

Chapter 2

Morphogenetic
Diagnostics, Classification
and Systematic Research
Object Soils

2.1 Morphogenetic Diagnostics of the Research Object Soils

The following soil types are selected and studied comparatively for the research object on the basis of the available materials (Soil Map of Azerbaijan, 1991; Morphogenetic profile of soils of Azerbaijan, 2004; Babayev and et. al., 2006; Babayev and et. al., 2010; Mammadov, 2002; Mammadov and et. al., 2002; Mammadova, 2006; Aliyev, 1964; Kovalov, 1966; Salayev, 1991) paying attention to agricultural direction, research and mapping materials, crop rotations availability etc. because of through study of the natural-climatic condition in Absheron, Shirvan, Guba-Khachmaz and Lankaran regions where the experimental areas of the subtropic zone selected for comparison: grey-brown for Absheron region, grey-meadow for Shirvan plain, alluvial meadow-forestry for Guba-Khachmaz and gleyey- yellow soils for Lankaran region.

2.1.1 Soils of Arid Subtropic Zone

Absheron Region, Irrigative Grey-Brown Soils

The first information about Absheron soil cover is given in V.P. Smirnov Loginov's works (Smirnov-Loginov, 1928). The author who investigates over routes systematized spreaded soils in the peninsula as the following: brown, grey-brown, grey and grey -brown solonchaks, salines, sands. The author came to such a conclusion that sands and sandy-grey soils spread on the relief hollow and low parts, while ascending up they are replaced with grey-brown soils, the brown soils are formed on the highest part of the peninsula paying attention to the mutual relation of these soils and comparing the zone where the presenting soils spread.

And this shows subordination spreading of the research zone soils to the vertical zonality.

A. S. Pryobradzensky (1934) notes that natural-historical elements of the Absheron peninsula aren't compared with the other elements of Caucasus and speciality of soil cover and the zone character of the soil cover diversity, is mainly connected with the influence geological factors of on soilforming process in the research zone.

N. A. Shulga, Z. R. Korobov (1938) conducted the soil researches in a large scale in the north-east of the peninsula, studied soils genesis, geography, physical- chemical characters, a character and direction of the changes formed in soils in connection with irrigation and melioration application and showed superiority of the semi-desert brown soils in the peninsula. Spreading of grey-brown and primitive grey soils is noted by K. A. Alakbarov, H. A. Aliyev, V. R. Volobuyev, A. K. Zeynalov, A. N. Izyumov, R. V. Kovalyov and M. E. Salayev in the first printed map in 1957 (1957).

The soil map in a scale of 1:100000 has been given by M. E. Salayev, R. A. Aliyeva and CH. M. Jafarova (1985) generalizing the information about Absheron soils. Solonetzificated, salinized, saline, gypsic, not developed wholly, primitive versions of grey-brown soils have been separated and described. An exact - detail and stasionar complex soil researches have been carried out, a map of the zone on a large scale (M 1:50000) has been composed, nomenclature of the grey-brown soils which is a main soil type has been improved, systematic has been given, morphological-genetic sings, physico-chemical characters of these soils have been determined by V. H. Hasanov and Ch. S. Galandarov (1928). The following versions of the grey-brown soils spreaded in Absheron have been separated in a legend of Azerbaijan State Soil Map composed on the

basis of (M 1:100000) Azerbaijan State Soil Map by H. A. Aliyev, M. E. Salayev, G. SH. Mammadov, M. P. Babayev and others: saline grey-brown, salinized grey-brown deeply, saline irrigative grey-brown, solonetzificated irrigative grey-brown, high gypsic grey-brown., bogged grey-brown (Legenda of Soil Map of Azerbaijan State, 2003).

Last years the soil cover of the Absheron peninsula has been studied with the different purposes (scientific-research, project, planting of greenery, melioration, recultivation and etc) and exposed to scaled, geographical, stasionar, generalizing researches (Babayev and et. al., 2000; 2003; Hasanov and et. al., 1987; Movsumov, 2006, Salayev and et. al., 1985). A complex relief and arid climatic condition of the Absheron region were a reason for intensive antropogen effect (agriculture, industry, life and etc) soil cover degradation (Babayev and et. al., 2003). In comparison with the unpracticed versions which are analogues of the main soil type of grey-brown soils under long intensive condition it was a reason for morpho-genetic and physico-chemical indicators, sharp change of plant productivity. The following changes are observed in the grey-brown soils: salinized-solonetzificated, bogging, wind and irrigative erosion, dehumification and weakening of the biological activity, shortage of the nutrient and others. Prevention of soil degradation in Absheron, studying of biological process in crop rotation dynamically with the purpose of restoration of fertility and fruit-bearing ability study and management of the biological process is the day's most important problem in crop rotation. This gives a chance to prognosticate irrigation properly and to protect agricultural production from unfit effects.

The soils being exposed to antropogen effect are distinguished from inexperienced versions having analogues for antiquity, cultivation degree of irrigation, thickness of sowing layer and other signs together with the reflecting of

the zonality signs in itself. In spite of intensive use of soils under different agricultural plants since long, the irrigative soils become subordinate to the objective laws on natural- climate zones. An area of the irrigative soils (Gypsic Calcisols) is 95643 h or 7,0% in the Absheron region belonging to arid subtropic, semidesert including in the research object (Mammadov and et. al., 2002).

Absheron subsidiary Experiment Economy zone of the Institute of Vegetable-Seed Science Industry Unity has been selected as a research experiment area (100 h). This zone is rich in soil-climate condition, economy direction, exact research (soil, water, plant analyses, productivity and etc) and mapping materials and it is characteristic for the Absheron region. In order to precise systematic of the irrigative grey-brown soils spreaded in the Absheron region the sections have been put. The natural soilsforming process, the changes occurring as a result of the antropogen effect, cultivation degree, formation of sowing and under sowing layer, hardening and etc influence on irrigative grey-brown soils. As a result of long use (40-50 years and more) a water regime changed in the grey -brown soils, in spite of semidesert soils typical for the same zone, hydromorphism which is characteristic for meadow soils created (Table 6, Figure 1).

The following morphogenetic profile is characteristic for irrigative grey-brown soils: $AU_{a\text{caz}}^I - AU_{\text{caz}}^{II} - BCA_s - C_{\text{csca}}$.

The thickness of the formed cultivated layer (AU_a) is 45-55 cm in the irrigative grey-brown soils, $AU_{a\text{caz}}^I$ is a tillage layer, thickness is 25-30 cm, granulometric structure is sandy-light loamy, structure is thin sandy, granular, colour is bright - brown-greyish, they are worked out by earthworms, plant remnants are met: AU_{caz}^{II} - under - tillage thickness is 20-25 cm, granulometric structure is sandy-loamy and structure hardened heapy, plant and root remnants

are met, transition illuvial layer is clear; B-illuvial layer thickness is 30-40 cm, is characteristic by being carbonatic, gypsic, sometimes salty, hardened, stony: C-layer is met in the different depth of 25-30 cm, 50-100 cm, >100 cm, is mainly formed by carbonatic, gleyey loess like loamy, sandy sea deposits.

Table 6. Diagnostic parameters of the irrigative grey-brown soils.

Parameters	Irrigative soils
Thickness, cm AU ^I _a	25-30
AU ^{II} _a	20-25
AU _a	45-55
Structure AU ^I _a	Sandy, granular
AU ^{II} _a	Sandy-loamy
Layers expression level, cm	
Carbonates	40-70
Salts	100-120
Gypsum	120-150
Granulometrik structure, %	45-55
(<0,01 mm)	20-22
Waretstable aggregates, >0,25 mm %	30-35
Volume weight, g/cm ³	1,2-1,3
Temperature, °C	
minimum	12-13
maximum	25-27
Humidity, %	
minimum	18-20
maximum	24-25
Productive humidity, mm/min, 0-25 cm	70-80
Humus, % AU _a layer	1,5-1,9
C:N	4-6
Absorption capacity, mg.ekv	20-25
Ca:Mg	2,0-4,0
Na, %	10-15
CaCO ₃ , %	5-10-15
pH water solution	8,2-8,4
Dry residue (0-50 cm), %	0,1-0,2

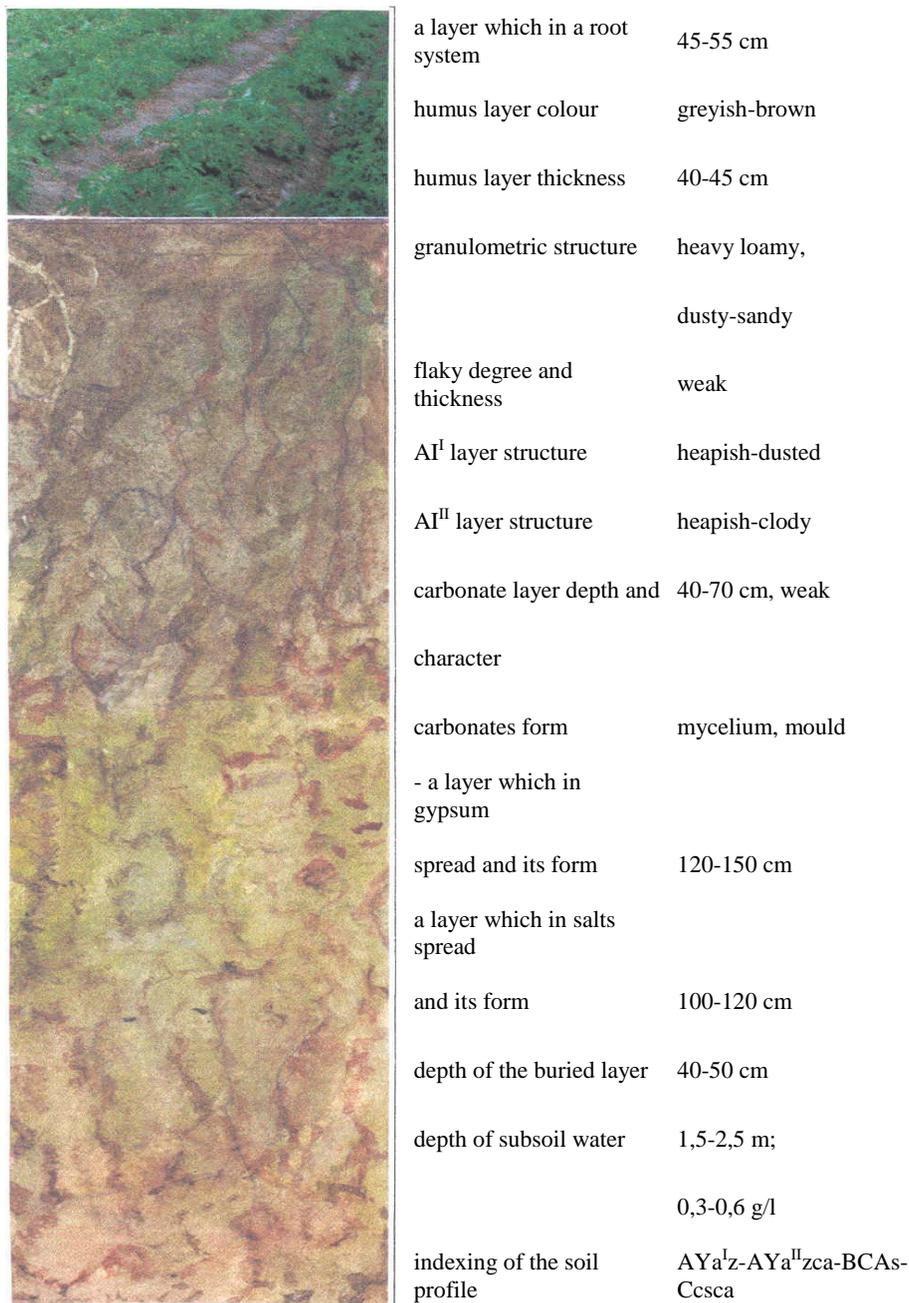


Figure 1. Morphological description of the irrigative grey-brown soils profile.

The cultivated horizon has got heavy-and light loamy granulometric structure in the irrigative grey-brown soils and dusted in them and silty particles are superior. Waterstable aggregates are $> 0,25$ mm-30-35%, a volume weight of the tillage layer is $1,2-1,3$ g/cm³, it is less than raw soils. Humus quantity is 1,5-1,9%, and rises from little cultivated soils towards high cultivated soils, C: N ratio is narrow 4-6, absorption capacity is high 20-25 mg ekv in 100 g of soil, Ca quantity is high in absorbed bases Ca : Mg 2-4, as a result of growing alkalinity of absorbed bases (water solution) rises – 8,5-9,2. Irrigative grey-brown soils are formed under a condition of irrigation a half automorph humidity regime.

Shirvan Plain, Irrigative Grey-Meadow Soils

The soil researches were conducted in Azerbaijan for the first time including Shirvan plain by S. A. Zakhorav (1926) in 1912-1926, dependence of the soils cover on relief, sanlinization degree and subsoil waters depth was determined and Azerbaijan Soils Map was composed.

According to the researches carried out by M. P. Babayev V. H. Hasanov, Ch. M. Jafarova (2004; 2006), H. A. Aliyev (2002), M.R. Abduev (2003), V. R. Volobuyev (1953), R. H. Mammadov (1989), M. E. Salayev (1991) and others the grey-meadow soil type formation process, forming and possessing special peculiarities in Kur-Araz lowland are noted L. P. Rozov (1956) showed brown soils spreading in the same zone and clayey in profile, and called them grey-brown soils. Besides brown soils the grey-brown soils, boggy soils from hydromorf soils, meadow-boggy, solonetrificated and other soils spread in the Shirvan plain. The soils which are moistened with subsoil waters and meadow-crusts are met in the zone, their formation depends on mineralogical structure, soil high dispersity, and more silt and colloid particles.

Salted soils of the Shirvan plain possess very different salt structure. Sulphat salts dominate in cone debris of the middle and low parts, hydrocarbonates and relatively Na in Bozdag slope extension on the upper part of the river debris cones with little salt. NaCl salinity developed in Padar mulda and around Kur, in the zone near Langabiz mountain range on the east part of the plain. A source of salinity is the third mountain rocks, ancient Caspian Sea deposits, debris of the Kur and Shirvan river. The salted soils conform to the plain low part and they are characteristic for the zones near subsoil waters and covered dispersions. More salinized and solonchak soils spread in the zone of Padarchol, Hajiqabul and Kur bank of the Alijanchay, Turanchay, Goychay, east end of the plain on the cone middle and periphery parts of the west rivers. Unsalted, weak salted soils are considered qualitative soils and spread in good drained zones. Such soils are met in light mechanical structural parts of the complex rocks, separate narrow part and height of the Kur river, on the upper part of the Shirvan river debris cones, at foothill zones. 60% of the spreaded soils are little or salinized too much degree; approximately 30% are the soils which need for basic melioration works in the Shirvan plain. The solonetzificated soils spread widely, they are defined by being weak, strong of solonetzificating according to gradation.

Solonetzification is striking on the tillage layer, sometimes on surface of the soils spreaded in the zone of the plain east part in the Padar soil-meliorative district.

Solonetzification spread in the meadow soils depending on clay diversity. A filtration ability of the Shirvan plain is very different and depends on deposits characters and soils forming condition.

The irrigative grey-meadow soils (Calcisols Combisols in WRB) in Azerbaijan spread mainly in the Kur-Araz lowland, with the raw soils in a complex form in Nakhichevan plain and partial in Samur-Davachi (Shabran) and form transition among irrigative grey and meadow soils on zonality side. An area is about 300000 h. The irrigative grey-meadow soils combine the soils which possess different irrigation history in themselves. The grey-meadow soils irrigating with the river, canal and subsoil waters of the Ujar supporting station which is a research object are characteristic for the Shirvan plain from the stand point of soil cover and irrigation system. An influence of subsoil water is weak, and reflects signs of the ancient agricultural culture itself in these soils.

At present the soils have got irrigation-ground hydromorph regime. The subsoil water level changes by 3-6 m. There is an effect of the subsoil waters soaking on profile low layers. A humid and heat regime makes a condition for biological process development. The irrigative grey-meadow soils are characterized with the following diagnostic signs (Table 7, Figure 2).

The contemporary cultivated layer in 40-50 cm thickness is grey-brown, a tillage layer (AI^Ia) with 25-30 cm of thickness in dusty-heaplike structure is greyish, possesses dusty-heaplike structure. Under tillage (AI^{II}a) is formed from hardened layer in 15-20 cm of thickness. Salinity and claying signs are met in irrigative grey-meadow soils profile.

Table 7. Diagnostic parameters of the irrigative grey-meadow soils.

Parameters	Irrigative soils
Depth of subsoil water, m	3-6
Thickness, cm AI_a^1	25-30
AI_a	15-20
Structure	Dustlike-heaplike
Expression depth, cm	
Gypsum	140-160
Carbonates	70-80
Gleyey	150-160
Salthness	130-170
Silthness degree, %	50-52
Waretstable aggregates, %	
>0,25 mm	45-55
Aggregating degree, %	35-50
Volume weight, g/cm ³	1,10-1,29
Soil temperature, °C	
minimum	13-14
maximum	28-30
Soil humidity, %	
minimum	16-18
maximum	22-24
Productive humidity, mm/min, 0-25 cm	80-90
Humus, % AUa	1,3-2,8
C:N	12-15
$C_{h.a.}:C_{f.a.}$	1,0-1,5
Absorption capacity, mg.ekv	25-30
Ca:Mg	8,8-9,0
Na, %	10-12
pH water solution	7,6-7,8
Easy solving salts, %	0,5-0,7
Productivity, s/h real	
cereal	20-25
cotton	10-15
potential cereal	35-45
cotton	15-20



layer which in a root	
system spreads	45-50 cm
humus layer colour	greyish
thickness of humus layer	45-50 cm
granulometric structure	heavy-loamy,
All layer structure	dustlike-heaplike
AllI layer structure	heaplike-clody
layer structure	
handened layer thickness	level, 27-30 cm
7080 sm	
Carbonates form	mycelium, mould
Gypsum spreading layer	140-160 cm
gleyey	150-160 cm
a layer of soils	130-170 cm
subsoil water depth	3-6 m
indexing of soil profil	AYalcaz-AYalIcaz- Bca,z,sm- BCca,cs-Csca

Figure 2. Morphological description of the irrigative grey-meadow soils profile.

The granulometric structure is comparatively heavy >0,01mm particles are 65-70%. The silt particles dominate and silty degree is more than 50%. Along the upper part of the canal and irrigative ditches the granulometric structure becomes lighter (>0,01 mm-38-42%), sand fractions dominate. The waterresistant aggregates (>0,25 mm) quantity is comparatively high (45-55%) and it is distributed equally over all the contemporary cultivated layers. The profile is characterized by not very high volume weight-1,10-1,29 g/cm³ and being high porosity of the tillage layer-52-58%. Humus quantity is 1,3-2,8% on the tillage layer, it rises from weak cultivated new irrigative soils till irrigative high cultivated soils, C:N ratio is high (12-15). Humic structure is humat-fulvatic, carbonatic quantity changes 10-15% along all the profile, absorption capacity is high (25-30 mg -ekv), Mg and Na dominate among absorbed cations, Ca:Mg ratio is less than raw soils (8,8-9,0). Gleyey and solonatzification is rising by increase of absorbed Na beginning from 30-40cm in weak cultivated versions. The profile structure is as following: AYa^Icaz-AYa^{II}caz-Bca,z,sm- BCca,cs-Csca.

2.1.2 Soils of the Semiarid Subtropic Zone

Guba-Khachmaz Region, Irrigative Alluvial Meadow-Forest Soils

Some works are dedicated to the study of soil process, soil resources in the Guba-Khachmaz zone (H.Aliyev, 1978; Izyumov, 1949). Five administrative regions include in Guba-Khachmaz economic region: Shabran, Khachmaz, Guba , Gusar, Siyazan. The East part of the Great Caucasus the part in Azerbaijan is being studied.

With the exception of a great soil scientist Dokuchayev's travel to the Caucasus for a short time, the first systematic research of the soils belongs to

S. A. Zakharov (1927) and I.Z.Imishensky (1928) while organizing expeditions with the purpose of studying Azerbaijan regionalization. I.Z.Imishensky (1928) studied from the Alazan river of the south slope of the Great Caucasus till the shore of the Caspian Sea and former Shamakhy and Guba Zones (administrative regions) and these researches were the first material for learning of the zone soils in future.

According to the carried out researches I. Z. Imishensky (1928) showed that salty-saline grey carbonatic, alluvial, silty-boggy and sub-boggy soils are met around Caspean lowland but carbonatic tugay soils are met on the south part. A. N. Izyumov (1949) separated grey-carbonatic tugay, special tugay and forest-tugay soils in this zone. According to K. A. Alakbarov's (1961) researches the grey-tugay and tugay-soils residues spread on the low part along the Samur-Davachy canal. The researches of the forests on the low part of this zone have been conducted by H. A. Aliyev (1978). The author separated mountainbrown, meadow-forest and alluvial meadow-forest soils in the zone. A problem of steppization of the mountain-brown soils is reflected in H. A. Aliyev (1978), M. E. Salayev (1991) and other's works. A diversity of the relief and climate, a special development history of the zone were a reason for creation of the different soil cover in natural-economical zone of Guba-Khachmaz.

Spreading of the soils becomes subordinate to the vertical zonality and the following soils are investigated in this zone: mountain-brown soils, grey-brown, meadow-brown, alluvial-meadow and etc.

The irrigative alluvial meadow-forest soils (Irragric Mollic Fluvisols) form 92439 h or 6,8 % in the Guba-Khachmaz region. The alluvial meadow-forest soils spread in tugay forests and in the zone with meadow pastures since ancient times. The forests were cut in one part of the zone and they are used to grow

grain, fodder crops and vegetable-orchard plants from agricultural plants. The irrigative alluvial meadow-forest soils strongly distinguished from raw soils according to the humidity degree of soils. Systematic of irrigative alluvial meadow-forest soils is specified for the cuts. The insufficiency of humidity is ensured with irrigation and atmospheric rainfalls. Soilforming rocks consist of clayey-loamy, carbonatic alluvial deposits, a level of subsoil waters is in 2,5-3,0 m of depth.

A granulometric structure of the irrigative alluvial meadow-forest soils is heavyloamy. Silty degree is 36-41%, they mainly gather on middle layer (in B layer) of the soils profile (Table 8, Figure 3). A layer water resistant aggregates are $>0,25$ mm-20-60%, volume weight is 1,12-1,15 g/cm³, rises till 1,42 g/cm³ along profile, porosity is 40-50%, on upper layers-water permeability is 0,4-1,0 mm/min and field humidity forms 32-40%. A humus quantity in the irrigative alluvial meadow forest soils forms 3,0-3,5%, reserve is 170-190 t/h on the upper layers, C:N ratio is 8-10, C_{h.a.}:C_{f.a.} is 1,2-1,4 and carbonization is observed (12-13% on A-layer, 13-17% on B layer) along profile, an absorption capacity is 25-28 mg/ekv in 100 g of soil, Ca:Mg-2,5-3,0 weak alkalinity is noticed in all the profile (pH-8,0-8,4), there is no salinity in the soils. The irrigative alluvial meadow-forest soils are divided into subtypes: new irrigative and irrigative.

The new irrigative alluvial meadow-forest soils are in the first stage of development and keep the peculiarities characteristic for zonal soil type. The cultivated layer thickness (AUa) is 45-50 cm, genetic layers aren't fully formed, new tillage (Ala^I-25-57cm) and under tillage layer (Ala^{II}-20-23 cm) are formed as a result of constant irrigation the soil structure is hardened and its colour is greyish, greyish-brown. The plant residues, earthworm roads are met

and the following morphological profile is characteristic for them:
AUa^I-AUa^{II}-B-BCg-Cg.

Table 8. Diagnostic parameters of the irrigative alluvial meadow-forest soils.

Parameter	New irrigative soils	Irrigative soils
Thickness, cm AUa ^I	25-27	28-30
AUa ^{II}	20-23	22-25
AUa	45-50	50-55-70
Strukture AUa ^I	Heaplike-dustlike	Heaplike-dustlike
AUa ^{II}	Clody-heaplike	Heaplike
Gleyey, cm	70-80	50-55
Granulometrik structure, % (<0,01 mm)	55-60	56-58
Silty degree, by %	38-40	36-41
Ware resistant aggregates, % >0,25 mm	30-35	25-40-60
Volume weight, g/cm ³	1,12-1,14	1,12-1,15-1,42
Soil temperature, °C		
minimum	2,0-2,8	2,3-3,0
maximum	27-28	26-27
Soil humidity, %		
minimum	13,0-14,1	15,3-16,1
maximum	26,5-26,9	27,0-27,6
Productive humidity, mm/min 0-25 cm	40-60	60-80
Ca:Mg	2,2-2,8	2,5-3,0
Absorption capacity, mg. ekv	18-20	25-28
Humus, % AUa ^I layer	2,0-2,5	3,0-3,5
C:N	8-10	8-10
C _{h.a.} :C _{f.a.}	0,9-1,0	1,2-1,4
SiO ₃ :R ₂ O ₃ in soil		3,5-4,1
in silt fraction	-	2,5-3,8
pH- in water solution	8,0-8,4	8,0-8,3



Humus layer thickness	55 cm
Granulometrik structure	heavy-loamy
layering degree and thickness	weak, average 50 cm
Al ^I layer structure	granular-dusty
Al ^{II} layer structure	clody
handened layer thickness	20-25 cm
Depth and character of carbonatic layer	50 cm weak
carbonates form	in a mould form
gleyey, depth	55-70 cm
Depth of subsoil water	2,5-3,0 m
indexing of soil profile	AUa ^I vz-AUa ^{II} vz-A/ Bzg-Bg-Cg

Figure 3. Morphological description of the irrigative alluvial meadow-forest soils profile.

Enough thick cultivated layer AUa^I (50-70 cm) is created in irrigative alluvial meadow-forest soils because they are irrigated with the turbid river waters, a colour of this layer is dark greyish and structure is granular-dusted, agroirrigation debris is met in the profile, it is characterized by many porosities, earthworm roads, plant residues, under tillage layer is distinguished by

hardiness and cloudiness of structure. A structure of the irrigative alluvial meadow-forest soils morphogenetic profile: AUa^Ivz-AUa^{II}vz-Bzg-Bg-Sg.

2.1.3 Soils of the Moderately Humid Subtropic Zone

Lankaran Region, Irrigative Gleyey-Yellow Soils

R.V. Kovalyev (1966) showed four main bioclimate type-humid subtropic forests, xerophyl subtropic forests and steppes, humid subboreal forests and subboreal steppes paying attention to being a main term of the climate in soilforming process, he separated the soil types which are distinguished for hydrothermic state, direction of the weathering process and other signs in these bioclimate types-yellow, brown, bright-brown soils and steppe soils. The yellow soils spreader in Lankaran develop in different biogeomorphological condition-in mountain, foothill plain and plain areas differing for water regime, intersoil motion of the substances, plant cover and other signs. The three soils groups can be distinguished in these soils: mountain-forest yellow, podzolic yellow and gleyey-yellow soils. The gleyey-yellow soils develop on hallow places of the sea-shore plain on prolluvial-alluvial deposits of the Lankaran region and in cone appendixes of the ravine. A character peculiarity of Lankaran soils is gleyzation. A main character of gleyzation is reduction of ferrium three oxides (Fe_2O_3) and turning into ferrium two oxides (FeO). The characteristic feature of the soilforming process is to be soil moisture regime of subsoil and surface waters.

An area of the irrigative gleyey-yellow soils (Gleyic Livosols in WRB) is 56810 h or 4,2% in the Lankaran region. The gleyey-yellow soils in Lankaran exposed to ploughing, intensive cultivation, application of mineral and organic fertilizers in a high norm, therefore 45-55 cm and very thick cultural soil

horizon is formed. The water-physical characters of the irrigative gleyey-yellow soils are mainly satisfactory, water permeability is high, are ensured with the nutrient well. Productive humidity is enough in the soils for a year, a reason is nearness of subsoil waters the surface and this regime is kept as a result of irrigation effect.

These soils possess acid and weak acid environment, it is mainly good for river and other subtropic plants. The physical-chemical characters under paddy have been improved, used under vegetable and interrow growing plants. The following morphogenetic profile is characteristic for the irrigative gleyey-yellow soils: AUa^Ivz-AUa^{II}gz-BTg BTcg-CL-[A].

AUa^I-tillage-humus layer density is 27 30 cm, colour is dark greyish-chaff, yellowish-brown and structure is heaplike-nutlike, plant residues are met and granulometric structure is loamy (Table 9, Figure 4).

Table 9. Diagnostic parameters of the irrigative gleyey-yellow soils.

Parameters	Irrigative soils
Thickness, sm AUa ^I	27-30
AU ^{II}	20-25
AUa	45-55
AUa	40-50
Color of the layers, AUa ^I	greyish-chaffy, yellow-grey
Strukture of the layers, AU ^I	Heaplike-dustlike
Expression depth, cm	
Gleyey	40-65
Humus horizon, % AUa ^I	2,5-5,0
C:N	7-11
C _{h.m.} :C _{f.m.}	0,8-1,2
Absorption capacity, mg. ekv	25-30
Ca : Mg	2-5
pH – in water solution	5,5-6,5
pH – in salt solution	5,0-5,5

AUa^{II}-undertillage layer density is 20-35cm, it harden, structure isn't clear and heap-like nutlike, granulometric structure is mainly clayey, there are little and large plant roots. B-transitional horizon thickness is 40-60 cm, colour is filthy-yellow and bluish-rusty, hardened granulometric structure is light and heavy loamy, spots by manganie and ferrum origin are met. C-horizon-maternal rock consists of different mechanical structural gleyey layers complex. The sandy, gravel-clayey horizons, buried ancient soils are characteristic for morphological profile of majority of the irrigative gleyey-yellow soils. The humus quantity is 2,5-5,0% on upper layer, 1,0-2,0% on low layers, C:N ratio is 7-11 on upper layers, 5-7 on low layers, in the irrigative gleyey-yellow soils, and it shows good provision of the soil with nitrogen $C_{h.a.} : C_{f.a.}$ ratio is 0,8-1,2, silty degree is 40-58%, waterresistant aggregates are >0,25 mm-45-70%, absorption capacity is 25-30 mg/ekv, Ca:Mg-2-5 and a total quantity of ferrum is-7-12%. The soils environment is acid (water solution is 5,5-6,5, salt solution is 5,0-5,5). These soils are mainly without carbonate, on low layers carbonates are met in a form of shell consisting of sea deposits.

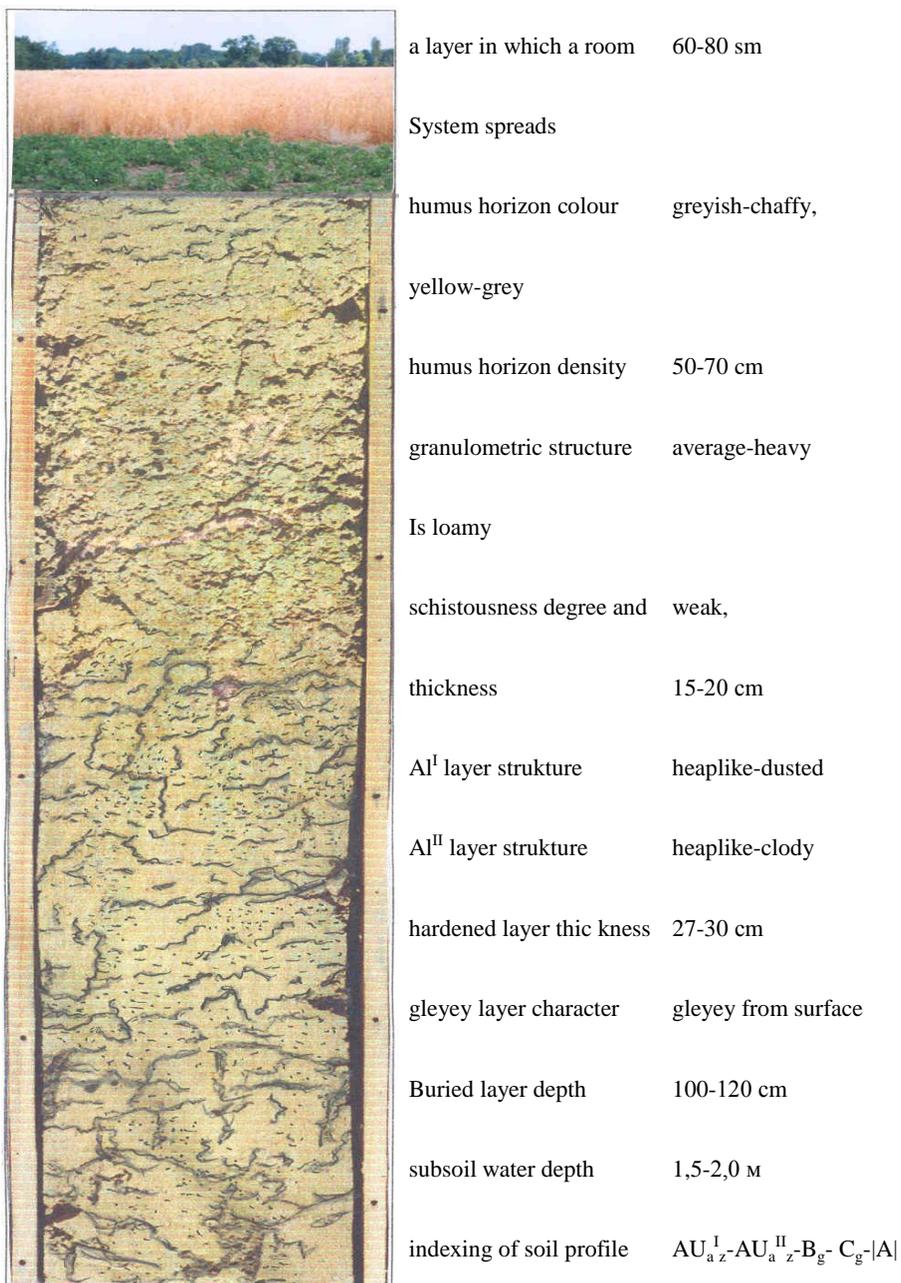


Figure 4. Morphological description of the irrigative gleyey-yellow soils profile.

2.2 Classification of the Research Object Soils

Soil classification is necessary for scientific and applied investigations related to the assessment of land resources, the compilation of soil maps, and the adequate regulation of soil fertility. The first soil classification system for Azerbaijan was proposed by S. A. Zakharov (1927) and was then considerably improved by A. N. Dimo, V. P. Smirnov-Loginov, V. R. Volobuyev, I. A. Aliyev, M. E. Salayev, and other scientists.

The systematized list of soils of Azerbaijan was an important contribution to the classification. It was compiled at the final stage of the land inventory of the republic and the compilation of the soil map of Azerbaijan on a scale of 1: 200 000 (1995).

The list of soils was discussed at the Dokuchaev Soil Science Institute of the USSR Academy of Sciences in 1966 and tested during the Transcaucasia Symposium on the Problems of Nomenclature and Classification of Transcaucasia Soils. The final version of the systematized list of soils of Azerbaijan was published in 1969 in *Izvestiya AN AzSSR* (1969).

After that, more detailed soil system and soil nomenclatures were elaborated on the basis of a comprehensive analysis of the results of large-scale soil surveys in Azerbaijan. The new list included 1600 soil names. The names of soils of dry subtropical steppes and hydromorphic and irrigated soils of Azerbaijan were improved and added to (Salayev and et. al., 1979).

Special studies of the energy of pedogenesis and the ecology, composition of organic matter, agrophysical characteristics, and mineralogical composition of Azerbaijan soils were conducted. In a generalized form, the results of these studies were taken into account during the preparation of the new soil

classification system of the Soviet Union (Classification and Diagnostics of Soils of the USSR. Moscow, 1977).

An improved variant of the classification of Azerbaijani soils was also developed (Salayev, 1999). This classification system was based on the properties and regimes of soils with due account for the soil-forming factors. It differed from the previous classification by a new ecologic-genetic concept and a more detailed system of soil taxa (Aliyev and et. al., 1969).

The classification system has been successfully used for soil investigations and mapping in Azerbaijan up to now.

At present, the development of international cooperation in different sciences, including soil science, poses the problem of the creation of a new soil classification system that should be based not only on the regional and national classification concepts but also linked with the internationally accepted soil classification systems.

We have made an attempt to elaborate a classification of this kind.

The proposed Azerbaijani soil classification system is based on the concepts of the types of soil formation adopted in the Russian school of soil classification.

The World Reference Base for Soil Resources (WRB) (World Reference Base for Soil Resources, 1998). and the Russian Soil Classification System (Shishov and et al., 2004) are the main documents used at present for soil mapping purpose, creation of the soil information base, and soil assessment. The World Reference Base for Soil Resources (World Reference Base for Soil Resources, 1998) was developed on the basis of the legend to the

FAO-UNESCO Soil Map of the World (FAO-UNESCO-ISRIC, Soil Map of the World: Revised Legend, 1994) and it is not a proper soil classification. It is aimed at the correlation of national soil classification systems.

The new classification of Russian soils (Shishov and et al., 2004) based on the soil classification system elaborated V.M. Frindland (1982). In essence, it is a substantive-genetic soil classification system, i.e., it is based on the morphology and properties of soil profiles as reflecting the character of soil-forming processes. The highest levels of the classification (soil orders and soil types) are distinguished with respect to a characteristic set of interdependent genetic horizons and diagnostic soil properties formed by the particular processes (State Soil Map of Azerbaijan, 1997).

Classification units are specified with respect to diagnostic soil horizons determined on the basis of their qualitative morphological and chemical characteristics. Quantitative characteristics are also used when necessary.

National and World soil classification systems are being continuously improved and refined, as well as the soil nomenclature; many countries use the soil names suggested in the most popular soil classification systems along with national, regional, and local soil names.

2.2.1 The Class-Naturally Evolved Soils

Azerbaijan is characterized by a great diversity of natural and anthropogenically transformed landscapes. The vertical natural soil zonation is complicated by the agrogenic factor of soil formation. It includes forest cutting, grazing pressure, intensive land use with water and chemical amelioration, and technogenic disturbances of the soil cover.

These conditions require a new approach to soil classification (Babayev and et. al., 2006; Orudzheva and et. al., 2013). It is based on the concept of soil appreciation as a natural object that is constantly transformed under the impact of natural factors of pedogenesis and anthropogenic activity.

Following the modern classification of Russian soils (Shishov and et al., 2004), the new classification of Azerbaijan soils is based on the genetic principle with due account for soil evolution. It is developed as an open hierarchical system based on the profile-genetic concept, which makes it possible to consider both natural and anthropogenically transformed soils within the unified system of soil classification.

The new classification naturally absorbs and develops the positive features of previous soil classification systems; traditional national soil names are preserved in it.

Prior to elaboration of the new Azerbaijan soil classification system, a complete systematized list of soils was compiled on the basis of the explication to the soil map of Azerbaijan on a scale 1: 100 000 (State Soil Map of Azerbaijan, 1997), which characterizes in detail the spatial distribution of different genetic soil groups (H. Aliyev and et. al., 2003).

The new soil classification system includes a number of additional divisions in comparison with the previous classification (Salayev, 1999). In particular, the classes of anthropogenically transformed soils and technogenically disturbed soils (polluted with oil and disturbed upon mining) are included into it.

The correlation of the soil units distinguished in the new national soil classification with the soil units of international soil classification systems is

important for the more efficient use of the new classification in the republic and abroad.

The taxonomic soil units are determined in terms of the characteristic morphogenetic features of the soil profile. The highest levels of the classification are soil classes and soil orders.

Soil classis is the taxonomic unit of the highest level. It is specified by the ratio between the natural and anthropogenic soil-forming processes in the soil development.

Three soil classes are distinguished: (A) naturally evolved, (B) anthropogenically transformed, and (C) technogenically disturbed soils (table).

Soil orders include soils with similar soil-forming processes and morphology of their profile, i.e., the sequence of genetic horizon related to the environmental and anthropogenic factors of soil formation.

The class of naturally evolved soils includes all the natural soil types with similar leading soil-forming processes. The orders distinguished in this class correspond to the notions of the types of soil formation, soil associations (as suggested by Volobuev and Kovda) (Kovda, 1973; Volobuyev, 1980), soil families (as suggested by Glazovskaya, 1966), or large soil groups (as suggested by Sokolov, 1989). For creation of classification of soils we also had been used biological parameters (Babayev and et. al., 2009; Orudzheva et al., 2013; Orudzheva, 2011; 2012).

The following soil orders are distinguished in the class of naturally evolved soils.

The order of soddy organic-accumulative soils includes well-drained soils with pronounced accumulation of organic matter and the formation of soddy horizons in which living or dead plant roots are abundant. The order of soddy organic-accumulative soils includes the types of mountainous meadow soils subdivided into primitive, soddy-peat, and soddy subtypes.

The order of texture-differentiated soils encompasses soils with a pronounced redistribution of mineral particles in the soil profile. Soils of this order are formed in the semihumid subtropical zone of Azerbaijan.

The order of humus-accumulative soils is relatively large; it includes the soils with active decomposition of organic matter and the formation of deep humus horizons.

The order of low-humus carbonate-accumulative soils includes the soils with a low humus content, an enrichment of the soil profile with carbonates, and accumulation of soluble salts and gypsum. *The order of metamorphic soils* includes the soils with a relatively weak differentiation of the soil profile and the formation of metamorphic horizon in the middle part of the soil profile.

The order of alluvial soils is distinguished on the floodplains in the arid and semihumid subtropical zones of Azerbaijan.

The order of halomorphic soils includes solonchaks that form complexes and combinations with dry-steppe and desert-steppe zonal soils of Azerbaijan.

2.2.2 The Class of Anthropogenically Transformed Soils

The class B of anthropogenically transformed soils. The genetic specificity of irrigated semidesert and desert soils of Central Asia was shown by pedologists of the Dokuchaev school (Dimo, Orlov, and Rozanov). Their ideas on the genesis

of irrigated soils were further developed by N. G. Minashina (1974), M. P. Aranbaev (1995) and others.

Soils of the dry-steppe subtropical zone in the Transcaucasian region have been irrigated for thousands of years. In Azerbaijan, they were first distinguished as a separate taxonomic unit by M. P. Babayev (1984). The area of anthropogenically transformed soils in Azerbaijan is about 2.6 million ha. Irrigation-induced changes in the air and water regimes and biological activity and the formation of a layer of agroirrigation horizons are the features that specify the separation of irrigated soils on agroirrigation deposits into the class of anthropogenically transformed soils.

Irrigation results in changes in the water, temperature, and air regimes of irrigated soils as compared with their rainfed analogues. We recognize the following stages of development of irrigated soils: (a) soils with unstable soil-forming processes in recently irrigated plots (their morphology and properties generally correspond to those of natural zonal soils), (b) soils with a stabilized regime of pedogenesis after a long-term irrigation period (their morphology and properties are strongly changed and differ considerably from natural soils and newly irrigated soils), (c) soils in the areas of ancient agriculture (long-term irrigation with turbid river and flood water has resulted in the formation of new genetic horizons on agroirrigation deposits of 1.5-2.0 m in thickness; these are very homogeneous and highly fertile soils).

Thus, anthropogenically transformed (irrigated) soils are subdivided into the groups of newly irrigated and old-irrigated soils, and a specific group of soils on agroirrigation deposits is formed upon long-term irrigation with turbid water.

Irrigated soils are classified with respect to the duration of the irrigation, the degree of soil cultivation, and the zonal soil features. It should be noted that

intensive soil management on irrigated fields attenuates the initial zonal soil differences. However, natural factors exert a certain effect on the human-controlled soil formation.

The morphogenetic classification of anthropogenically transformed soils of Azerbaijan is elaborated on the basis of data on the soil properties at different stages of the development of irrigated soils.

The class anthropogenically transformed soils is subdivided into several orders with respect to the main tendencies of the pedogenesis.

The order of texture-differentiated soils includes irrigated zheltzemic gley soils of the humid and semihumid subtropical zone of Azerbaijan; these soils are used for growing tea, vegetable, cucurbits, and cereals.

The order of alluvial soils includes irrigated alluvial meadow-forest and meadow soils.

Irrigated alluvial meadow-forest soils are widespread in tugai lowland forests that have been partly cut to free the area for crop growing. These soils are used for growing cereals, fodder crops, vegetables, and cucurbits. They are characterized by a deep dark gray cultural horizon.

The order of humus-accumulative soils includes several types of soils that have been irrigated since ancient times with artesian and water. These are irrigated meadow-cinnamonic, cinnamonic, chestnut, sierozems, and meadow-sierozems soils. The subtypes of well-cultivated (cultural) soils and irrigated soils are distinguished.

The order of carbonate-accumulative soils includes gray-brown and sierozemic soils irrigated for a long period with clear river and artesian kahriz

waters. The thickness of the upper cultural (agric) horizon (Aa) in these soils reaches 40-50 cm.

The order of irrigation-accumulative soils includes soils irrigated since ancient times turbid river water. These soils are developed from thick agroirrigation deposits enriched in nutrients and soluble salts. The layer of agroirrigation deposits has an indistinct stratification, because the original stratification of the irrigation deposits was disturbed in the course of the soil cultivation; it may contain gley features. Under this layer, the profiles of buried natural or cultivated soils are found. The surface soils have completely lost the features of zonal soils and have a specific profile. Soils with a thickness of the agroirrigation deposits of 40-80 cm characterize the first stage of the human-controlled pedogenesis. Long-term irrigation results in the formation of deep uniformly colored fertile soil (Babayev, 1984).

The types of dry-steppe irrigation-accumulative, semidesert irrigation-accumulative, gleyed irrigation-accumulative and vertic irrigation-accumulative soils are distinguished in this order.

The class of technogenically transformed soils occupies considerable areas in Azerbaijan, especially on the Apsheron Peninsula. The class is subdivided into the orders of oil-polluted soils and soils disturbed upon mining of mineral resources.

The order of oil-polluted soils includes soils with well-pronounced features of morphological transformation of the soil profile under the impact of aggressive chemical substances (oil, gas condensate, and deep rocks). Soils of oil fields are also polluted by industrial and municipal wastes and are disturbed by trenches and pits.

The order of soils disturbed upon mining includes artificially created man-made soils, truncated soils, and landfills. At present, these specific bodies are insufficiently studied.

Soil taxa of the highest levels-soil classes and orders-are specified in the new classification system of Azerbaijan soils for the first time. The following taxonomic units are distinguished in this system: soil classes, orders, types, and subtypes. Three soil classes-naturally evolved, anthropogenically transformed, and technogenically disturbed soils-are recognized.

The class of naturally evolved soils includes all the natural soils specified with respect to the leading soil-forming processes or the types of pedogenesis; the orders of soddy organic-accumulative, texture-differentiated, humus-accumulative, low-humus carbonate-accumulative, alluvial, and holomorphic soils are distinguished in this class.

The class of anthropogenically transformed soils includes the soils with considerably changed natural pedogenesis under the impact of irrigation. These soils have specific water, air, and biological regimes. In the course of long-term irrigation with turbid water, a thick layer of agroirrigation deposits is formed; the surface soil is developed from this specific and fertile substrate. The orders of texture-differentiated, alluvial, humus-accumulative, carbonate-accumulative, and irrigation-accumulative soils are distinguished in this class.

In this paper, the first attempt to correlate the major soil units in the national soil classification system of Azerbaijan with the soil units in the internationally recognized WRB system is made.

Table 10. Classification System-Anthropogenically transformed soils.

No.	Type	Subtype
1	2	3
		Class B: Anthropogenically transformed soils <i>Order of texture-differentiated soils</i>
1	Irrigated zheltozemic gley	1. New irrigative
2	Irrigated alluvial meadow forest	2. Irrigative <i>Order of humus-accumulative soils</i>
3	Irrigated meadow brown	Cultivated brown Cultivated chernozems
4	Irrigated grey-brown (chestnut)	1.New irrigative grey-brown (chestnut) 2. Irrigative grey-brown (chestnut) 3. Irrigative compact grey-brown (chestnut) 4.Cultiveted grey-brown (chestnut)
5	Irrigated meadow sierozems	1.Irrigative meadow grey 2.Irrigative compact meadow grey
6	Irrigated meadow	1. Irrigative taminated meadow 2. Irrigative gleyey meadow 3. Irrigative morly meadow <i>Order of carbonate-accumulative soils</i>
7	Irrigated sierozems	1.New irrigative gray 2. Irrigative gray 3. Irrigative compact gray
8	Irrigated gray brown	1. New irrigative gray brown 2. Irrigative gray brown <i>Order of irrigation-accumulative soils</i>
9	Irrigation accumulative dry-steppe	Irrigative accumulative gleyey meadow
10	Irrigation accumulative semidesert	
11	Irrigation accumulative meadow	Compact irrigative accumulative meadow Class C: <i>Technogenically disturbed soils</i> <i>Order of technogenically disturbed soils</i>
12	Oil polluted	1.Mazut 2.Bitumen 3.Polluted by oily-mazut waters <i>Order of soils disturbed upon mining</i>
	Soil-ground	1.Cutting soil-ground 2.Filling soil-ground

Table 10. Continued.

No.	Profile	WRB analogues
1	4	5
		Iragric Gleyic Acrisols
1	AUIv-AYcIIg-A/BTg-BTfe-CL	
	AUa ^I -AUa ^{II} -Bgh-Cg	Iragric Fluvisols
2	AUaIvi-AUa ^{II} zi-Bgh-Cg	Iragric Mollic Gleyic Fluvisols
	AUa ^I -AYa ^{II} zca-A/Bzvg-Bg-Cg	Iragric Gleyic Kastonozems
3	AUa ^I z-AYa ^{II} zca-BMcavc	Antric Kastonozems
	AUa ^I z-AYa ^{II} vz-BTcavc-Ccas	Antric Chernozems
	AUa ^I -AYa ^{II} -BCA-Ccs	Iragric Coleocic Kastonozems
4	AUa ^I z-AYa ^{II} z-BCA-Ccsca	Iragric Kcastonozems
	AUa ^I v-AYave-BCAvc-Ccaacs	Iragric Vertic Kastonozems
	AUa ^I v-AYa ^{II} z-BCAz-Cca	Antric Kastonozems
	AUa ^I caz-AYa ^{II} caz-BCAsg-Ccaacs	Iragric Gleyic Calsisols
5	AUa ^I ca-AYa ^{II} cazve-BCAsve-Ccaacs	Iragric Vertic Calsisols
	AUa ^I -AYa ^{II} zI-BCAIIg-(Cg)-Cca	Iragric Fluvic Gleysols
6	AUa ^I -AYa ^{II} z-BCAgox-B/Ccagox-Cg	Iragric Gleysols
	AUa ^I z-AYa ^{II} zcs-BMLcaacs-CMLca	Iragric Gypsic Gleysols
	AUa ^I -AYa ^{II} ca-BCgca-Cscs	Iragric Haplic Calsisols
7	AUa ^I z-AYa ^{II} ca-BCAs(n)-Ccascs	Iragric Gypsic Calsisols
	AUa ^I z-AYa ^{II} zca-BCAve-Ccaacs	Iragric Vertic Calsisols
	AYa ^I z-AYa ^{II} -BCAs-Ccascs	Iragric Calcic Gypsisols
8	AYa ^I z-AYa ^{II} z-BCAs-Ccascs	Iragric Luvic Gypsisols
		Iragric accumulic
9	AYa ^I iz-AYa ^{II} iz-Aa ^{III} iz-Bica-Ahhd-Chhd	Anthric cumilic Kastonozems
	AYa ^I izca-AYa ^{II} izca-Bicars-Ahhds-Bhhs-C/D	Iragric accumulic Anthric Colsols
10	AYa ^I i-AYa ^{II} izg-Big-Ahhzv-Bhh-C/D	Iragric accumulic Anthric Gleysols
11	AYa ^I zi-AYa ^{II} zi-BTvc-Ahh-Bhh-CD	Iragric accumulic Vertisols
		Oil polluting
		Mazut
12	Am-Ab(A)-(B)h-(C)	Bituminization
		Polluted by Tower Rocks
		Cutting Soil Ground
		Filling Soil Ground

Note: Explanation of the indices of the soil horizons.

- O:** litter composed of deformed and semidecomposed plant and animal remains, sometimes with an admixture of fine earth: the thickness is 3-10 mm.
- AT:** Raw-humus horizon; dark brown or brown compact mixture of raw organic material with mineral soil.
- AY:** Light humus with a weak thin platy structure; the humus content is low (2-3%); fulvic acids predominate in the soil humus; the horizon is saturated with bases.
- AU:** Dark humus horizon: dark gray or dark brown, with crumb-granular structure: the humus content is about 4-7%: humate and fulvate-humate types of humus predominate; the horizon is saturated with bases and has a neutral or slightly alkaline reaction.
- EL:** Eluvial light-colored horizon; whitish-pate, with loose crumb structure; impoverished in clay and sesquioxides; the humus content is 1.5-2.5% with a predominance of fulvic acids.
- BT:** Clay-illuvial (textural) horizon; brown, with angular blocky structure; compact; clayey and iron-clayey films are seen on ped faces; the texture is heavy due to the accumulation of clay.
- BM:** Metamorphic horizon, brown or gray-brown, with coarse angular blocky or prismatic structure; the structure is poorly manifested in the very compact horizons; vertic features may be present; the horizon is enriched in clay and sesquioxides.
- BCA:** Carbonate-accumulative horizon; pale brown, with coarse angular blocky or coarse crumb structure; carbonate concentration of different morphologies (veins, nodules, soft powder, etc.) are abundant.

- fe:** Iron-manganic concentrations of illuvial origin (typical of the BT horizon).
- se:** solonetzic or solonchakous pedofeatures.
- v:** Living parts of plants forming a dense sod mat on the soil surface.
- s:** Soluble salts (in the subtypes of saline soils).
- g:** Dove-colored and rusty spots (gley features).
- ca:** Accumulation of Ca and Mg carbonates, which is typical of the subtypes of chernozemic, gray-brown and sierozemic soils.
- h:** Buried dark brown humus horizons (the content of humate or fulvate-humate humus may be higher than in the top humus horizon).
- cs:** Presence of gypsum crystals.
- n:** Hard nodules of any composition that can be easily separated from the soil mass.
- a:** Anthropogenically transformed horizons.
- p:** Pebbles (from fine to coarse) and rock fragment in amounts of 10-15% of the horizon volume.
- z:** Abundant features of zoogenic activity.
- I:** Stratified soil profile with layers of different mineralogical and textural compositions.
- i:** Agriirrigation sediments with poorly pronounced stratification and with gley features.

ve: Vertic properties (slickensides; high compaction in the dry state and high viscosity and stickiness in the wet state).

d: Artifacts (pieces of broken pottery brick fragments, tc).

ox: Abundant rusty spots.

L: Rock.

2.3 Systematics of the Vegetable Suitable Soils of the Subtropic Zone

Paying attention to the main principles (Soil Map of Azerbaijan, 1991) of the soil systematics, the exact soil researches that have been carried out (Morfogenetic profile of soils of Azerbaijan, 2004; Babayev and et. al., 2000; Mammadov, 2002; Mammadova, 2006; Hasanov and et. al., 1987) in the vegetable suitable soils of the Azerbaijan Republic (Absheron, Shirvan, Guba-Khachmaz and Lankaran) by the scientists the systematics of vegetable suitable of grey-brown, grey-meadow, alluvial meadow-forest and gleyey-yellow soils of the research object have been improved for use.

Grey-brown soils:

- salinized, silty-dusty, heavyloamy grey-brown,
- stony surface, dusty-silty, light-loamy grey-brown.

Irrigative grey-brown soils:

- thick, high cultivated, heavyloamy irrigative grey-brown,
- thick, stony surface, high cultivated, heavy loamy irrigative grey-brown,

- thick, hardened, salinized, weak cultivated, light loamy irrigative grey-brown,
- average thickness, cultivated, heavy loamy irrigative grey-brown,
- average thickness, stony, cultivated, loamy-sandy irrigative grey-brown,
- average thickness, buried, cultivated, heavy-loamy irrigative grey-brown,
- average thickness, stony, cultivated, loamy irrigative grey-brown,
- average thickness, stony, cultivated, heavy-loamy irrigative grey-brown,
- average thickness, hardened, weak cultivated, weak salinized, dusty-glauyey irrigative grey-brown,
- little thickness, stony, weak cultivated, silty-dusty-loamy irrigative grey-brown.

Grey-meadow soils:

- salinized loamy-silty grey-meadow,
- solonchak-like light clayey grey-meadow.

Irrigative grey meadow soils:

- thick, cultivated, dusty-silty, clayey irrigative grey-meadow;
- thick, shistous, cultivated, silty-dusty, clayey irrigative grey-meadow,
- thick, weak salinized, cultivated, silty-dusty, clayey irrigative grey-meadow,
- thick, weak salinized, clayey, cultivated, silty-dusty, heavy-clayey irrigative grey-meadow,

- thick, solonchak-like, cultivated, dusty-silty, clayey irrigative grey-meadow,
- thick, saline, laminated, weak cultivated, silty-dusty, light clayey irrigative grey-meadow,
- thick, saline, hardened, weak cultivated, dusty, dusty-silty, clayey irrigative grey-meadow,
- average thickness, hardened, weak cultivated, silty-dusty, heavyclayey irrigative grey-meadow,
- average thickness, saline, hardened, weak cultivated, dusty-silty, clayey irrigative grey-meadow,
- thick, high cultivated, loamy irrigative grey-meadow,
- thick, deeply salinized, high cultivated, heavy-loamy irrigative grey-meadow,
- thick, deeply salinized, high cultivated, lightloamy irrigative grey-meadow,
- thick, deeply clayey, high cultivated, clayey irrigative grey-meadow,
- thick, weak hardened, cultivated, loamy irrigative grey-meadow,
- thick, weak solonitificated, cultivated, clayey irrigative grey-meadow.

Alluvial meadow-forest soils:

- alluvial heavy-clayey meadow-forest,
- gleyey-clayey alluvial meadow-forest.

Irrigative alluvial meadow-forest soils:

- thick, high cultivated, heavyloamy clayey irrigative alluvial meadow-forest,

- thick, cultivated, heavyloamy irrigative alluvial meadow-forest,
- thick, gleyey, cultivated, clayey irrigative alluvial meadow forest,
- thick, hardened, high cultivated, clayey irrigative alluvial meadow-forest,
- thick, hardened, cultivated, clayey irrigative alluvial meadow-forest,
- thick, gleyey, cultivated, heavyloamy, new irrigative alluvial meadow-forest,
- thick, gleyey, hardened, cultivated, clayey, new irrigative alluvial meadow-forest,
- thick, gleyey, cultivated, heavyloamy, new irrigative alluvial meadow-forest,
- average thickness, hardened, cultivated, heavyloamy, irrigative alluvial meadow-forest,
- average thickness, hardened salinized-solonetzificated, weak cultivated, clayey irrigative alluvial meadow-forest,
- average thickness, hardened, cultivated, clayey new irrigative alluvial meadow-forest.

Gleyey-yellow soils:

- thick, loamy-clayey, gleyey-yellow,
- fully undeveloped gleyey-yellow.

Irrigative gleyey-yellow soils:

- thick, high cultivated, heavyloamy clayey irrigative gleyey-yellow,
- thick, gleyish, high cultivated, heavy loamy-dusty silty irrigative gleyey-yellow,

- thick, cultivated, loamy-dusty-sandy irrigative gleyey yellow,
- thick, cultivated, lightloamy irrigative gleyey-yellow,
- thick, hardened, cultivated, heavy-loamy-dusty-silty irrigative gleyey-yellow,
- thick, hardened, stony, cultivated, loamy-dusty-sandy irrigative gleyey-yellow,
- thick, hardened, gleyish, buried, cultivated, loamy-dusty-sandy irrigative gleyey-yellow,
- average thickness, high cultivated, heavyloamy gleyey-yellow,
- average thickness, high cultivated, loamy-dusty-silty-sandy irrigative gleyey-yellow,
- average thickness, gleyish, cultivated, heavy loamy-dusty-silty irrigative gleyey-yellow,
- average thickness, stony surface, cultivated, heavyloamy irrigative gleyey-yellow,
- average thickness, gleyish surface, hardened, weak cultivated, lightloamy-silty-dusty irrigative gleyey-yellow,
- average thickness, buried, weak cultivated, loamy-dusty-silty irrigative gleyey-yellow,
- little thickness, cultivated, heavyloamy irrigative gleyey-yellow,
- little thickness, hardened, weak cultivated, heavyloamy irrigative gleyey-yellow,
- little thickness, shistous, hardened, stony, weak cultivated, sandy... irrigative gleyey-yellow.

