



**TRANSNATIONAL INTEGRATED MANAGEMENT OF WATER
RESOURCES IN AGRICULTURE FOR EUROPEAN WATER
EMERGENCY CONTROL (EU.WATER)**

Priority Axis: Protection and Improvement of the Environment

Area of Intervention: A.O.L. 1.2 Improve integrated water management and flood risk prevention

Project Duration: 36 months

Regional report for the collected information: Odessa region, Ukraine

WP3: Knowledge capitalization and sensitive area maps

Act 3.2: Organization / rationalization of data concerning the available information, deliverables and guidelines about water management in agriculture (relevant normative frameworks & agronomic features included)

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Odessa, December 2010

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1. Odessa region, Ukraine

1.1 Location, general description and topography of the study area

Odessa region is located on the South-West of Ukraine, and occupy an area 33.3 thousand square kilometers (5.5% of Ukraine). The population is approximately 2.4 million people. At the west side the region borders with Republic Moldova, at the north side with Vinnytsia and Kirovograd regions of Ukraine, at the east side with Mykolaiv region of Ukraine and from the south side with Romania and the Black sea (Fig. 1).



Fig. 1 Location and boundaries of Odessa region, Ukraine.

Odessa region is located within the basins of the rivers Danube, Dniester and Southern Buh and directly the Black sea.

The climate is temperate continental with mild winters, hot summers and generally dry, especially in central and southern parts of the region.

The soil cover is dominated by black soils (chernozems) of heavy texture (granulometric composition) on loess, which are characterized by high natural fertility.

In terms of physical-geographic zoning of Ukraine (Marynich et al., 2003), the region is located within the Forest-Steppe zone (northern part of the region) and two subzones of Steppe (central and southern parts of the region) physical-geographical zone (Fig. 2).

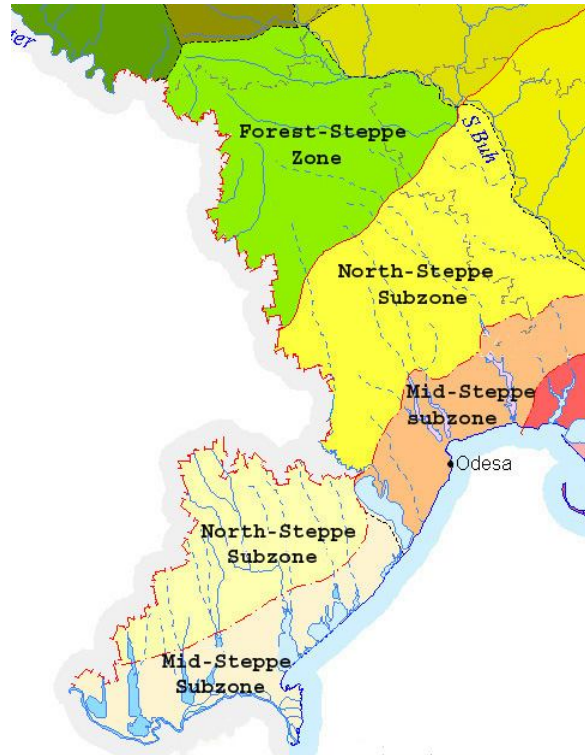


Fig. 2 Physical-geographic regionalization of Odessa region and adjacent territory (Atlas of Ukraine, 2000)

The region belongs to the intensive agriculture area. There are over 2.5 million hectares of agricultural lands in the area, including more than 2 million hectares of arable lands, more than 80 thousand hectares of vineyards and orchards. Agricultural specialization of the area - grain, corn, sunflower and other oilseeds, vegetables, grapes and fruits.

Relief of the territory is flat. The range of elevations is equal about 285 m. Within the region elevations change from 281.3 m in northern part to -4 m on south shore of the Khadzhybey estuary of the Black sea (near Odessa city).

Greater part of the region (its South and Center) lies within the limits of the Black Sea (Prychernomorska) Lowland. The border of this part of the region in the north corresponds to the counter line 150 m. Northwards between the rivers Danube and Dniester there is the spurs of Upland Codry (maximum elevation equals 232 m), and between the rivers Dniester and Tylihul (Tiligul)– spurs of Podolia Upland (with maximum elevation 281.3 m) (Fig. 3).

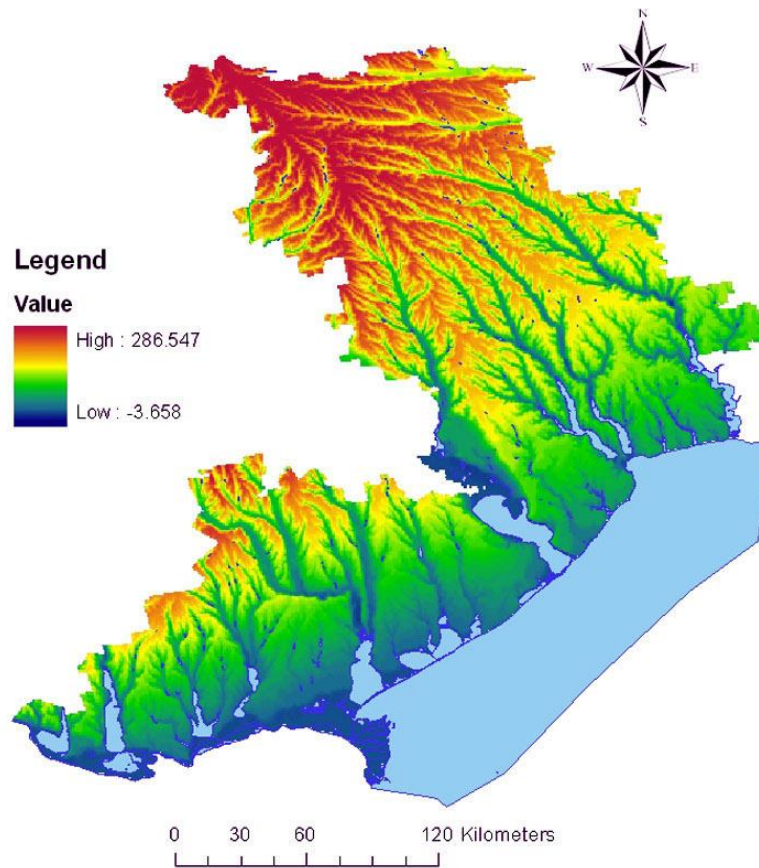


Fig. 3 Digital elevation model of the study area (with reservoirs and lakes)

1.2. Hydrometeorological conditions

There are a dozen weather stations of state meteorological network within the Odessa region. For the analysis of intra- and inter-annual variability of the main meteorological variables were used the data of observation for three stations with long periods of observations: Ljubashivka (Ljubasevka) - 47°54' N, 30°18' E, altitude 182 m; Odesa (Odessa, HMO) - 46°26' N, 30°46' E, altitude 42 m and Bolgrad - 45°42' N, 28°36' E, altitude 80 m. The station Ljubashivka located in the north of Odessa region, within its Forest-steppe part, Odesa station located in the center part of the region within Steepe zone on a seashore, station Bolgrad - in the south of the area in its most arid part within the Steppe zone.

The average annual air *temperature* within the Odessa region increases from 8.1-8.3°C in the north to 10.6-11.1°C in the south (Table 1). At the same time the highest average air temperature is characteristic for the Black Sea coast, where it is about 0.5°C above the zonal values.

Table 1. Meteorological data for the reference stations

Ljubashivka – 182 m 47°54' N, 30°18' E, 1961-1990			Odessa – 42 m 46°26' N, 30°46' E 1961-1990			Bolgrad – 80 m 45°42' N, 28°36' E 1961-1990		
Month	Rain (mm)	Temp (°C)	Month	Rain (mm)	Temp (°C)	Month	Rain (mm)	Temp (°C)
Jan	40	-5.0	Jan	42	-1.7	Jan	34	-2.2
Feb	39	-3.5	Feb	41	-1.0	Feb	39	-0.7
Mar	34	1.1	Mar	31	2.6	Mar	32	3.7
Apr	39	9.1	Apr	34	9.0	Apr	36	10.4
Mai	52	15.2	Mai	39	15.1	Mai	51	16.3
Jun	62	18.5	Jun	42	19.4	Jun	67	20.0
Jul	82	20.0	Jul	49	21.4	Jul	54	21.6
Aug	55	19.5	Aug	34	21.2	Aug	50	21.1
Sep	43	15.2	Sep	36	17.1	Sep	47	16.9
Oct	28	8.8	Oct	26	11.1	Oct	27	10.9
Nov	43	2.9	Nov	42	5.9	Nov	36	5.3
Dec	43	-1.7	Dec	48	1.4	Dec	39	0.4
Year	560	8.3	Year	464	10.1	Year	512	10.3

The warmest month of the year in the region is July, when the average temperature from north to south of the region varies from 20,0°C to 22,2°C, the coldest - January, the average temperature of which varies from -5,0°C in the north to -0.7°C in the south of the region. On the coast of the Black Sea in winter temperatures 1.0-1.5°C higher than in the depths of the continent. In summer this difference in average monthly temperatures expressed in a much lesser extent (is less than 0.5°C).

Rainfall amount in the region generally decreases from north to south, reaching the smallest values on the Black Sea coast. According to meteorological observations in northern part of the region average for climatic period (1961-1990) annual precipitation equals 525-575 mm, in the central and southern parts - 475-525 mm, in the coastal zone -400-450 mm (Table 3). In the region dominated precipitation of warm period. For the most points of meteorological observations the precipitation of warm half year (April-September) constitutes 55-65% of the annual amount. When approaching the Black Sea coast difference in rainfall warm and cold periods is reduced.

The monthly precipitation in average equals 30-50 mm. In northern and central areas the maximum precipitation falls in July, in the south - in June, although the difference in rainfall in June and July is small - 2-7 mm (Table 2).

Table 2. Average monthly and annual amount of precipitation for individual stations of meteorological observations (in the numerator - in mm, in the denominator – in % of the annual amount)

Station	Month														Year
	J	F	M	A	M	J	J	A	S	O	N	D	O-M	A-S	
Ljubashivka	40	39	34	39	52	62	82	55	43	28	43	43	199	361	560
	7.1	7.0	6.1	7.0	9.3	11.1	14.6	9.8	7.7	5.0	7.7	7.7	35.5	64.5	100
Odessa	42	41	31	34	39	42	49	34	36	26	42	48	204	260	464
	9.1	8,8	6.7	7.3	8.4	9.1	10.6	7.3	7.8	5.6	9.1	10.3	44.0	56.0	100
Bolgrad	4	39	32	36	51	67	54	50	47	27	36	39	180	332	512
	6.6	7.6	6.3	7.0	10.0	13.1	10.5	9.8	9.2	5.3	7.0	7.6	35.2	64.8	100

Visual representation of annual distribution of precipitation gives Fig. 4.

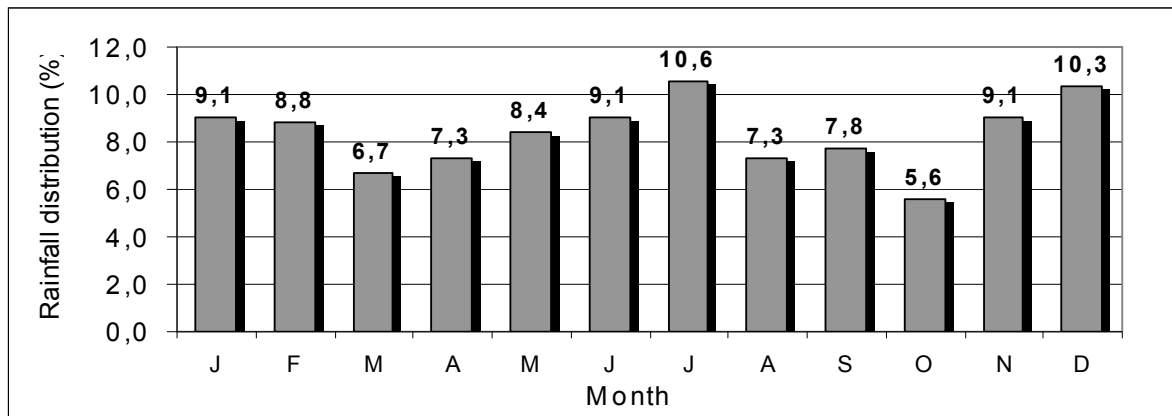


Fig. 4 Annual rainfall percentage distribution for the station Odessa

The warm season is characterized by heavy rains. Amount of precipitation for rainstorm repeatability 1 time in 100 years changes in the region within 100-150 mm.

Potential evapotranspiration (evaporability) calculated by the complex method of M.I.Budyko (Budyko, 1956; Zubenok, 1976). In accordance with this method, the potential evapotranspiration is proportional to the deficit of air humidity and defined according to the

temperature of the evaporating surface by the formula

$$E_0 = \rho D(q_s - q), \quad (1)$$

where E_0 – potential evapotranspiration; ρ - density of air; D - integral coefficient of eddy diffusivity; q_s - specific humidity of saturated air at a temperature of the evaporating surface Θ_ω ; q - specific humidity of air. The temperature of evaporating surface Θ_ω determined from the equation of heat balance of land surface provided that it is sufficiently humidified.

For the practical use of the method were developed nomograms (Zubenok, 1976), which are allowed for various natural zones, using average monthly deficit of air humidity, for each month of the year to get the average layer of potential evapotranspiration. Thus obtained the average monthly amounts of potential evapotranspiration for the three above mentioned (reference) meteorological stations in the region are presented in Table 3. Analysis of these data shows that, in general, from north to south potential evapotranspiration increases, keeping the same type subannual unimodal distribution with a maximum in June-August and minimum amount - in the winter. Herewith, from March to October potential evapotranspiration exceeds precipitation, especially strong (in 2-3 times) in the summer months (Fig. 5).

Table 3. Monthly amounts of potential evapotranspiration (mm) for reference stations

Station	Month												Year
	J	F	M	A	M	J	J	A	S	O	N	D	
Ljubashivka	10	13	30	87	123	141	142	130	97	50	19	10	852
Odessa	13	19	36	64	106	137	149	136	97	54	25	14	850
Bolgrad	12	20	50	94	127	153	157	144	105	60	28	13	963

Annual potential evapotranspiration, calculated by the Budyko method, for the three reference weather stations of the region is 852 mm, 850 mm and 963 mm, respectively (Table 3). These figures are substantially higher than the corresponding values calculated by the Thornthwaite formula $E_p = 116.02 T^{0.7344}$, where T - the average annual air temperature - 549 mm, 634 mm and 643 mm for stations Ljubashivka, Odessa and Bolgrad, respectively.

Analysis of the results of the calculation of potential evapotranspiration that were done for the territory of Ukraine by other, approved in the country methods, evidence in favor of the Budyko method. In particular, the layer of evaporation from water surface (which is often seen as a potential evapotranspiration), calculated using the formula by Kaganer

(Kaganer, Dyukel, 1966) for the station Bolgrad equals 960 mm (Byshovets, 1986). Maximum possible evaporation, calculated from the radiation balance by Mikhailov (Mikhailov et al, 2001), varies across the region from 750 mm a year in the north to 1000 mm a year in the south, and calculated by the equation of heat balance of land surface by the method of Mezentsev (Mezentsev, Karnatsevich, 1969) varies in the Odessa region from 900 mm in the north to 1000 mm in the extreme south (Gopchenko, Loboda, 2001).

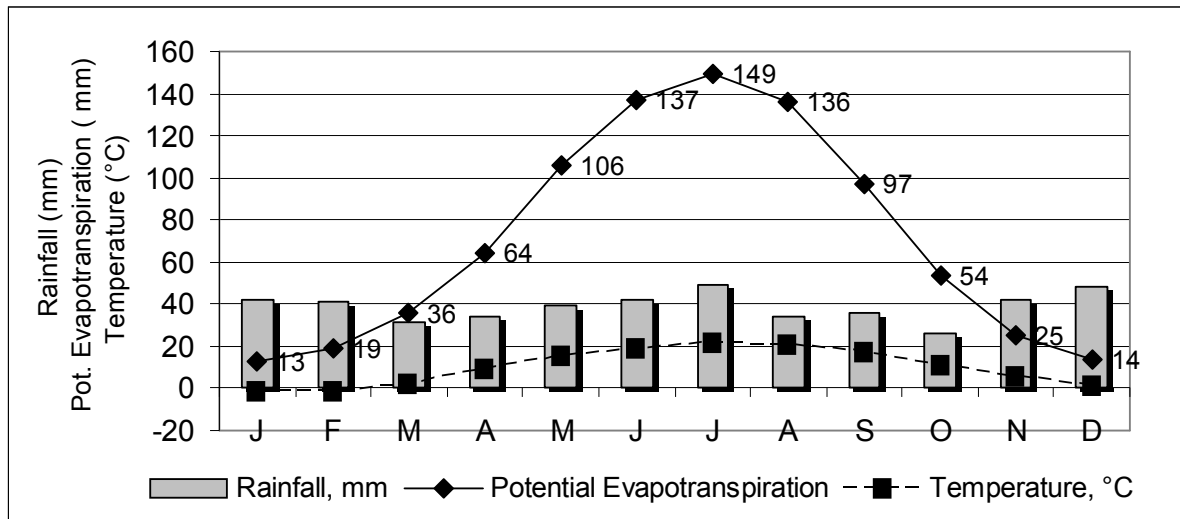


Fig. 5 Monthly potential evapotranspiration, calculated by the Budyko method, rainfall amount and mean temperature variations for Odessa station

With regard to long-term dynamics of climate, it may be noted that during the entire period of meteorological observations (from 1894 for the station Odessa) in the region marked increase in the average annual air temperatures, especially noticeable in the last two decades, and an increase in annual precipitation. (Fig. 6, 7).

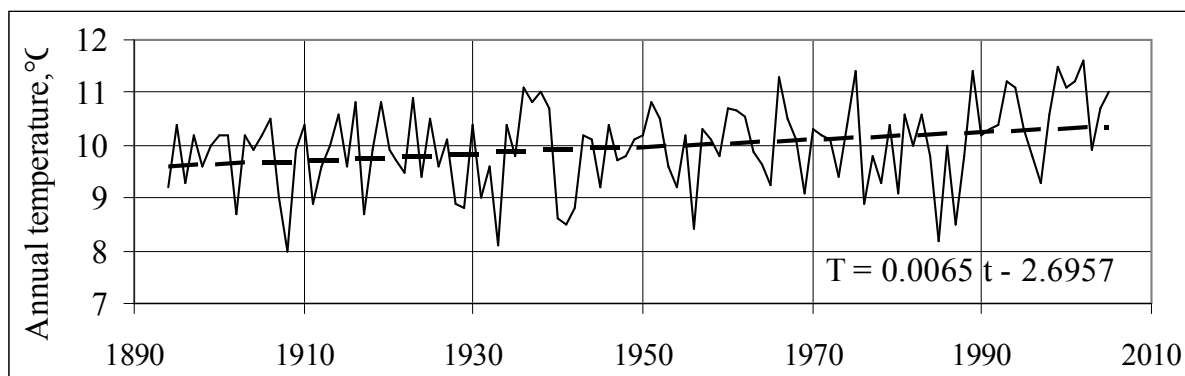


Fig. 6 Long-term variation of average annual air temperature for station Odessa

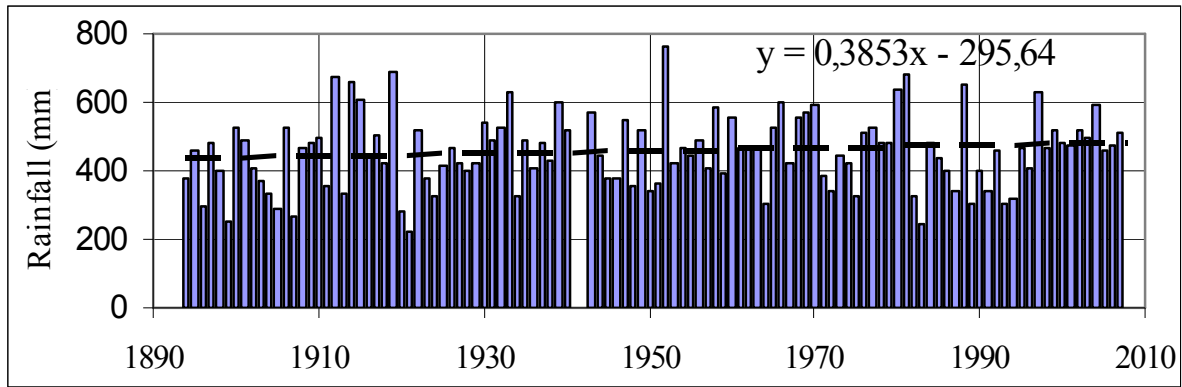


Fig. 7 Long-term variation of annual rainfall for weather station Odessa

1.3 Soil properties

In accordance with the genetic classification of soils, used in Ukraine (Soils of Ukraine..., 1988; Field determinant..., 1981), the chernozems on loess of heavy texture (silty clay or sandy clay and clay), which are zonal genetic type of soils here, occupying more than 90% area of the region.

Within northern forest-steppe part of the Odessa region soil cover is enough various, but typical, regradated and podzolized in a different degree eroded chernozems are prevailed (Table 4). There are grey and dark-grey podzolized soils in many places but their total area is only 0.4% territory of the region. Within the northern part of Steppe zone (North-Steppe subzone) ordinary chernozems is widespread, within the southern part of Steppe zone (Middle-Steppe subzone) southern chernozems is prevailed. Besides zonal soil types and subtypes within the bottomlands of river valleys meadow-chernozemic, meadow, meadow-boggy and bog and soddy soils are widespread. On the coast of the Black sea solonetz soils occupy considerable areas.

Humus content in the soils decreases from a north to the south in accordance with the increase of droughty of climate. Within the Forest-Steppe zone and North-Steppe subzone chernozems medium humus are prevailed (>6%), on the south of region within the Middle Steppe subzone chernozems meagre (3-6%) and weakly (< 3%) humus are dominated.

The Odessa region is characterized by considerable distribution of soil erosion processes. Presently near the half (48% or 1241.5 thousand ha) of agricultural lands of the region are eroded, including 35% of middling and strongly washed off soils. Within limits of the region over 1100 ravines are placed by an area 13.7 thousand ha. It is necessary to add the destructive processes in soils, provoked by its intensive use, development of erosion processes, irrigation in south and central part of the region: de-humification, second

(irrigational) salinization, getting up of the ground waters, decarbonatization and physical compaction.

Table 4. Main genetic types and subtypes of soils of the Odessa region (Soils of Ukraine..., 1988; Field determinantion..., 1981; Soils of Odessa region ..., 1969)

Soil type	Texture	Rock	Area		Humus content %
			thousand km ²	%	
Grey podzolized	Sandy clay and clay	Loess and clay	2.3	0.1	2.0-2.5
Dark grey podzolized	Sandy clay and clay	Loess and clay	7.6	0.3	3-4
Podzolized chernozems	Sandy clay and clay	Loess and clay	40.8	1.6	2-2.5 (for sandy clay); 4-4.5 (for clay)
Regradated chernozems	Sandy clay	Loess	96.2	3.8	3-5
Typical chernozems	Sandy clay and clay	Loess	330.8	13.0	4.7-6.5
Ordinary chernozems	Silty clay and clay	Loess	1114.2	43.7	3.8-5.9 (for meagre humus); 6-7 (for medium humus)
Southern chernozems	Silty clay loam and silty clay	Loess	500.9	19.6	2.7-3.3 (weakly humus); 3.5-4.0 (for meagre humus)
Chernozems on fine clays	Clay	Fine clay	130.0	5.1	3-6
Chernozems and soddy rock debris soils on rocks eluvium	Silty clay	Rocks eluvium	23.5	0.9	4-4.5
Chernozemic clay-sand and sandy loam	Clay-sand and sandy loam	Loess	57.4	2.3	1-3
Chernozems alkaline and residual alkaline	Silty clay	Loess	76.4	3.0	3-5
Meadow-chernozemic	Sandy loam and sandy clay loam	Loess	53.5	2.1	1.7 (for sandy loam); 4.7 (for sandy clay loam)
Meadow	Sandy clay	Deluvial and alluvial deposits	52.5	2.1	1.6-2.4
Meadow-boggy and bog	Sandy clay loam	Alluvial deposits	20.0	0.8	3-4
Soddy mainly gleyed	Sand, clay- sand and sandy loam	Alluvial deposits	18.1	0.7	2-2.5
Solonetz	Silty clay	Loess	7.5	0.3	3-4

In terms of soil classification USDA, the vast majority of soils of the Odessa region in granulometric composition (texture) belong to the heavy soils (sandy clay, silty clay, clay). On a north-west and, especially, on the south-west of the region, between Danube and Dniester rivers, moderate heavy soils (clay loam, sandy clay loam, silty clay loam) are widespread. More light soils occupy a small area within the bottoms of river valleys and on the coast of the Black sea. In particular, moderate and medium soils (sandy loam, silty loam, silt) are widespread in flood-plan of Danube, and light soils (sand) – within the limits of bottoms of small rivers valleys.

According to location in the relief expediently to select as the lowlands the bottoms of river valleys with elevations, as a rule, less than 50 m above a sea level, as the upland – all the other part of the region. For drainage soils can be identified not well drained soils as soils with the near bedding of the ground waters (<1 m below soil surface). In this case on the soil map of the Odessa region the following classes will be selected (Fig. 8):

1. Light not well drained lowland² soils (sandy soils of Danube flood-plane);
- 2 Moderate and medium not well drained lowland soils (clay-sand and sandy loam soils within Danube flood-plane);
3. Light lowland soils (sandy soils in small rivers valleys and on shore of the Dniester estuary);
4. Moderate heavy lowland soils (sandy clay loam soils within the bottoms of small river valleys);
5. Moderate heavy upland soils (silty clay loam or sandy clay loam soils of watershed plateaux and slopes);
6. Heavy upland soils (silty clay and clay soils of watershed plateaux and slopes).

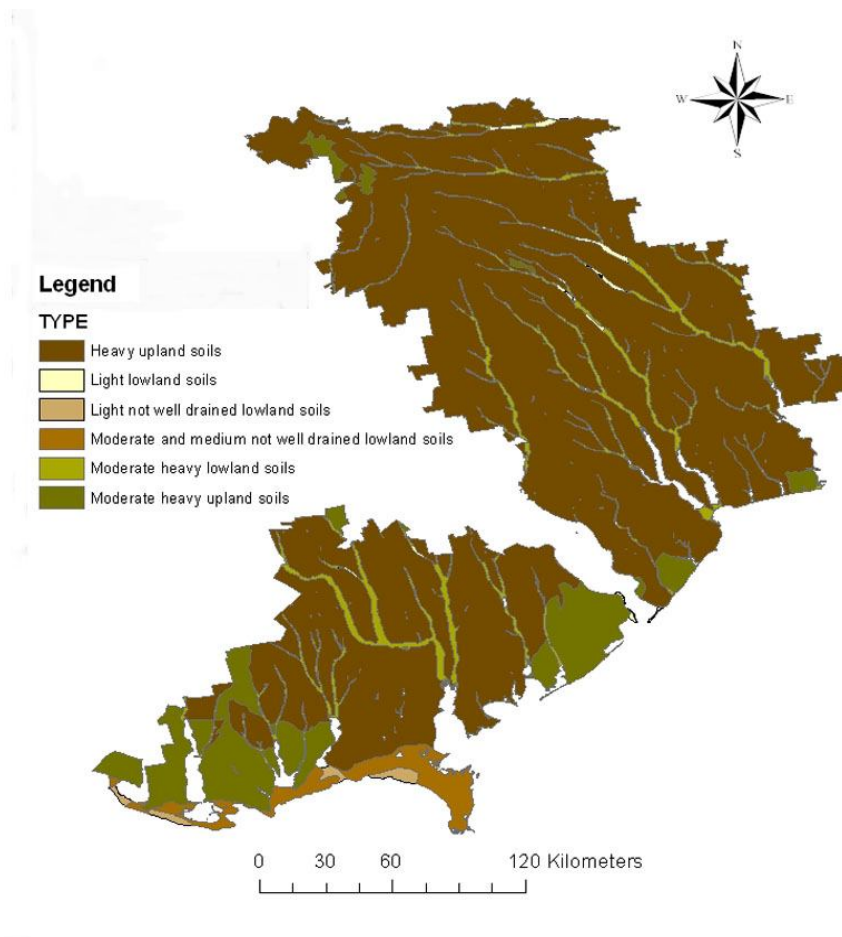


Fig. 8 Soil classes

1.4 Land uses and agricultural land

Of the total area of 3331.3 thousand hectares, agricultural land covers 2661.6 thousand ha or 79.9% of all region's area. In composition of agricultural lands the area of plough-land is 2067.6 thousand ha (62.1% of the region's area and near 78% of agricultural lands), haymakings and pastures – about 408 thousand ha and gardens and vineyards – about 90 thousand ha. Forests occupy 223.9 thousand ha, bogs and boggy lands – 72.2 thousand ha, internal waters – 211.8 thousand ha, built-up lands – 128.2 thousand ha (Table 5, Fig. 9).

Corn cultures (wheat, barley, rye, maize) prevail in the structure of sowing areas (Table 6). Considerable areas are occupied by technical crops (mainly sunflower, sugar beet and the last years the rape).

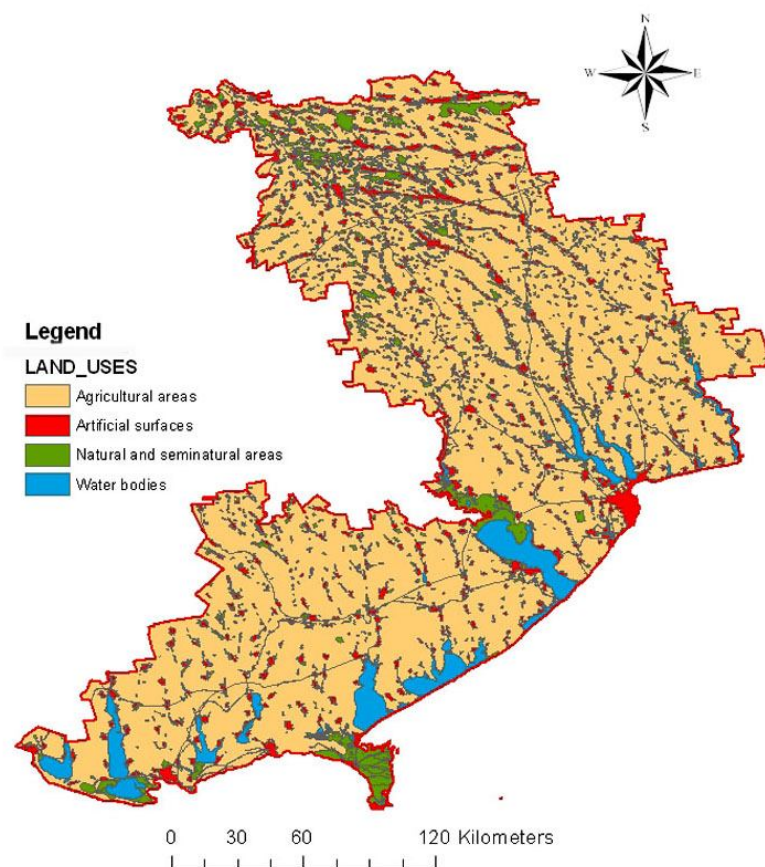


Fig. 9 Land use map

Table 5. Structure of land-use

Type of land use	Area		Area		Area	
	as of 1.01.2005		as of 1.01.2007		as of 1.01.2009	
	thousand	% of	thousand	% of	thousand	% of
	ha	total	ha	total	ha	total
	area	area	area	area	area	
Agricultural lands	2662.4	79.9	2662.1	79.9	2661.6	79.9
plough-lands	2068.3	62.1	2067.4	62.1	2067.6	62.1
hayfields and pastures	405.6	12.2	405.6	12.1	407.8	12.2
gardens and vineyards	90.3	2.7	90.8	2.7	89.9	2.7
Forests	223.3	6.7	223.4	6.7	223.9	6.7
Bogs and boggy lands	72.5	2.2	72.6	2.2	72.2	2.2
Internal waters	211.6	6.4	211.7	6.4	211.8	6.4
Built-up lands	127.8	3.8	127.8	3.8	128.2	3.8
Protected areas	102.2	3.0	102.4	3.1	126.5	3.8

Table 6. Structure of sowing areas

Crops	Area (2005)		Area (2008)	
	thousand	%	thousand	%
	ha		ha	
Corn crops (wheat, barley, rye, maize)	1155.3	66.3	1219.8	66.9
Technical crops (sunflower, sugar beet, rape)	342.5	19.7	432.3	23.2
Potato, vegetable and melon crops	75.4	4.3	72.8	4.0
Fodder crops (grass, forage beet etc.)	168.0	9.6	99.0	5.4
General sowing area	1741.2	100.0	1823.9	100.0

In the region there are 58 irrigation systems, most of which was built in 60 th - 80 th years of last century. The total area of irrigation systems equals 226,861 hectares, the total length of irrigation network - 5388.1 km. Irrigated land almost entirely (95%) are located on the south and south-west of the region. Sprinkler irrigation with using a different sprinkling machines is the predominant method of irrigation in the region, although there are irrigation systems where are used surface irrigation methods. But it must be emphasized, that from a total area of irrigated lands, which exceeds 200 thousand hectares, due to economic difficulties in the past two decades in the country actually are irrigated only 30-50 thousand hectares.

1.5 Surface waters

There are three big rivers within the limits of the region: Danube, Dniester and Southern Buh, about thirty small rivers, 58 reservoirs with a volume of water from 1 to 100 million m³ and the total area of water table of 58,799 ha, 37 lakes with a total water table area of about 73,400 hectares and about 940 ponds with a total water table area more than 12,200 hectares (Fig. 10).

Danube flows in the far south-west region over 174 km. The part of the watershed area, which lies within the region, is equal to 6.650 thousand km² (the total length - 2960 km, the catchment area - 817 thousand km²). In the Danube water regime is well expressed three phases: spring floods, summer and autumn floods, autumn and winter mean water. Flooding begins in February-April and in the downstream continues until June. Average annual water discharge of Kiliya branch of the Danube, along which Ukraine borders with Romania, equals 6430 m³/s, the average annual runoff equals about 205 km³. Danube carries a lot of sediments that are deposited in the lower reaches, especially in the mouth of the river, thus

contributing to the growth of the delta.

Dniester originates on the northern slopes of the Carpathians and flows into the Dniester estuary of the Black Sea. The length of the river within the Odessa region 116 km (from 1362 km of its total length), basin area 72 thousand km², its average annual runoff in the mouth is 10.2 km³. Dniester is a river mixed type of water alimentation to the advantage of snow with a substantial share of rainy. Water regime in the lower reaches (within the territory of Odessa region) depends on the mode of operation of the Dniester and Dubosarska reservoirs located upstream of the river (the first in Ukraine, the second in the Republic of Moldova).

Danube and Dniester are major sources of irrigation of agricultural lands in the region, their water is also used extensively for water supply, including drinking water supply.

Southern Buh originates on Podolia Upland and flows into the Bugskiy estuary of the Black sea. From the total length of 857 km only 40 km is within the Odessa region. Surface runoff, which is formed within the catchment area of the Southern Bug, is 3.4 km³. Water alimentation mixed, with the prevalence of snow. Water regime is characterized by uneven distribution of runoff during the year. Well-expressed spring flood and rain waters during the year are typical for the river.

On the flow regime of the river significantly affects overregulation of the river flow upstream within the territory of neighboring Vinnytsia region.

Small rivers of the region Kodyma, Savranka, Chichikleya, Tylihul, Kuchurhan, Large and Small Kuyal'nyks, Sarata, Khadzhyder, Kohilnyk and others are shallow and many of them completely drying up in the summer season. The average annual runoff of small rivers varies from 50 million m³ in the north to less than 20 million m³ in the south and south-west of the region. Alimentation of the rivers is mostly snow: during spring flood passes about 80% of annual river runoff.

Estuaries (lymans) occupy former river valleys and are oriented mainly from north to south. The biggest of them are: Dniester (360 km²), Sasyk (210 km²), Tylihul (170 km²), Alibey (101 km²), Shahany (70 km²), Khadzhybey (70 km²) and Kuialnyk (56 km²). The final formation of estuaries was a result of Holocene transgression of the Black Sea's waters into river valley and next separation of the bays, which appeared, from a basic aquatorium by accumulative sand banks. Physical and chemical properties of the estuaries waters and other their characteristics depend on the degree of connectivity of estuaries with the sea, the volume of the river flow in them and the number and composition of brought solid sediments. However, the waters of all estuaries have high salinity and can't be used for irrigation and

water supply without special processing.

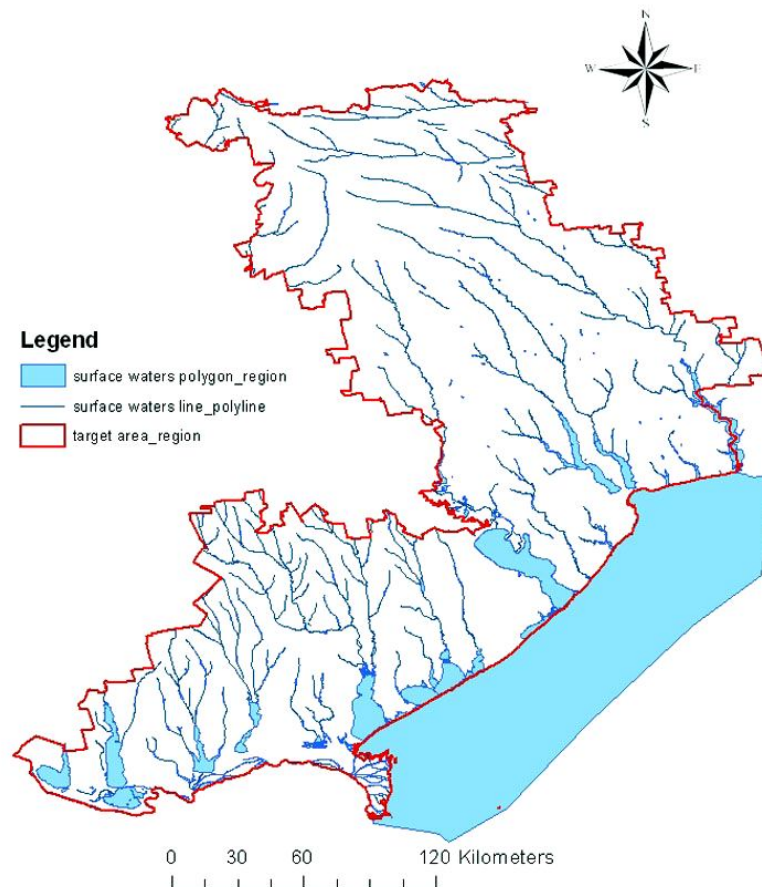


Fig. 10 Hydrography of Odessa region

Lakes. There are about 37 lakes in the region with total area of 73.4 thousand hectares. The largest lakes Yalpuh (149 km²), Kahul (90 km²), Kugurlui (82 km²), Kotlabukh (68 km²) and Kytai (60 km²) are located at the northern part of flood-plain of the Danube river. Historically they formed in a result of flooded mouths of its tributaries. In the late 50-ies of the twentieth century, they were separated from the Danube and were turned into the reservoirs with an artificially controlled water regime, and are used for irrigation, fish farming, recreation needs and for drinking and agricultural water supply.

Reservoirs. In total in the region there are 58 reservoirs. The main amount falls to reservoirs, which have volume from 1 to 100 million m³. The total surface area of reservoirs is equal 58799 ha, and volume of water in them at mean water level equals 1966.68 million m³. Five reservoirs (former lakes of Danube flood-plane and desalted Sasyk reservoir, a former estuary Sasyk) have over 100 million m³ of water volume. Reservoirs used for

irrigation of agricultural lands, fish farming, recreation. Some reservoirs are built specifically for the needs of large industrial enterprises (eg, a reservoir on Small Kuyal'nyk river for water supply of Chervonoznamenska sugar factory) or electric power plants (eg, a reservoir on the Kuchurgan river for the work of the Moldovian Electric Power Plant).

Ponds. According to the inventory of water fund as of 01.01.2007 the amount of ponds was over 940 with the total surface area of water more than 12 200 ha. About half of ponds have a surface area near one hectare or less and little depths. Water retarded facilities are represented by earthen dam with earthen escape channel, in some cases with tubular culverts. More than 10% of small ponds don't have escape channels and during major flood water breaks through earth dams. Most ponds are now intensely silted and constantly losing usable volume, and in some cases - and their total volume. Ponds are used mainly for recreation, fish farming and rarely - for growing waterfowl.

1.6 Hydrogeology and ground water quality

1.6.1 Hydrogeology and aquifer characteristics

Geology and hydrogeology. Odessa region is located within the south-western outskirts of the Eastern-European platform of pre-Riphean age, which in the northern part of the territory is represented by the slopes of the Ukrainian shield, in central and southern parts - by South-Ukrainian syncline, in the extreme south-west - by the Pre-Dobruja depression. Pre-Riphean basement is represented mainly by granite, gneiss, transitive between these two rock types and crystalline schists of various compositions. The depth to crystalline basement increases from 0-100 m in the north to about 2000 m near the Black Sea coast around Odessa, and up to 7-8 thousand meters in the Danube region. Above the crystalline basement overlain the Paleozoic, Mesozoic and Cenozoic sediments, which are presented by marls, sandstones, siltstones, limestones, sand and clay. The bedrock is overlain by Pliocene-Anthropogene red-brown clays and Anthropogene (Quaternary) loess and similar rocks of heavy granulometric composition.

Quaternary and Pliocene continental sediments are widespread, forming the cover of uneven capacity. They are represented by formations of loess (quaternary) and a red-brown colored argillaceous (Pliocene). Subaerial rocks lay above sea level, with the exception of the southern territory, where the absolute elevations of base of subaerial deposits decreased to - 55 m. The thickness of subaerial rocks increases near the major river valleys, estuaries and the sea coast, which are characterized by tectonic subsidence in the Pliocene-Quaternary

(latest stage).

Total thickness of Quaternary deposits within the interstream areas varies from 25 to 50 m, dominates (except slopes) 27-28 m.

Groundwaters. In the hydrogeological relation the region belongs to the north wing of the Black Sea artesian basin, which is characterized by monocline nature of lying of sedimentary rocks of different ages. Ground water is distributed in the deposits of all stratigraphic systems - from Archaean-Proterozoic to modern structures. Crystalline rocks of basement as well as sedimentary rocks of Cretaceous, Paleogene, Neogene and Quaternary are an aquiferous rocks. They are characterized by different depth, means and availability of extraction, prevalence, quality and quantitative indicators. Therefore, their role in the structure of economic and drinking water-supply divers. Below is presented the characteristic of the most important unconfined groundwater aquifers, i. e. the first from the earth's surface underground subterranean waters with a free surface, the most vulnerable to various kinds of pollutants coming from the earth's surface, including nitrogen compounds (nitrates, nitrites).

Unconfined groundwater aquifers. Groundwater is contained in rocks of different genesis: alluvial, aeolian-deluvial, alluvial-deluvial, marine, estuary and other. Distribution and depth of the groundwater within the area constructed on the basis (Specialized hydrogeological map ..., 1986; National Atlas of Ukraine, 2009) are shown in Fig. 11. Depth to groundwater in the valleys and floodplains, as a rule, is 0-3 m, on the watersheds - predominantly up to 20 m. The largest groundwater aquifers are the following.

Aquiferous layer of modern alluvial and alluvial-delyuvial deposits is distributed within the thalwegs of the river flood plains and small flat-bottom valleys. Aquiferous rocks are represented by sandy, loam with layers and lenses of sands and sandy, sometimes by inequigranular sand; within the small flat-bottom valleys there is sometimes the crushed limestone and other rocks. The thickness of aquifers ranges from 1-2 m to 15 m and reaches the greatest values in the valleys of major rivers. As usual the water has free water table and only if there is poorly permeable to water the roof strata it has a little pressure. Discharges of wells that capturing these waters do not exceed predominantly 0.3 L/sec, rarely reach 1 L/sec at decrease level to 1-5 m. The values of discharges of boreholes are within 0.1–0.3 L/sec. Water supply aquifers is due to infiltration of precipitation and also due to river water during floods.

In total mineralization and chemical composition the unconfined groundwater of the region is quite diverse. Thus, the total mineralization varies within 0.5-3.0 g/L, and total rigidity - from 8 to 25 mmol/L. By macrocomponent composition along with hydro-sulphate

waters frequently are found sulphate and chloride-sulphate calcium-sodium and sodium water.

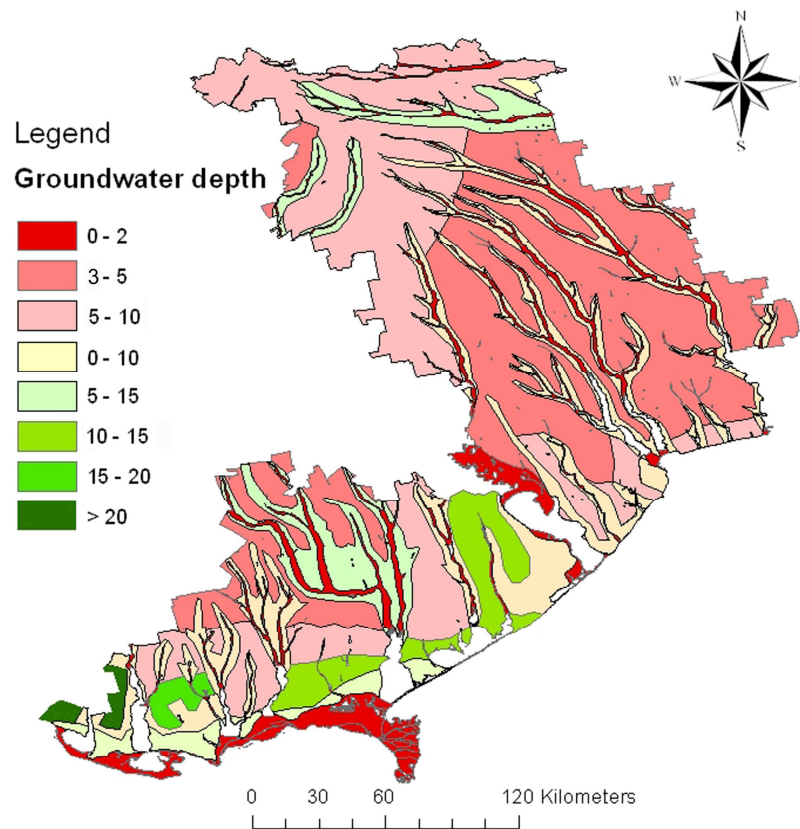


Fig. 11 Distribution and depth (m) of groundwater

Aquifer of eolian-deluvial deposits is distributed in interfluvial spaces (on the watersheds) and on the slopes of river valleys. Aquiferous rocks here are loess loam and sandy loam. The aquifer is formed on the layer of red-brown clay or heavy loess loam. The thickness of aquifer ranges from 0.5 to 10-12 m or more. The depth to water level is in the range from 0.5 to 20 m, the groundwater layer has no pressure.

The discharges of wells by which the exploitation is carried out, varying from 0.05 to 0.5 L/sec, sometimes - more. The total mineralization, total hardness and other quality indicators are quite diverse and vary within limited land areas.

Water supply of the aquifer is due to infiltration of precipitation on the area of distribution. Additional (and sometimes main) sources of water for the aquifer there is irrigation water and loss from communications in settlements.

Few discharges of wells because of the low water yield of loess ground, and low spatial stability of quantitative and qualitative indicators significantly limit the use of

groundwater. However, in the absence of better quality water in rural areas they are the main source of decentralized water supply. At the moment rural population in the region uses water from 2381 public wells.

1.6.2 Groundwater quality

The natural quality. Formation of chemical composition and other indicators of groundwater quality occur with the participation and under the influence of number of factors: lithological features of aquiferous rocks, composition and content of water-soluble salts, climate conditions and so on.

Indicators of groundwater quality (total salinity, general hardness, the content of sulphate-ion and chlorine-ion) naturally deteriorating in the general direction from north to south and southwest from the areas with high amounts of rainfall, relatively lower evaporation, lower salinity of rocks of aeration zone to the areas with respectively worse indicators of conditions. The increase in the mentioned direction of general mineralization is due to chlorine- and sulfate- ions content and also calcium-ion, that is one of the reasons of significant increase of hardness of groundwater.

Table 7 provides information about the compliance with current standards of main indicators of groundwater quality in northern, central and south-western areas (administrative regions) based on the study of more than 1000 of chemical analysis of water samples from wells (Rotar, 2006). According to (Sanitary rules ..., 1988) the total salinity standard (maximum allowable concentration) is 1000 mg/L, the total hardness - 7 mmol/L, content of sulfate-ion - 500 mg/L, chlorine-ion - 350 mg/L.

The analysis of the table shows that by total salinity the most qualitative is groundwater of the northern regions, within of which the share of analysis that meet the standard, exceeds 80%, and total mineralization of the rest fit in a double standard. As we move towards the south the share of first is gradually decreasing and at the southwest reaches 15-0%. At the same time is increasing the number of analysis in which the standard is exceeded in 2-3 times or more. On the general background of increasing salinity in some districts (Reni, Izmail, Bilgorod-Dnistrovsk in part), it decreases due to the use of fresh groundwater within the alluvial deposits of river terraces. Somewhat reduced this indicator also in Biljaivka and Ovidiopol districts that are situated near the northern border of distribution of groundwater in the upper Sarmatian sediments.

Waters near the seashore are characterized by the best indicators of the total hardness. This is due to predominance in the cation composition of sodium ions with insignificant

content of calcium ions. To the soft waters are related also Tarutino hydrocarbonate sodium waters and of adjoining parts of adjacent districts.

Table 7 Results of quality estimation of groundwater for some indicators (% of total number of studied samples)

Concentration in relation to the standard (H)	Districts*					
	1	2	3	4	5	6
Total salinity (H=1000 mg/L)						
less than H	23.5	23.7	14.1	23.1	7.7	5.8
more than 1 H	76.5	76.3	85.9	76.9	92.3	94.2
more than 5 H	0	1,9	6.2	9.6	21.7	46.2
more than 10 H	0	0	0	0	1.3	1.7
Total hardness (H=7 mmol/L)						
less than H	18.8	6.6	10.2	9.6	0	0
more than 1 H	81.2	93.4	89.8	90.4	100.0	100.0
more than 5 H	2.4	6.6	19.3	17.2	41.6	55.7
more than 10 H	0	0	2.6	1.9	14.3	15.4
Sulfate-ion (H=500 mg/L)						
less than H	88.2	69.7	62.8	59.7	26.0	21.2
more than 1 H	11.8	30.3	37.2	40.3	74.0	78.8
more than 5 H	0	0	5.2	3.8	24.6	28.9
more than 10 H	0	0	0	0	2.6	5.8
Chlorine-ion (H=350 mg/L)						
less than H	95,3	88.8	66.7	67.3	29.5	19.2
more than 1 H	4,7	11.2	33.3	32.7	70.5	80.8
more than 5 H	0	0	0	0	1.3	7.6
more than 10 H	0	0	0	0	0	3.8

*Notes: under numbers 1-6 are shown districts: 1 – Kotovsk (northern part of the region), 2 – Chervony Okha (north-eastern part), 3 – Shirjaevo (center part), 4 – Ivanovka (center part), 5 – Artsyz (south-western part), 6 – Tatarbunary (southern part).

By sulfate ion content groundwater is rather qualitative: in the absolute majority of the areas it not exceeds the standard value or very closes to it. Significant excess of this indicator is marked only in Kiliya, Tatarbunary, Kominternovo (southern) districts of the region.

In water in mentioned above and some other regions contains increased amount of chlorine ion. In particular, in Kiliya, Bolgrad and Kominternovo districts waters by this

indicator are characterized by more than triple excess of the standard.

Within the seven regions, situated mostly in southern and south-western part of the region, attention is drawn to a reduced in 1.5-4 times content of calcium in comparison with the optimum.

Groundwater pollution. Groundwater in Odessa region (as Ukraine in whole) is classified as not protected from pollution. Consequently, they are largely polluted by biogenic substances, pesticides, heavy metals, petroleum products. The most significant is the pollution of groundwater by nitrogen compounds, especially by nitrates.

Evaluation of nitrate pollution of groundwater is made according to 1047 of chemical analysis of water from wells approximately of 250 settlements in the northern, central and north-western areas (Rotar, 2006). The results of the research is presented in Table 8.

The analysis of the table shows that on the average water of every two wells from five does not meet the current standard by the content of nitrates (not more than 45 mg/L). In some regions, particularly in the southwest part of the region, almost in 85% of the wells the content of nitrate is exceeded the standard (State of the Environment ..., 2009). Too high nitrate pollution of groundwater of the southwest part is connected with high proportion of irrigated lands here, into which were taken increased dose of nitrogenous fertilizer. Shallow depth of groundwater has also contributed to pollution.

Table 8 Information about the presence of nitrate-ion and distribution of it's content relative to the standard in the groundwater of the region

Availability and content of nitrate ion	Number of analysis	% of total number of analysis
Absent	122	11.6
Present – “traces”	456	43.6
Present – less than 45 mg/L (standard, H)	59	5.6
<i>Total below the standard</i>	<i>637</i>	<i>60.8</i>
Present with the content:		
to 5 standards (H)	151	14.4
from 5 to 10 H	128	12.2
from 10 to 20 H	83	7.9
from 20 to 30 H	26	2.5
from 30 to 40 H	10	1.0
from 40 to 50 H	6	0.6
more than 50 H	6	0.6
<i>Total above standard</i>	<i>410</i>	<i>39.2</i>

Researches of nitrate pollution of groundwater outside of the settlements on arable lands, carried out in seven administrative districts of the region (Rotar, 2006), showed that the nitrate content in groundwater ranged from 117 to 1091 mg/L that exceeds appropriate standard in 2.6-24 times. The main sources of nitrate pollution of groundwater under the cropland are nitrogen fertilizers.

1.7 Pollution sources

The main sources of pollution of surface water bodies of the region (rivers, reservoirs and lakes) are: untreated and inadequately treated sewage of settlements, industrial and agricultural enterprises; placing the livestock farms and complexes as well as rubbish dumps without safeguard measures within the coastal strips of rivers and reservoirs; improper storage and use of mineral and organic fertilizers and pesticides. Influx to the water bodies of pollutants with surface runoff is largely stimulated by plowing lands up the shoreline, the destruction of forest strips and riparian meadows. As well this promotes to unhindered inflow to the water bodies of soil's particles, which washed off from the slopes, and with them fertilizers and pesticides, invected into the soil. Soil erosion is widespread in the region. Eroded land occupies 1241.5 hectares, representing 48% of the total area of farmland. The area of gullies equals 13.1 thousand hectares (Regional report ..., 2009; State of the Environment..., 2009)

The main sources of groundwater pollution are an invected on the agricultural lands fertilizers and agricultural chemicals (mainly pesticides), as well as the places of storage of fertilizers and pesticides, livestock farms and complexes and dumps of solid waste.

In 2008 in the region used 307.7 million m³ of water and into water bodies dumped 257 million m³ of reverse waters, of which 187.6 million m³ (73%) are untreated or insufficiently treated (Cities and districts ..., 2009). Water consumption is divided as follows: domestic and drinking needs - 123.5 million m³ (40%); industrial needs - 68.25 million m³ (22.2%), agricultural water - 12.19 million m³ (4%); irrigation - 63.79 million m³ (20.7%), fisheries - 67.1 million m³ (21.8%), other needs - 7.972 million m³ (2.6%). The main pollutant of surface waters, thus, is the housing and utility.

There are in the region 134 systems of sewage treatment facilities design capacity of 844 thousand m³/day, about 40% of them are in poor condition. One of the main reasons of such situation is that the treatment plants and sewer network was constructed in the 70-80th years of past century, today they are morally and physically obsolete and do not meet modern requirements, they are transferred to the rural councils that have no money for maintenance

and proper operation of these constructions. In some settlements, including even in district centers (such as Savran, Frounzivca, Shiryaev, V.Mihaylivca, Micolaivca) treatment facilities are not available.

However, treatment facilities, which are in satisfactory condition in violation of wastewater treatment technologies do not achieve the design parameters. In recent years there is a trend of increasing concentration of pollutants (particularly nitrogen groups, phosphates, synthetic surfactants) at the input of treatment facilities above design parameters, that leads to the exceeding of concentrations of standard indexes on the output of treatment plants.

Important environmental problem in the region represent an improper use and storage of fertilizers and pesticides. And although in recent years the use of organic fertilizers and pesticides due to the reduction of livestock and poultry dropped significantly due to the deep economic crisis in agriculture, the use of mineral fertilizers is growing. So, from 2000 to 2008, the total amount of used mineral fertilizers has increased four times, reaching 47.4 thousand tons, including nitrogen fertilizers - 36.6 thousand tons (73 and 56.5 kg/ha, accordingly).

Storages of fertilizers and pesticides remain a thorny problem. Storage facilities provide only 30% of the required amount of fertilizers. Losses of fertilizers in storage reaches 20-30%. Around the storage of fertilizers and pesticides are formed centers of high and dangerous pollution. Special danger in connection with violation of the rules of storage represent a warehouses of obsolete and banned for the use pesticides and agrochemicals, which have accumulated in amount more than 1900 tons. At the same time most of the warehouses, in which they are stored, is in unsatisfactory condition (65 of 119).

Significant environmental load associated with livestock farms and complexes. On livestock farms of the region only two-thirds of livestock are provided by storages of manure, there are practically absent modern capital storages of manure. There are cases of arrangement of storages of manure within the coastal strips of water objects, and in some cases - within the river-beds of small rivers and beams. Manure and contaminated sewage, which are concentrated here in large numbers, become the sources of contamination of atmospheric air, surface and underground waters.

The volume of household waste in the region is about 5 million cubic meters per year. The number of dumps of solid waste is 614 (on the area 4219.7 ha), which is 52% of the settlements of the region (1190). Most of dumps are a largely rural landfills, which are in poor condition and operated in violation of environmental, epidemiological and health legislation (not maintained technology storage of solid waste, drainage filtrate absent, no

protective screens), in consequence of that dumps of solid waste are one of the sources of pollution of surface and ground waters.

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2. Questionnaire for Odessa region, Ukraine



Questionnaire (Qs) for data collection on water and nitrogen management in agriculture

Project Title: Transnational integrated management of water resources in agriculture for the EUropean WATER emergency control

Date: 15 December 2010

In the framework of: WP3 "Knowledge capitalization and sensitive areas maps"

Responsible Partner: Odessa National Polytechnik University, Ukraine

Introduction

This Qs has been prepared by the Aristotle University of Thessaloniki in the framework of the European-funded project EU-WATER in order to facilitate the collection of available data regarding water and nitrogen management in the designated target areas of the project. The aim of this task is to standardize the mapping process for the development of the GIS platform.

All partners are requested to fill in the Qs for their target areas. Each question is appropriately explained with added clarifications (red font) wherever necessary. Most questions are straightforward and require a short answer (yes, no, %, quantity etc.); if however, you need to elaborate any of your answers, please expand the size of the cells, as needed.

General

- 1 Date
- 2 Partner name
- 3 Country
- 4 Name of the target area
- 5 Total area (km²)
- 6 Population
- 7 Number of cities/towns/villages
- 8 Population density (no. / km²)

15 Dec. 2010
ONPU
Ukraine
Odessa region
33,310
2,392,200
7/45/1127
71.8 pers./sq. km.

Production sectors

- 1 Main production sectors (in terms both of income generation and people employed).

Please mark the right answer below; if possible, provide percentages of a total of 100%

	Income, mln UAH	Percent	People employed, thous. pers.	Percent
Agriculture	6,747.08	6.83	179.9	16.86
Mining	34.00	0.03	0.3	0.03
Manufacture	34,393.52	34.83	148.1	13.88
Forestry	36.92	0.04	1.5	0.14
Energy	3,280.88	3.32	7.1	0.67
Tourism	124.50	0.13	3.3	0.31
Services	50,147.00	50.78	506.6	47.47
other (medicine, education, public administration)	3,985.10	4.04	220.4	20.65
TOTAL	98,749.00	100.00	1,067.2	100.00

- 2 Main agricultural products

Please mark the right answer below; if possible, provide quantities (tonnes)

	mark	quantity (thousand tonnes)
Cereals	X	3,681.5
Fruits	X	68.1
Vegetables	X	486.4
Sunflower	X	313.3
Potato	X	201.1
Sugar beets	X	25.0
Dairy products	X	35.0
Oil	X	147.6
Wine	X	59.8
other		

thousand m³

- 3 Livestock heads

Please give numbers of livestock heads

	System	Thousand heads
Cattle	in pasture	187

	stabled	n/a
Pigs	in pasture	283.4
	stabled	n/a
Birds	stabled	5408.6
Sheep and goats	in pasture	387.8
	stabled	

Economic data of the target area

1 Percentage (%) contribution of the target area in the total Gross National Product (GNP) of the country

4.6

2 Unemployment rate
Please mark the right answer

0-5%	<input checked="" type="checkbox"/>
5-10%	<input type="checkbox"/>
10-15%	<input type="checkbox"/>
>15%	<input type="checkbox"/>

3 Employment by economic sector
Please give approximate percentage of employees occupied in the most important production sectors of the area (especially in agriculture)

Economic sector	%
Agriculture	16.86
Industry	9.92
Commerce, hotel and restaurant business	23.49
Transport and communications	11.47
Real estate	6.56
Building	4.65
Education	8.87
Health-care system	6.65
Other	11.52
Total	100.00

- 4 Average income
Please give average income in the most important sectors (especially for farmers)

Economic sector	€/month
Agriculture	83
Industry	174
Commerce, hotel and restaurant business	114
Transport and communications	244
Real estate	157
Building	133
Education	136
Health-care system	121

- 5 Is there a development plan for the area?
Please mark the right answer

Yes	No	Comment (if necessary)
X		The development strategy of Odessa region has few indicators which can be measured; this is its imperfection

- 6 Total percentage of enterprises that receive EU grants for agricultural production (i.e. CMO, CAP, Rural Development Program)

%	Comment (if necessary)
n/a	

Legislation

- 1 Are there any protective sites within the target area? (Places of natural interest, Natura 2000 sites, National Parks, natural heritage areas etc.)

Yes	No	Comment (if necessary)

X		Biosphere reserve "Danubian" Regional landscape parks: 1. "Izmail islands" 2. "Tiligul" 3. "Tuzla firth" Partial reserve - 33 items Nature sanctuary - 57 items Wildlife sanctuary - 4 items
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2 Is the WFD in operation?

Yes	No
	X

3 Have management zones (based on river basins) been developed in the framework on WFD?

Yes	No
	X

4 Are there any designated "nitrate-vulnerable zones" (NVZs) in the target area?

Yes	No
	X

Climate and meteorology

1 Meteorological stations

Do you have data from meteorological stations (number, coordinates, datasheets)? If no, please answer Qs 2-7 below.

Yes	No
X	

2 Average Temperature of summer growing season (May to October)

3 Average Temperature of growing season (November to April)

4 Average Precipitation of growing season (May to October)

5 Average Precipitation of growing season (November to April)

Value	Unit
17.6	°C
2.7	°C
226	mm
238	mm

For Odessa HMO weather station

- 6 Average Reference Crop Evapotranspiration of summer period (May to October)
- 7 Average Reference Crop Evapotranspiration of winter period (November to April)

543	mm
171	mm

Land use

- 1 Land use. Please provide percentage of the total area.

	%
Artificial surfaces	3.8
Agricultural areas	79.9
Forest and semi-natural areas	6.7
Wetlands	2.2
Water bodies	6.4
TOTAL	100

Bogs and boggy lands

Crops Data

- 1 Crops / Irrigation / Fertilization. Please fill in the table for the main crops

Crop	Rice	Wheat	Maize	Sunflower	Potato	Vegetables	Fruits
Area (ha)	2,300	537,800	112,500	234,800	36,200	30,000	11,600
Irrigation method (ex. drip irrigation)	basin flood	sprinkler	sprinkler	sprinkler	sprinkler	sprinkler	furrow
Origin of irrigation water (surface water or groundwater or both)	surface water	surface water	surface water	surface water	surface water	surface water	surface water
Irrigation amount (mm) and number of applications	190 mm on average, 2 applications						
Average crop factor of the growing season for the calculation of evapotranspiration	1.10	0.80	0.82	0.78	0.83	0.84	0.70
Nitrogen fertilization rates and type (kg/ha) and methods (basal, surface and number of applications)	surface method, 1-2 applications						
Total nitrogen uptake (kg/ha)	56.5 kg/ha on average						
Crop cycles (summer or winter or both)	summer	both	summer	summer	summer	summer	summer
Plow depth for every crop (cm)	22	22	22	22	22	22	22
Average yield (kg/ha)	4,250	3,320	3,210	1,350	5,560	16,260	6,540

Cost of fertilizers and pesticides (€/ha) 8-21 €/ha on average

2 Irrigation water pricing method

Please mark the right answer

- Method A: Cost per ha for every crop (e.g. consumption is not considered)
- Method B: Consumption-based pricing (e.g. type of crop is not considered)
- Method C: Both consumption and type of crop are considered
- Other (please describe)

0.025-0.15 €/m³

Cost of irrigation water

3

Please give cost of irrigation water for each of the aboved methods

	Crop	Rice	Wheat	Maize	etc	etc.
Method A (€/ha for every crop; multiple values)						
Method B (€/cm ³ ; single value)		48-285 €/ha				
	Crop	Rice	Wheat	Maize	etc	etc.
Method C (€/cm ³ /crop)						
Other method						

Pollution sources

1 Point sources

Please mark the point sources identified in the target area

- Urban wastes (hospital, hotel, garage, car repair etc.)
- Pit active or filled up with various waste types or abandoned used as inert wastes dump
- Abandoned waste fields
- Industrial wastes
- Cattle breeding wastes
- Fuel storage tanks (Petrol or gas station)
- other (please add)

2 Non-point sources

Please mark the non-point sources identified in the target

area

Agricultural practices (spreading of fertilisers and pesticides)	X
Surge of sea water	
Storage and disposal of manure	X
Stockpiling of materials	
Road salting	X
other (please add)	

Nitrogen

1 Are there any practices in order to limit leaching during the wet seasons?

Please mark the right answer

crop rotations	X
soil winter cover	
catch crops	
other (please describe)	

2 Are there any "buffer" natural areas (ex. non-fertilised grass strips and hedges) along watercourses and ditches?

Yes	No	Comment (if necessary)
	X	

3 Is fertilization applied in inclined or bare surfaces without incorporation in the soil?

Yes	No
X	

4 Is fertilization applied in periods where the climatic conditions favour soil water saturation or frosted soil or snow cover? (rainy periods or very cold periods)

Yes	No	Comment (if necessary)
X		

5 Which is the dose of nitrogen in the manure applied in the region?

Please mark the right answer

0-50 kg N/ha

50-100 kg N/ha	<input checked="" type="checkbox"/>
100-150 kg N/ha	<input type="checkbox"/>
>150 kg N/ha	<input type="checkbox"/>

6 Surface fertilization is applied at once or in doses?

Once	Doses	Comment (if necessary)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>

7 Is fertilization applied in regions close to water bodies (lakes, rivers, drainage ditches)? **Please note that minimum restricted distance from water body is 2m, while in case of slopy areas the distance is proportionate to the % of slope (e.g. the maximum distance of fertilization for areas with 5% slope is 5m from water bodies)**

Yes	No	Comment (if necessary)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>

8 Is there any disposal sources of treated sludge in region closer than 50 m from water bodies?

Yes	No	Comment (if necessary)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>

9 Which irrigation method is applied in slopy areas (>6%)?
Please mark the right answer

Drip irrigation	<input type="checkbox"/>
Irrigation ditches in hill areas which have been flattened	<input type="checkbox"/>
Sprinkler irrigation	<input checked="" type="checkbox"/>

10 Do manure and soil analysis take place in the target area? If yes, how often?

Yes	No	If yes, how often?
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="text"/>

11 Are there any Fertilization Plans in place?

Yes	No	Comment (if necessary)
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="text"/>

12 Have specific limits been set for the application of livestock manure?

Yes	No	Comment (if necessary)
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="text"/>

13 Is there sufficient manure storage?

Yes	No
	X

14 Have cost-efficiency studies on preventive measures on nitrates been carried out in the target area?

Yes	No
	X

15 Are there any rivers and lakes that show eutrophication symptoms or bring high nitrogen fluxes to coastal water and sea?

Yes	No	Comment (if necessary)
X		There are rivers that bring high nitrogen fluxes to coastal water and sea?

Water Quality

1 Methods used to collect info (ex. samples, in-situ methods etc.)

Please give the methods used for the different water bodies

	Monitoring system	Samples	In situ	None
Lakes	X	X		
Rivers	X	X		
Water wells (groundwater)		X		
Rainfall water				X
Irrigation water		X		

2 Type of data (existing data will be entered in appropriate fields in the database)

Please mark the data you have for the target area (use both tables)

	pH	Ecw	NO ₃ ,	NO ₂	NH ₄
Lakes	X		X	X	X
Rivers	X		X	X	X
Water wells (groundwater)	X		X	X	X
Rainfall water					
Irrigation water	X		X	X	X

	SAR	BOD _{5r}	COD	DO
Lakes	X	X	X	X
Rivers	X	X	X	X
Water wells (groundwater)	X	X	X	X
Rainfall water				
Irrigation water	X	X	X	X

Soil properties

1 Soil Type Classes

Please give % coverage of each soil type in the total target area

	%
Light lowland soils	0.4
Medium lowland soils	5.1
Heavy lowland soils	0.0
Heavy not well drained lowland soils	0.0
Light or medium not well drained lowland soils	3.3
Light upland soils	0.0
Medium upland soils	10.3
Heavy upland soils	80.9
TOTAL	100

2 Slope of soil surface

Please give % of the whole target area

	%	% of plough-lands
0-3%	81.4	
3-7%	17.1	
>7%	1.5	
TOTAL	100	

3 Organic matter at 0-30 cm

Please give % of the whole target area

	%
0-1%	1.2
1-2.5%	2.5
>2.5%	96.3
High organic soils >20%	0.0

TOTAL 100%

4 Special characteristics

Please mark the right answer and, if yes, give % coverage of the whole target area

	Yes	No	%
Salinity problems (EC _s at saturation > 2 mS/cm)	X		2.7
Sodicity problems (Exchangable Sodium Percentage ESP > 15)	X		2.6
Acidity problems (pH < 4.5-5.0)		X	0.2
Erosion problems	X		48.0
Calcareous soils (Ca and Mg Carbonates > 10%)			

GIS data (existing data will be entered in appropriate fields in the GIS platform)

1 Digital Data. Do you have digital data of the following elements?

	Yes	No
Digital Elevation Model (raster) or Digital contours (polylines)	X	
Digital boundaries of the study area (polylines or polygons)	X	
Digital data for hydrographic network (polylines)	X	
Digital data for water bodies i.e. lakes, acquifers (polygons)	X	
Digital data for water wells (points)		X
Digital data of water table (points or polylines)	X	
Digital data for land use (polygons)	X	
Digital data for irrigation network? (polylines)	X	
Digital data for water reservoirs or dums (points or polygons)	X	
Digital data for protected areas (polygons)		X
Digital data of point pollution sources (points or polygons)		X
Digital data for pathogen regions (Salinity, Acidity, erosion or other toxic pollutants) (polygons)		X
Digital data with soil type classes (polygon)	X	
Digital data for water quality (points or other)		X