert.

25. Loess and desert alluvial soils are fine sandy or silty stone-free soils, devoid of profile development, calcareous or highly calcareous and sometimes slightly saline. They comprise the recent wind and water transported silty sediments (regosolic loess and loessial regosols).

26. Peat and organo-mineral soils are soils with more than 20% organic matter throughout the profile. They were formed mostly through accumulation of Cyperus papyrus and similar plant remains. Lime content and pH are variable.

27. Gley and hydromorphic soils are generally fine textured soils with a prominent gley layer in the profile. They are formed from fine alluvial material where non-saline groundwater comes seasonally close to the surface.

28. Nazaz (pseudogley) soils have an ABC horizon sequence. The A horizon is

sandy, yellowish-grey; the B horizon is very dense and fine textured, grey with brown, red and yellow mottling and black concretions; the C horizon is in most cases a red loam. These soils are non-calcareous and slightly acid. They are formed on the lower slopes and swampy periphery of the coastal sand hills and ridges.

29. Solonchaks are soils with considerable amounts of salts (mainly NaCl) in the upper layers; pH is usually below 8.5. They are formed from recent alluvial material where saline groundwater seasonally comes close to the surface.

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## B. THE SOIL ASSOCIATIONS

### I. Soil associations of subdued mountains and high plateaux.

#### 1. Terra rossa, brown rendzina and pale rendzina soils.

Suggested correlation: Red Mediterranean soils and lithosols - RM/Li.

a) Composition. Mainly shallow terra rossas with inclusions of brown rendzina and pale rendzina soils in addition to numerous outcrops of limestone. The soil depth differs greatly within short distance, so that deep soils occurring in solution pockets or in hollows may alternate abruptly with rock outcrops. Grumusols form inclusions on bottomland. Colluvial-alluvial soils occur in narrow valleys.

b) Parent material. Harld limestone and dolomite with inclusions of chalk, marls and calcareous shales.

c) Distribution. This association is typical for most of the hilly area of northern and central Israel.

d) Physiography. This association occurs in the mountainous and hilly country at elevations of 200 to 1000 m. Steep slopes comprise most of the area, but moderate slopes and small plateaux occur occasionally near summits and water divides. The northern parts of Israel exhibit a typical karstic character. Surface water runoff is less than 10% of total rainfall.

e) Climate. The climate is of the mediterranean type, with warm dry summers and humid winters. The annual precipitation ranges from 400 to 900 mm. Mean annual temperature is 18°C, coldest month (January) 10°C, hottest month (July-August) 24°C.

f) Land use. The native vegetation consists of dense scrub (maquis), which was cleared in past centuries for cultivation or for firewood. The natural soils seem to contain a moderate to high content of organic matter but this was destroyed as a result of cultivation and erosion. The moderately deep soils on gentle mountain slopes and narrow valleys are mainly used for fruit growing

including grapes, olives, plums, apricots and apples, often on terraced land, while the shalow and rocky soils are left for grazing and reforestation. Valleys are cultivated for different field crops, lately with supplemental irrigation.

2. Brown rendzina and pale rendzina soils.

Suggested correlation: Red Mediterranean soils and lithosols - RM/Li,

a) Composition. Mainly shallow brown rendzina soils with numerous outcrops of limestone or calcareous crust. Shallow to moderately deep pale rendzina soils are typical of slopes where the calcareous crust has been eroded. Grumusols and grumusolic dark brown soil form inclusions in bottomland and small plateaux, while colluvial-alluvial soils occur in narrow valleys.

b) Parent material. Soft chalk and marl covered partly by nari lime crust, and hard chalk.

c) Distribution. This association covers parts of the hilly country in northern and central Israel.

d) Physiography. The topographic pattern is characterized by steep slopes. Moderate slopes and plateaux are widespread on or near mountain summits. The hills are dissected by many valleys, some of them quite large. Elevation is up to 450 m.

e) Climate. The climate is of the mediterranean type, with warm dry summers and moderate humid winters. The annual precipitation ranges from 400 to 700 mm. Mean annual temperature is 20°C; mean temperature of coldest month (January) is 11°C, of hottest month (July) 26°C.

f) Land use. The native vegetation comprises maquis or open oak forest. As a result of clearing of the vegetation for cultivation only small remnant are preserved. The principal crops are fruit trees, olives and grapes. Shallow and rocky soils are used for grazing and afforestation.

3. Brown lithosols and loessial arid brown soils.

Possible correlation: Brown soils and lithosols - Rb/Li.

a) Composition. This association consists of brown lithosols, some rendzinic desert lithosols and a high proportion of loessial arid brown soils. The soils are mostly shallow and stony with many rock outcrops, but on flat hilltops, plateaux, footslopes and in large valleys they are generally deep. Colluvial-alluvial soils occupy narrow valleys.

b) Parent material. The underlying rocks may be chalk, marl, limestone or conglomerate, most of which are covered by a hard lime crust. Most of the soils are affected by loessial dust which is deposited mainly on flat or moderately sloping areas.

c) Distribution. This association is restricted to the hilly area north of the Beersheba basin.

d) Physiography. The soils occur in a hilly region; the mountain slopes are generally quite steep with fairly large valleys in between. Undulating plateaux are found in strongly dissected areas.

e) Climate. The climate is of the arid mediterranean type. The annual rainfall ranges between 250 and 350 mm., falling entirely in winter. Mean annual temperature is 20°C, mean temperature of coldest month 12°C (January), of hottest month 26°C (July).

f) Land use. The soils are poor in organic matter and nitrogen, while other nutrients are present in ample amounts. The area suffers from severe erosion. The native vegetation consists mainly of small shrubs; annual grasses are also widespread, especially in the valleys. The steep slopes and small valleys are used for grazing while annual field crops, mainly wheat and barley, are grown on the deep soil of moderate slopes and large valleys.

4. Brown lithosols and loessial sierozem soils.

Possible correlation; Sierozems (rocky phase) - Se(R).

a) Composition. Shallow brown lithosols with numerous rock outcrops and rendzinic desert lithosols are typical of the steep hillslopes. Inclusions of loessial sierozems are found in broad valleys and on small plateaux. Loessial alluvial soils and stony desert alluvium cover narrow valleys.

b) Parent material. Mainly chalk and limestone. Small plateaux are often covered by aeolian or redeposited loess.

c) Distribution. This association is typical of most of the hilly and mountainous desert steppe of the northern and central Negev of southern Israel.

d) Physiography. Most of the area consists of steep mountain slopes. Some plateaux and moderate slopes occur near the summits and water divides. Many small and moderately broad valleys dissect the land.

e) Climate. The climate is arid. The annual rainfall is erratic and ranges from 80 and 200 mm. falling in winter. The summers are hot, the winters moderately cool to cool. Mean annual temperature is 20°C, mean temperature of coldest month (January) is 9°C and of the hottest month (July) 25°C.

f) Land use. The soils are poor in organic matter and nitrogen and contain, especially when deep, rather large amounts of soluble salts. The native vegetation consists mainly of small shrubs. Some of the small valleys which are watered by runoff water are vegetated by various annual grasses. Most of the area supports only poor pastures, but in some valleys winter crops are grown by beduins. In several periods during ancient times most of the valleys have been cultivated with the help of careful water collection and water spreading installations.

5. Bare rock and desert lithosols.

Suggested correlation: Lithosols - Li.

a) Composition. Most of the area consists of bare rocky mountain slopes. Shallow reg (hammada) soils are typical of small plateaux and moderately sloping divides. Shallow calcareous desert lithosols are found as inclusions on soft calcareous sediments. Coarse desert alluvium occurs in narrow valleys.

b) Parent material. Hard limestone, dolomite, chalk and flint are the major rocks occurring. Small areas of various magmatic rocks.

c) Distribution. This association is typical of the hilly and mountainous area of the extremely arid southern desert of Israel.

d) Physiography. Most of the area exhibits uncovered steep slopes. Some small plateaux occur, mainly on top of mesas. The area is dissected by many dry valleys, some of them quite large.

e) Climate. The climate is extremely arid with only sporadic rainfall averaging less than 80 mm. per year. Mean annual temperature is 22°C; coldest month 10°C (January), hottest month (July) 28°C, Average daily range of temperature up to 20°C.

f) Land use. The sparse shrub vegetation is restricted to rivulets and the water courses. The area as a whole is of no agricultural use.

## II. Soil associations of low plateaux and plains.

### 6. Grumusols.

Suggested correlation: Grumusols - Gr.

a) Composition. In areas with smooth to gently sloping topography, the landscape is almost completely occupied by grumusols. Hydromorphic grumusols, fine textured swamp soils and occasionally peat soils may occur in depressions. In dissected areas on basaltic rock shallow protogrumusols occur on eroded slopes. Occasionally alluvial soils cover the river banks.

b) Parent material. Fine textured alluvial sediments, and basalt.

c) Distribution. This association is typical of the great valleys and valley terraces in central and northern Israel as well as of the basaltic plateaux in this region.

d) Physiography. The soils occur on level to gently sloping plains or undulating to rolling, moderately sloping low plateaux. The gradient of the slopes generally does not exceed 8%.

e) Climate. The climate is of the mediterranean type. Winters are moderately cool while summers are hot. The rainfall ranges from 450 to 700 mm.; all of it falling in winter. Mean annual temperature in 20°C, coldest month (January) 12°C, hottest month (July) 26°C.

f) Land use. All the land has been cultivated for many centuries, so that there are no remnants of the natural vegetation. The main crops include various annuals, like wheat, barley, corn, sorghum, vetch, etc. Irrigated plots are cropped for sugar beets, cotton, forage crops, corn and even for various fruits although horticulture succeeds better on other soils.

Some of these areas suffer from impeded drainage, while other have deteriorated to some extent due to unsuitable irrigation.

7. Dark brown soils.

Possible correlation: Brown soils - Rb.

a) Composition. The moderately sloping hills are mostly covered by grumusolic dark brown soils. In the western part some of these slopes are occupied by coarse textured dark brown soils. Steep slopes are characterized by shallow pararendzinas. In eroded and dissected areas fossil soils appear today as brown clays and as husmas soils. On transitions to the hilly area brown rendzina soils may cover steep eroded slopes. Alluvial soils and grumusols are typical of the floodplains.

b) Parent material. These soils are developed from fine aeolian sediments, coastal sand, calcareous sandstone(kurkar), and medium to fine textured alluvial deposits.

c) Distribution. This association is typical of the southern coastal plain as well as of some vallyes in the semiarid zone of the country.

d) Physiography. The soils occur on level to gently sloping plains or undulating to rolling, moderately sloping low plateaux. Some of the plateaux and hills are severely dissected by erosion, and here slopes may reach up to 30-40%.

e) Climate. The climate is of the semiarid mediterranean type. Rainfall ranges from 400 to 500 mm. Winters are moderately cool, while summers are hot. Mean annual temperature is 21°C, coldest month 13°C, hottest month 26°C.

f) Land use. Most of the land, especially the fine textured soils, have been cultivated for many centuries. Remnants of the natural vegetation are confined to the shallow pararendzinas and some eroded areas and consist mainly of small shrubs. The fine textured soils are fertile and are used for various field crops, mainly under irrigation. Horticulture, especially citrus and subtropical fruits are concentrated on the better drained, moderately fertile medium to coarse textured soils.

8. Loessial arid brown soils.

Possible correlation: Brown soils - Rb.

a) Composition. Moderate slopes are covered mostly by loessial arid brown soils. In eroded and dissected areas, fossil soils or fossil alluvial and aeolian sediments cover the steep slopes. In the foothills somewhat stony brown soils and brown lithosols may cover steep slopes. Young loessial soils are found in floodplains and depressions.

b) Parent material. Mainly loessial sediments.

c) Distribution. This association is typical of the north-western Negev.

d) Physiography. This association is found on level to undulating, gently sloping plateaux as well as on dissected plateaux with locally hilly topography.

e) Climate. The climate is arid. Winters are moderately cool, summers are hot. The rainfall ranges from 250 to 400 mm. All of it falls during the winter. Mean annual temperature is 21°C; coldest month (January) 12°C, hottest month (July) 26°C.

f) Land use. Nearly all the land has been cultivated for many centuries so that there are hardly any remnants of the natural vegetation. The main crops in the past consisted of wheat and barley. Today, various field crops and some horticultural crops under irrigation are grown. Wheat, barley and sorghum are also grown as dry farming crops, some of them receiving supplementary irrigation.

9. Loessial sierozem soils.

Suggested correlation: Sierozems - Se.

a) Composition. Loessial sierozems, somewhat saline, are typical of plateaux and moderate slopes. The steep slopes are characterized by coarse textured and stony sierozems and even by brown lithosols. Young loessial soils are found in depressions and floodplains.

b) Parent material. Loessial sediments, some sandy sediments and gravel.

c) Distribution. This association is typical for the Beersheba plain and adjacent areas.

d) Physiography. The association occupies level to undulating, gently sloping plateaux as well as dissected plateaux with locally hilly topography.

e) Climate. Winters are moderately cool; summers are hot. The rainfall, which is restricted to a few winter months, is erratic and ranges from 150 to 250 mm. Mean annual temperature is 20°C; coldest month (January) 12°C, hottest month (July) 26°C.

f) Land use. Most of the area has been cultivated for a long time for wheat and barley though yields were poor and approximately only one crop in three-four was successful. Today most of the area is left for grazing and only part of it is dry-farmed. Irrigation is possible only after leaching of the salts. In leached irrigated plots various field crops, as sugar beets, cotton, etc. are grown.

10. Reg (Hammada) soils and coarse desert alluvium.

Correlation: No equivalent in soils of Europe.

a) Composition. Reg (Hammada) soils are typical for the level plateaux. The slopes are characterized by various sediments, mainly stony debris, while stony and gravelly desert alluvium occupies the valleys and fans. Locally silty alluvial soils are found in depressions.

b) Parent material. Mixed stony mainly unconsolidated deposits.

c) Distribution. This association is typical for the valleys and plains in the extreme south of Israel.

d) Physiography. The association occupies level plateaux and plains as well as dissected low plateaux.

e) Climate. The climate is extremely arid. Winters are moderately cool while summers are very hot. The daily temperature range reaches 15°C. The erratic rainfall is restricted to the winter months and is less than 80 mm. Mean annual temperature is 23°C, coldest month (January) is 15°C, hottest month (July) 32°C.

f) Land use. Shrubby native vegetation is restricted entirely to the wadis and runlets with occasional runoff. The area has almost no agricultural value. The native vegetation can supply only very poor grazing for camels, goats and sheep.

11. Hamra soils.

Suggested correlation: Red mediterranean soils - RM, or Brown mediterranean soils - BM.

a) Composition. The undulating to sloping hills are covered by red hamra soils while on the lower slopes and in small depressions nazaz (pseudogley) soils are found. The broader valleys are occupied by brown hamra soils, various alluvial soils and grumusols. Pararendzina soils cover the steep hilly slopes.

b) Parent material. Coastal sand, calcareous sandstone; in the valleys also fine textured alluvial sediments.

c) Distribution. This association is typical for the central coastal plain of Israel.

d) Physiography. The association occupies an undulating to rolling topography, alternating with broad valleys. Typically the topographic pattern consists of calcareous sandstone ridges enclosing sandy plains or even peaty swamps.

e) Climate. The climate is typically mediterranean. Winters are mild while summers are warm to hot. Rainfall is restricted to the winter months and ranges from 500 to 650 mm. Mean annual temperature is 20°C, coldest month (January) 13°C and hottest month (July) reaches 26°C.

f) Land use. Small remnants of the natural vegetation include mainly oak trees (Quercus ithaburensis). The soils are moderately fertile, but their good drainage makes them suitable for many crops under irrigation. The major crops are citrus and other subtropical fruits, vegetables, peanuts, etc. On fine textured soils, cotton, corn and other irrigated field crops are grown. The nazaz (pseudogley) presents cultivation problems and is used mainly for forage crops or irrigated pasture.

12. Sandy regosols and arid brown soils.

Suggested correlation: Regosols - Re.

a) Composition. Shallow ( $<$ 1 m.) young sandy deposits cover almost the whole landscape. Underneath the sand psammic arid brown soils and other arid brown soils are found on the moderately sloping lands, while in depressions the sand is somewhat deeper (1-2 m.) and covers silty loess deposits.

b) Parent material. Mainly coastal sands and sandy deposits.

c) Distribution. This association is typical of the southernmost part of the coastal plain of Israel.

d) Physiography. The association occupies low, undulating to moderately sloping hills with broad depressions and valleys.

e) Climate. The winters are mild to cool; summers are warm to hot. Rainfall, which is restricted to the winter months, ranges from 150 to 250 mm. Mean annual temperature is 21°C, coldest month (January) is 12°C, hottest month (July) reaches 26°C.

f) Land use. The natural vegetation includes mainly sand loving plants like Artemisia monosperma, Panicum turgidum, Cynodon dactylon and many annuals. The soils are poor, but because of the good physical properties and drainage they are suitable for horticulture under irrigation. On irrigated plots the leading crops are citrus and other fruit trees, peanuts and vegetables, while the non-irrigated area is left for grazing.

13. Pale rendzina, grumusols and protogrumusols.

Suggested correlation: Regosols and grumusols - Re/Gr.

a) Composition. This is dominated by pale rendzinas and protogrumusols which cover the steep eroded slopes. Sometimes brown rendzinas also occur. The more gentle slopes are occupied by grumusols.

b) Parent material. Mainly basalts, chalk and shales.

c) Distribution. This association is restricted to the slopes of the dissected basaltic plateaux of eastern Galilee.

d) Physiography. Dissected basaltic plateaux. Many of the steep slopes owe their origin to faulting.

e) Climate. The climate is of the Mediterranean type, mean annual precipitation is 350 - 450 mm, falling entirely during the winter. Mean annual temperature is 20°C; coldest month (January) is 13°C, hottest month 29°C.

f) Land use. Most of the area is used for grazing. Occasionally dry farming with wheat, barley and sorghum is practiced on the deeper soils.

14. Sand dunes.

Suggested correlation: Regosols (dune phase) - Re(D).

a) Composition. Most of the area consists of shifting sand dunes and sand plains.

b) Parent material. Unconsolidated dune sand.

c) Distribution. This association covers non-continuous accumulations of coastal sands along the Mediterranean coast. Another area includes the inland dunes in the western Negev.

d) Physiography. The dune phase occupies the level to gently rolling, moderately dissected coastal area. The dunes may have gentle or sharp slopes and their elevation may reach 30 m. Dune belts on the coast vary in width from a few hundred metres to several kilometres. The shifting dunes in the Negev are long seif dunes alternating with strips of fixed sand.

e) Climate. The climate is Mediterranean. Winters are mild, while summers are warm to hot. Mean annual rainfall decreases from about 600 mm. on the northern coast to 150 mm. in the Negev. Mean annual temperature is 21°C. Winds mainly from S.W.

f) Land use. The dunes are generally barren and unsuited for agriculture. Some areas are afforested but the growth is generally poor.

15. Calcareous sierozem soils.

Suggested correlation: Sierozems - Se.

a) Composition. This association includes calcareous sierozem soils and hydromorphic grey calcareous soils on level topography, while rendzinic desert lithosols and pale rendzinas cover the steep terrace escarpment.

b) Parent material. The soils are derived from chalky and marly lake sediments and travertine.

c) Distribution. This association occupies the central Jordan Valley.

d) Physiography. The area includes two distinct river and lake terraces. The topography of the terraces is level, while the escarpments are steeply sloped.

e) Climate. The climate is arid. Temperatures are very high in summer and mild in winter. Rainfall is concentrated to the winter months and ranges from 250 to 400 mm. Mean annual temperature is 22°C, coldest month 14°C, hottest month 30°C.

f) Land use. The entire area is irrigated. Crops include tropical and subtropical fruits, such as bananas, dates, grapes, pomegranates, etc., cotton and winter vegetables. The soils are problematic because of the high carbonate content, but are intensively cultivated prompted by the abundance of irrigation water and the mild winter.

16. Hydromorphic and gley soils.

Suggested correlation: Grumusols (hydromorphic phase) - G(H).

a) Composition. This association includes mainly hydromorphic grumusols, fine textured swampy soils and peat. Locally on river levels even some medium to fine textured alluvial soils belong to it.

b) Parent material. The soils are derived from fine textured alluvial sediments.

c) Distribution. This association is restricted to the deeper parts of the large valleys in the north of Israel, including the drained Hule and Jezreel valleys.

d) Physiography: Flat level land. Water table often reaches the surface during the winter rains and flooding may last several months.

e) Climate: The climate is of the Mediterranean type. Winters are moderately cool; summers are hot. Rainfall ranges from 450 to 700 mm. and falls entirely during winter. Mean annual temperature is 20°C, coldest month (January) is 12°C, hottest month (July) 26°C.

f) Land use. Most of the area is already drained and grown to various field crops. Undrained areas may give poor stands of annual crops.

17. Solonchak soils.

Suggested correlation: Alluvial soils (saline phase) - A(S).

a) Composition. This association includes various solonchak soils. The texture ranges from sand to clay; all of the soils suffer from a high water table and some of them are extremely saline with up to 50% salts in the upper horizons.

b) Parent material. Recent alluvial deposits ranging in texture from sand to clays.

c) Distribution. Mainly in the Arava Valley of the southern desert of Israel. Solonchaks also occupy small areas in other climatic areas.

d) Physiography. The soils occupy the central part of lowlying terminal drainage valleys and closed basins.

e) Climate. In the Arava Valley extremely arid. The temperatures are very high in summer and mild to cool in winter. Rainfall mostly does not exceed 50 mm. Mean annual temperature is 25°C; coldest month 16°C, hottest month 33°C. Occasionally also in the region of Mediterranean climate.

f) Land use. The native vegetation includes many halophytes like Tamarix, Nitraria retuse, Sireda monoica, etc. Part of the area is bare because of excess salinity. Without drainage the area has almost no agricultural value. Some dates are grown on the periphery of the depressions where the groundwater is still relatively fresh.

## AREAS OF THE SOIL ASSOCIATIONS OF ISRAEL

| | | $km^2$ | % |
|---|---|---|---|
| I. | Soil associations of subdued mountains and high plateaux | 10,660 | 51.5 |
| 1. | Terra rossa, brown rendzina and pale rendzina | 1,950 | 9.4 |
| 2. | Brown rendzina and pale rendzina soils | 1,040 | 5.0 |
| 3. | Brown lithosols and loessial arid brown soils. | 390 | 1.9 |
| 4. | Brown lithosols and loessial serozems. | 2,710 | 13.1 |
| 5. | Rock outcrops and desert lithosols | 4,570 | 22.1 |
| II. | Soil associations of low plateaux and plains. | 9,600 | 46.4 |
| 6. | Grumusols | 1,880 | 9.1 |
| 7. | Dark brown soils | 730 | 4.0 |
| 8. | Loessial arid brown soils | 830 | 4.0 |
| 9. | Loessial serozems | 740 | 3.6 |
| 10. | Reg (hamada) soils and coarse desert alluvium | 2,290 | 11.1 |
| 11. | Hamra soils | 750 | 3.6 |
| 12. | Sandy regosols and arid brown soils | 470 | 2.3 |
| 13. | Pale rendzina, grumusols and protogrumusols | 400 | 1.9 |
| 14. | Sand dunes | 1,150 | 5.6 |
| 15. | Calcareous serozems | 140 | 0.7 |
| 16. | Hydromorphic and gley soils | 130 | 0.6 |
| 17. | Solochak soils | 90 | 0.4 |
| | Total land area | 20,260 | 97.9 |
| | Lake Tiberias and Dead Sea | 440 | 2.1 |
| | Total area of Israel | 20,700 $km^2$ | |

# ISRAEL
## SOIL ASSOCIATIONS
# ישראל
## ציבורי קרקעות


J. DAN & H. KOYUMDJISKY – VOLCANI INST. FOR AGRIC. RESEARCH
Z. RAZ – MINISTRY OF AGRIC. SOIL CONSERVATION DEPT.
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י. דן וח. קויומג'יסקי – מכון וולקני לחקר החקלאות
צ. רז – משרד החקלאות, האגף לשימור הקרקע
ד. יעלון – האוניברסיטה העברית בירושלים


30′ 35° 30′

33° 33°

30′ 30′

32° 32°

30′ 30′

31° 31°

30′ 30′

30°

חיפה
HAIFA

נצרת
NAZARETH

ים כנרת
Lake Kinneret

ים התיכון
Mediterranean Sea

תל אביב
TEL AVIV

ירושלים
JERUSALEM

עזה
GAZA

ים המלח
Dead Sea

באר שבע
BEERSHEBA

אילת
EILAT

| מקרא | LEGEND | |
|---|---|---|
| טרה רוסה רנדזינה חומה ורנדזינה בהירה | 1 | TERRA ROSSA, BROWN RENDZINA, AND PALE RENDZINA (XERORENDZINA) |
| קרקעות רנדזינה חומה ורנדזינה בהירה | 2 | BROWN RENDZINA AND PALE RENDZINA (XERORENDZINA) SOILS |
| ליטוסול חום וקרקעות חומות בהירות לסיות | 3 | BROWN LITHOSOL AND LOESSIAL ARID BROWN SOILS. |
| ליטוסול חום וסירוזיום לסי | 4 | BROWN LITHOSOL AND LOESSIAL SEROZEMS |
| שטחים סלעיים וליטוסולים מדבריים | 5 | ROCK OUTCROPS AND DESERT LITHOSOLS |
| גרומוסולים | 6 | GRUMUSOLS |
| קרקעות חומות כהות | 7 | DARK BROWN SOILS |
| קרקעות חומות בהירות לסיות | 8 | LOESSIAL ARID BROWN SOILS |
| סירוזיום לסי | 9 | LOESSIAL SEROZEMS |
| קרקעות רג ואלוביום מדברי גס | 10 | REG SOILS AND COARSE DESERT ALLUVIUM |
| קרקעות חמרה | 11 | HAMRA SOILS |
| חול איאולי וקרקעות חומות בהירות | 12 | SANDY REGOSOLS AND ARID BROWN SOILS |
| רנדזינה בהירה גרומוסול ופרוטוגרומוסול | 13 | PALE RENDZINA (XERORENDZINA) SOILS GRUMUSOLS AND PROTOGRUMUSOLS |
| חולות נודדים | 14 | SAND DUNES |
| קרקעות סירוזיום גירי | 15 | CALCAREOUS SEROZEMS |
| קרקעות הידרומורפיות וגלי | 16 | HYDROMORPHIC SOILS AND GLEY |
| קרקעות סולונצ'ק | 17 | SOLONCHAK SOILS |

BASED ON SOIL SURVEYS:
NORTH – 1:20,000 (1949/52), SOIL CONSERVATION DEPT.
SOUTH – 1:100,000 (1956/60) AGR. RESEARCH STATION

מבוסס על סקרי הקרקע הבאים:
צפון – 1:20,000 (1949/52), האגף לשימור הקרקע
דרום – 1:100,000 (1956/60), התחנה לחקר החקלאות

0 10 20 Km.

Drawn by CARTA, Jerusalem