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# STATE AND WAYS OF ENHANCING THE WATER SUPPLY OF THE SOUTHERN REGION OF UKRAINE BY USING THE WATER RESOURCES OF THE DANUBE RIVER

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*The current state of water supply in the south of Ukraine with local and transit water resources, the forecast territorial and sectorial imbalance between their availability and need for them, as well as expediency and possibility of increasing water availability of the population and sectors of the economy water security of the region through the use of the waters of the Danube River are considered.*

***Key words:*** *water security, water resources, water supply, irrigation, groundwater, surface water, river runoff, structure of water use, typization*

**Formulation of the problem.** Water resources belong to a strategic, vital natural resource, which is of particular importance for the development of society. They are one of the natural components of the socio-economic development of the regions, providing all spheres of human life and economic activity, identifying opportunities for the development of industry and agriculture, the location of places of residence and rest, preservation and consistency of natural ecosystems, etc. The importance and priority of the water resources supply problem is also related to security aspects both at the national level and within individual regions.

The growing shortage of high-quality water supplies for drinking water supply, meeting the needs of various sectors of the economy, including agriculture, leads to increased attention of scientists to the problems of the use, protection and reproduction of water resources [1-12].

Against the backdrop of regional manifestations of global climate change with an increase in its aridity, the problem of providing the population and sectors of the economy with high-quality water resources, especially in the southern region of Ukraine (Odesa, Mykolayiv, Kherson, Zaporizhzhya regions and the Autonomous Republic of Crimea), is characterized by a predominantly low self-sufficiency ( local) water resources, a significant deterioration in the quality of water in the main sources of water supply and a significant need for water.

This is largely due to the restoration and sustainable development of irrigation. The growth of the role of irrigated land in solving the problem of transforming Ukraine into a world leader in food production, including through the planned government by the country, is an increase in grain production associated with both the increase in the efficiency of their use and the subsequent increase in the area of irrigated lands. The latter, taking into account the tendency to increase the water requirements of agricultural crops grown now in irrigated lands, will require the attraction of additional water resources to increase water availability of existing irrigation systems and the construction of new ones.

According to the preliminary expert estimates of IWPLR NAAS [13,14], the solution of the problem of reliable drinking water supply, water provision of industrial facilities, agricultural production, including the further development of irrigation in the south of Ukraine, primarily in Odesa and, in part, in the Mykolaiv regions, is possible due to the waters of the Danube River. The necessity to work out the question of the expediency of attracting water resources of the Danube River to improve water supply in the southern regions of Ukraine was also emphasized by the decision of the National Security and Defense Council of Ukraine dated April 25, 2013 «On the state of implementation of the decision of the National Security and Defense Council of Ukraine dated February 27, 2009 «On the state of the state water safety and provision of population with quality drinking water in settlements of Ukraine», enacted by the Decree of the President of Ukraine No. 350/2013 dated June 25, 2013.

**The purpose of the research** is to substantiate the possibility of increasing the water supply of the southern region of Ukraine by attracting water resources from the Danube River. The research methodology is based on system analysis and generalization of information, application of cartographic and comparative methods.

**Research results.** The research and systematic analysis of the level of water availability of individual regions, the nature and degree

of natural provision of their available water resources, taking into account the qualitative state of the latter, with the subsequent territorial differentiation of available water resources, the peculiarities of their use and the possibilities of restoration or spatial (basin, regional) redistribution, that in the regional dimension the southern regions and the ARC are the least secured with their own freshwater resources in the state. This is connected, first of all, with their confinement, mainly to the steppe zone, which is characterized by a small amount of precipitation and increased evaporation, especially in the dry steppe subzone, relatively small number of small rivers, many of which are dries.

Data on the resources of the river flows in the southern region in the middle-long and in different years (Table 1) indicate a rather low level of provision of the regions of this region with local water resources. At the same time, the difference between the average annual values of the local river runoff in general is insignificant, and for very shallow water years water availability in separate regions differs by more than twenty times.

The resources of the average annual total river runoff vary from 0.91 km$^3$/year in the ARC to 54.4 km$^3$ / year in the Kherson region. At the same time, the most equipped with the total resources of the river flow in the region in the basin of the Dnieper River, which according to the volume of local drainage are quite low-income. Thus, the Kherson region is the least secured among all regions in terms of water resources of local drainage, while the total resources of the river flow, on the contrary, are the most secured in the country. In most regions, the flow of transit river flows significantly exceeds local resources: from 6 times (Mykolaiv region) to 350 times (Kherson region). The exception is the ARC, where there is no natural influx due to its borders.

In addition, it should be noted that the lower part of the Danube River is located in the extreme south-west of Odessa region, with an average of 123 km$^3$ of water per year in the Kilia Mud (mouth), and 95.5 km$^3$ in a very shallow water year [7]. The Danube River, which can be drawn to use in Ukraine, is, according to the calculations of the water balance, 30-35 km$^3$ [15]. At present, the Danube has a relatively limited use in Ukraine only in Odesa region.

Objective indicators of the natural maintenance of the territory by water resources are the amount of total and local river runoff per 1 km$^2$ of area and the volume of local and total resources per inhabitant (specific water availability). Data characterizing the specific supply of water resources of the river runoff of the southern region are shown in Table 2.

With an average supply of Ukraine's local long-term river runoff of about 90.0 thousand m$^3$/km$^2$ for the southern regions, the calculated value of this indicator is 4.9-33.7 thousand m$^3$/year per 1 km$^2$. In a very shallow year, the provision of local river runoff of 1 km$^2$ of the area is reduced to 0.7-15.9 thousand m$^3$, and according to updated data on runoff values [16] does not exceed 0.32 thousand m$^3$ (Kherson region) – 8.89 thousand m$^3$ (ARC).

More significant are the differences in the values of the specific water supply of 1 km$^2$ of the area with average annual total river runoff (average value for Ukraine about 150 thousand m$^3$/year): from 33.7 thousand m$^3$/year for the ARC to almost 1950.0 thousand m$^3$/year for Zaporozhye region.

**1. Water resources of the river flow of the southern region of Ukraine**

| Region | Water resources in different by water content years, km$^3$/year | | | | | |
|---|---|---|---|---|---|---|
| | Long-term annual average | | Low water | | Extremely low water | |
| | local | total | local | total | local | total |
| ARC | 0,91<br>0,91 | 0,91<br>0,91 | 0,65<br>0,53 | 0,65<br>0,53 | 0,43<br>0,24 | 0,43<br>0,24 |
| Zaporizhzhya | 0,62<br>- | 53,0<br>54,0 | 0,30<br>0,44 | 42,8<br>41,6 | 0,13<br>0,23 | 33,1<br>30,0 |
| Mykolaiv | 0,57<br>- | 4,0<br>4,14 | 0,33<br>0,23 | 2,78<br>2,72 | 0,16<br>0,08 | 1,71<br>1,61 |
| Odesa | 0,35<br>- | 12,9<br>12,8 | 0,17<br>0,25 | 10,1<br>9,45 | 0,076<br>0,12 | 7,41<br>6,70 |
| Khersonska | 0,14<br>- | 54,4<br>54,5 | 0,06<br>0,07 | 42,8<br>41,7 | 0,02<br>0,009 | 32,0<br>30,0 |

**Notes:** 1. In the numerator value is given by the data [15], in the denominator – according to the updated assessment [16].
2. The value of the runoff for Odesa region is given except the waters of the Danube River.

**2. Specific water supply of the southern region of Ukraine**

| Region (administrative region, autonomous republic) | The population as of 01.01.2016, thousand people | Provision of river runoff for 1 person, ths m³/year1) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Long-term annual average year | | Low water year | | Extremely low water year | |
| | | local | total | local | total | local | total |
| ARC | 2354,52 | 0,38<br>0,38 | 0,38<br>0,38 | 0,28<br>0,22 | 0,28<br>0,22 | 0,18<br>0,10 | 0,18<br>0,10 |
| Zaporizhzhya | 1753,6 | 0,35<br>- | 30,22<br>30,79 | 0,17<br>0,25 | 24,40<br>23,72 | 0,07<br>0,13 | 18,88<br>17,11 |
| Mykolaiv | 1158,2 | 0,49<br>- | 3,45<br>3,57 | 0,28<br>0,20 | 2,40<br>2,35 | 0,14<br>0,07 | 1,48<br>1,39 |
| Odesa | 2390,3 | 0,15<br>- | 5,40<br>5,35 | 0,07<br>0,10 | 4,22<br>3,95 | 0,03<br>0,05 | 3,10<br>2,80 |
| Kherson | 1062,4 | 0,13<br>- | 51,20<br>51,30 | 0,06<br>0,07 | 40,29<br>39,25 | 0,02<br>0,01 | 30,12<br>28,24 |

**Notes:** 1. In the numerator value is given by the data [15], in the denominator – according to the updated assessment [16].
2. As of 01.04.2014

According to the size of the specific population provision with local water resources (0.13-0.49 thousand m³ per inhabitant in the average per year), all regions are characterized by the classification of the UN Economic Commission for Europe (ECE) as catastrophically low water supplied ones (less than 1 thousand m³/year per person). In very shallow years per capita, from 20-30 m³/year (Kherson, Odessa regions) to 140-180 m³/year (Mykolaiv region, ARC) own water resources. At the same time, the presence of a tendency towards a permanent reduction of the population living in the southern regions does not significantly affect the improvement of the situation with regard to the provision of its life with local water resources.

The specific security of the total resources of the river runoff within the regions ranges from 0.4 to 51.2 thousand m³ per capita in the average per year water and from 0.2 to 30.1 thousand m³ per inhabitant – in a very shallow water year.

Thus, the southern region of Ukraine is characterized by catastrophically low local water resources supply of river runoff per capita and different security (from catastrophically low to high) – for the total resources of river runoff.

It is necessary to note the territorial heterogeneity of the provision of surface water and within certain areas. Thus, the least secure surface local water resources are the districts located in the southern part of the Mykolayiv, Odesa, Kherson regions and in the northern and central parts of the Plain Crimea, where the average multi-year flow of the rivers is less than 0.2 l/s per km². The northern and central parts of the Odessa region are characterized by limited water supplies, while the south and west, which tend to the Dniester and Danube rivers, have significant water supplies. The same applies to the Zaporozhye and Kherson regions, where the most secure rivers are adjacent to the Dnipro River and the Kakhovka Reservoir.

Water resources of the river runoff differ not only in quantity but also in quality. For surface waters of southern Ukraine, in most cases zonally characteristic is naturally high content of water dissolved in salts (mineralization). Lower values of surface water mineralization are observed in the Dnipro river basin, the highest (above 1,5-2,0 g/dm³) – in the rivers of the Azov Sea and the Black Sea.

In addition, monitoring data on surface water and quality of irrigation water maintained by the water management organizations of the State Agency of Water Supply of Ukraine and other environmental monitoring entities show that in significant areas in all regions, their pollution is negatively influenced by the quality of surface water, resulting in a deterioration of the possibility of using these water, in particular for drinking water supply, irrigation of lands, etc.

The total resource potential of groundwater, that is, their predicted resources (GPR) in the south of Ukraine, is 3.28 km³/year, or 9000.6 thousand m³/day, including mineralization to 1.5 g/dm³ – 2.73 km³/year, or 7473.6 thousand m³/day. The total explored groundwater exploitation reserves (EGER) now amount to 1.09 km³/year (2987.8 thousand m³/day), or 32.2% of the GPR [17].

In administrative terms, most of the GPR (more than 55%) are concentrated in Kherson region, where per capita accounted for 4.68 m³/day or 1.7 thousand m³/year, while the smallest in

Odesa region with specific provision of GPR 0.3 $m^3$/day per one resident.

The largest number of explored and approved EGER is located in the ARC and Kherson region, with the highest percentage of research of GPR (over 90%), while in Zaporizhzhya, Mykolayiv, Kherson regions, the propriateness of GPR is not more than 19%.

Underground water in the southern regions, in its quality, in large areas, does not meet the norms for water supply sources, which is related both to the natural conditions of their formation, and to the anthropogenic pollution, as well as to the depletion of groundwater. In recent years, in each of the southern regions, there are 10 to 40 main foci of groundwater pollution.

The results of generalization of data on the availability of surface and underground waters of different quality in the southern regions of Ukraine, their specific values (per unit area and one inhabitant), distribution of their use by separate industries and directions became the basis for identifying certain types of availability of water resources and state of water use.

By the nature of the natural supply of local and general water resources (Fig. 1), the ARC, Mykolayiv, and Odessa regions can be attributed to the poorly supplied, and Zaporizhzhya and Kherson – to sufficiently water-dependent. Given the differentiation of availability of water resources, which are formed directly in the region, and their total quantity taking into account the flow of transit waters, the following subtypes of water availability are distinguished: catastrophically low in terms of local and total water resources; catastrophically low in local and moderate (intermediate – according to the UNECE classification) for total water resources; catastrophically low in local and high in total water resources.

The first of the subtypes is characteristic for the ARC, where the resources of both surface and underground waters are insignificant, and the inflow from other regions by the river network is absent. The second subtype includes Mykolayiv and Odessa regions, if you do not take into account the transit flow of the Danube River. Otherwise, Odessa region, as well as Kherson and Zaporozhye regions, belongs to the third subtype.

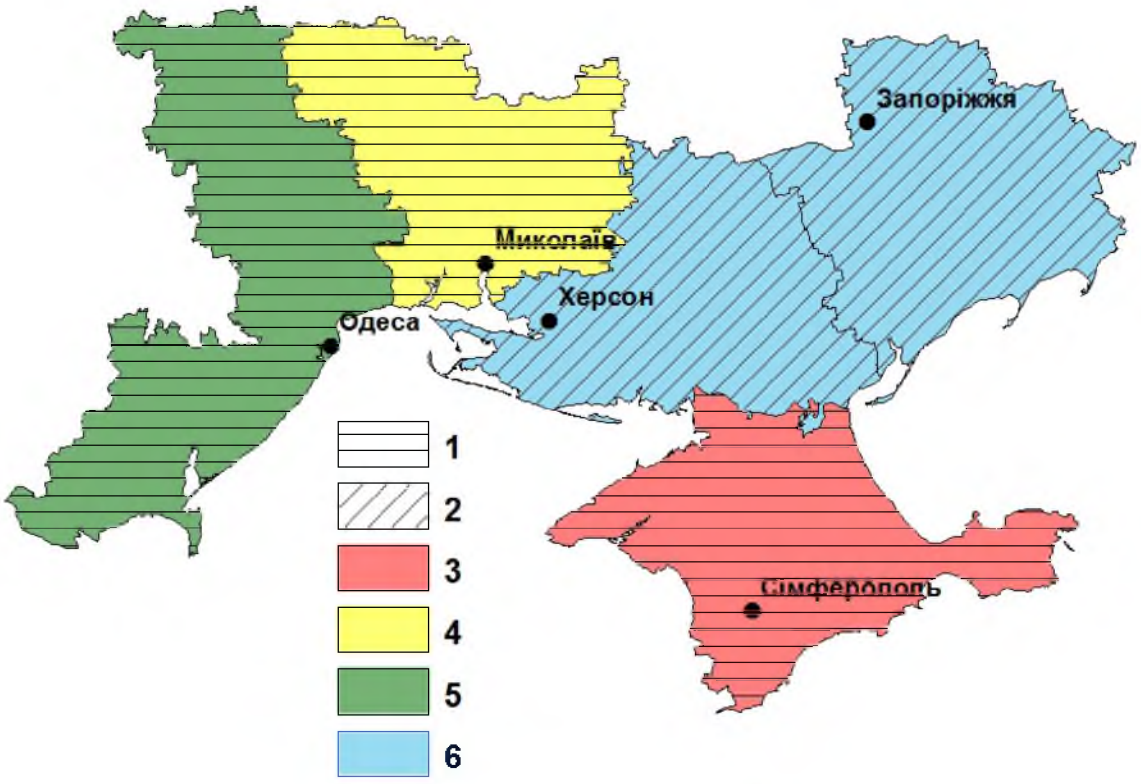


**Fig. 1. Typing of the southern region of Ukraine in terms of water resources:**
*1.2 – general provision: 1-poorly supplied; 2-enough water supply; 3-6 – differentiated security: 3-catastrophically low in local and total water resources; 4 is catastrophically low in local and moderate in terms of total water resources; 5- catastrophically low in the local and moderate (except the Danube River) and high (from the Danube River) in total water resources; 6- catastrophically low in local and high in total water resources*

The results of typing testify to the general low supply of all regions with their own water resources, the need for attracting to the use of transit waters, including their redistribution within a certain region or river basin, as well as the need for transfer from another region, the basin in the absence of inflow of water from the outside (in the ARC).

The structure of modern water use in a regional section is characterized by the following types: predominant use of water for production needs (characteristic of Zaporizhzhya, industrialized area); the predominant use of irrigation (Kherson region and the ARC-to its annexation of Russia), as well as mixed use, in particular, for the economic, drinking and production needs and irrigation (Odesa and Mykolaiv regions).

The estimation of disproportion in the system of water use, performed by comparing the natural water resource potential and the needs of the industries and population in separate territorial units, indicates a significant imbalance in the demand for water (current volumes of water abstraction) and the availability of own water resources in all southern regions. The high level of water use intensity on the indicator of the disproportion of the latter (from excessive to catastrophic) indicates the need to attract significant amounts of additional resources of transit flow for water needs of the population and sectors of the economy.

The problem of providing water to the southern region was largely solved by accumulating the Dnipro River water in reservoirs, first of all Kakhovsky, with subsequent transportation by channels and water pipes: North-Crimean, Main Kakhovsky, Dnipro-Ingulets, and others. Thus, the security of the Crimea, Kherson, Zaporozhye and Mykolaiv regions was raised several times. However, in recent decades, due to the economic crisis and certain social changes, water consumption has declined significantly, especially in industry and agriculture. However, this situation in the strategic plan can be considered, with some assumption, temporary.

The current state of actual water supply in the southern region is characterized by the use of mainly surface water sources, whose state is constantly deteriorating, the presence of a significant number of settlements, inhabitants of which use imported or well water, which is rather vulnerable to pollution, that is, low levels of access to drinking water.

The study of the level of prospective water availability in the region needs to be determined by water demand for a certain time perspective, opportunities and ways of their satisfaction. The justification of the needs of the administrative units of the region in water resources should be based on forecast data on their socioeconomic development, taking into account climate change and the need for Ukraine to fulfill its commitment to achieve the so-called water sustainable development goal, primarily in terms of ensuring universal access to safe drinking water.

It should be noted that regional manifestations of climate change have led to a significant increase in the deficit of natural moisture supply and, as a consequence, the dryness of the climate in the southern regions of Ukraine. As a result, dry land in the Kherson region and the ARC is 8 years out of 10, and in Odesa, Mykolaiv and Zaporozhye regions every second year [18]. The increase in the deficit of water supply leads to the need to increase irrigation areas in the south of Ukraine, and the threat of reducing river runoff can lead to a significant risk of implementing this technological process of cultivating crops on irrigated lands.

Current trends in water use suggest that the growth of water needs in the southern regions will be due, first of all, to the need to provide population with quality drinking water, the prospect of renewal and development of irrigation. An analysis of the current state of use of irrigation and the possibility of transforming Ukraine into a global food donor, which is impossible without the growth of the role of irrigated agriculture, suggests that the expansion of the area of irrigated land for the growth of norms of water demand for crops [18-20] requires the attraction of additional water resources to increase water availability of available irrigation systems and ensuring the functioning of new ones.

Estimation of possible volumes of selection of total renewable water resources within individual regions without a threat to the environmental and resource intensity of the water regime (low level 10-20%, permissible – up to 30%) indicates a significant shortage of own and total water resources in the ARC, which was covered by the account of the supply of Dnipro water by the North-Crimean channel, as well as the possibility of tensions in the Mykolayiv and Odessa region in the event of an increase in water sampling, and for a very shallow water years, the practical existence of such tensions ( Table 3).

Taking into account the natural water supply, as well as the existing water management and reclamation complex, created in the Kherson and Zaporizhzhia regions, it can be argued that sufficiently large amounts of surface waters, primarily the Dnipro river, accumulate in the Kakhovka Reservoir, from which can be supplied by a

**3. Deficiency of water resources and sources of its coverage**

| Region (administrative region, autonomous republic) | Total water resources, km³/year | | Ecologically maximum permissible water withdrawal, km³/year *) | | Current demand in water (average withdrawal from water bodies), km³/ year | The source of water deficit covering |
|---|---|---|---|---|---|---|
| | Long-term annual average | Extremely low water year | Long-term annual average | Extremely low water year | | |
| Крим | 0,91 | 0,43 | 0,18/0,27 | 0,10/0,13 | 1,7 | NCC |
| Запорізька | 53,41 | 33,51 | 10,7/16,0 | 6,7/10,0 | 1,5 | |
| Миколаївська | 4,6 | 2,31 | 0,92/1,38 | 0,46/0,70 | 0,4 | Dnieper River |
| Одеська | 13,00 | 7,50 | 2,60/3,90 | 1,50/2,25 | 1,5 | Danube River Danube River |
| Херсонська | 55,00 | 32,60 | 11,0/16,50 | 6,52/9,80 | 1,5 | |

**Note.** *) At the rate of 20% (numerator) and 30% (denominator) of renewable resources.

network of channels to irrigation systems these areas and to satisfy the household's drinking needs, and provide an opportunity to provide an acceptable level of actual water supply for irrigated areas by 225.0 and 140.0 thousand hectares Accordingly, the mainly in the area of the NCC and MKC as provided [18].

In determining the necessary volumes of water resources for Odesa and Mykolayiv regions, first of all, the needs of the population in drinking water and sanitary requirements should be taken into account; in the second place, agricultural water supply as a guarantor of food security of the country and its separate regions should be considered as a priority.

Currently, commercial water supply of large settlements of Odessa region is carried out using water pipes from surface sources. The vast majority of other settlements receive water from underground sources. In more than 160 settlements, inhabitants use imported water, that is, they practically do not have access to quality drinking water, according to the UN definition of water and sanitation rights.

In Mykolayiv region, water supplies from five cities, including the regional center, are carried out from surface sources (the Dnieper, Southern Bug, Ingul, and Sinyuk rivers). The majority of rural settlements and district centers of the region for drinking needs consume groundwater, some of them use imported water.

Based on the number of existing population of regions, incl. urban and rural, which is (as of 01.01.2016), respectively 790.6 and 367.6 thousand people. (Mykolaiv region) and 1597.0 and 792.9 thousand people. (Odesa region), as well as the tendency to reduce it, the need for water for household drinking water supply, taking into account specific norms of water consumption, will be approximately 100.0 and 210.0 million m³/year at current values of 35.0 and 100.0 million m³, respectively. Relatively low volumes of water use for drinking and household purposes, with a tendency for their further reduction, are obviously related to the lack of availability (including economic) of water of appropriate quality for the majority of the population, although this is one of the objectives of the Protocol on Water and Health to the United Nations Economic Commission for Europe Convention on the Protection and Use of Transboundary Watercourses and International Lakes and the Sustainable Development Goal № 6 to ensure universal equality of access to safe and inexpensive drinking water in odes for all [21].

In our view, the main growth in water demand in the medium term may be due, first of all, to the restoration and development of irrigation both in Odessa and in Mykolaiv region, which, in particular, provides a corresponding concept [18] and conceptual approaches that is the basis of the Strategy for the restoration and development of irrigation systems in Ukraine, which is currently under development with the support of the World Bank.

The Concept [18] for irrigation rehabilitation and development is to increase the area of irrigation in the Odessa region by approximately 100 thousand hectares, and in Mykolayivska (without the Ingulets irrigation system) – by 40 thousand hectares. According to the Concept

for the Development of Micro-irrigation in Ukraine by 2020 [22], the projected areas of drip irrigation of crops by 2020 may amount to 40.0-50.0 thousand hectares in Odessa region and 24.0-30.0 thousand tons. ha in Mykolaiv region at present about 15,0 thousand hectares and 8,0 thousand hectares, respectively.

Currently, there is a certain tendency to increase the area of rice crops due to the presence of significant demand for this crop production, both now and in the future. Consequently, we can assume that the area of rice on existing systems is not less than 5.0 thousand hectares. In addition, according to experts' estimates of the specialists of the Rice Institute of the National Academy of Sciences, the expediency and significant prospects for growing rice on subsoil drip irrigation in the areas of not less than 50,000 hectares in the southern regions, in particular, in Odessa and Mykolaivska, are worthwhile. Thus, we can focus on the construction of drip irrigation systems for rice up to 30,000 hectares in each of these areas. It should be noted that the need to increase the area of rice is connected, among other things, with the loss of a significant part of them in connection with the annexation of the ARC to Russia.

Taking into account the water requirements of different crops for irrigation by sprinkling and for drip irrigation [19, 20], as well as the cultivation of rice as flooding, and for the droplet method, the required volume of water to serve on irrigated land can be roughly estimated to be about 1000 million cubic meters (Odessa area) and about 600 million $m^3$ (Mykolayiv region), of which 750.0 and 500.0 million $m^3$ respectively are used for additional irrigation areas. Thus, for the restoration and development of irrigation in the Odesa and Mykolaiv regions, taking into account water losses during transportation, at least 1900 million cubic meters of water from sources outside the Dnipro River is required.

Taking into account the priority of providing the population of Odessa and Mykolaiv regions, including those who use imported water, high quality drinking water, poor quality of most groundwater in the region, it is expedient to attract additional water resources for irrigation, in our opinion, using the waters of the Danube River whose average annual flow is at the apex of the delta (Reni), about 200.0 km and about 125.0 $km^3$ along the Kilia mouth (Izmail), and the drainage of the shallow water is almost 130.0 $km^3$ and 95.0 $km^3$, respectively. The capture of a fraction of this water will make it possible to fully provide this region.

At the same time it should be noted that the improvement of water supply of the population of the southwestern region of Odessa region, where the resources of groundwater of drinking quality are either insignificant or absent, can also be achieved through the use of significant resources of drinking groundwater of the aquifer in the alluvial deposits of the Danube River, which requires the commissioning of the explored Danube deposits (Reni district). This requires significant capital investments, so the solution of this issue is possible only at the state level.

In our opinion, it would be desirable for the Danube water to provide the southwestern lowland areas of the Odessa region for the restoration and development of so-called small (local) irrigation, first of all dripping. In this case, the expediency and feasibility of such projects, as well as technical solutions for the supply of water from the Danube River, should be coordinated with the opportunity to ensure the return on incurred costs and acceptable water costs. Water supply to the existing irrigation systems of the area can be carried out by closed large water pipelines.

Taking into account the previous experience of developing a project for the construction of the Danube-Dnepr water management complex and its partial implementation [23-25], the final decision on the possibility of transferring the Danube River drainage to the less-favored regions, given the technical difficulties of implementing such a project, in particular regarding the methods of transportation and accumulation of water, taking into account also the ambiguity of the impact of such a large-scale event on the state of the environment, the transboundary status of the Danube River Basin, only after a lengthy comprehensive complex x research on ecological, social and feasibility study and discussion by its public.

**Conclusions.** One of the ways of solving the problem of providing the population and sectors of the economy, first of all, with agricultural, accessible water of the necessary quality and a radical improvement of the water and ecological situation in the southern region of Ukraine, in particular in Odessa region, in the conditions of the increase of arid climate, depletion and pollution of local water bodies is the involvement in the use of the Danube River.

Obligatory measures for the implementation of the idea of ecologically safe and economically expedient supply of Danube water for irrigation of fields and water supply in settlements of different regions of Odessa and, possibly, Mykolaiv regions should be such:

- detailed assessment of the availability and needs of water resources of rayons, communities,

etc. taking into account real prospects of development of irrigation, livestock breeding, poultry farming, etc.;

- conducting complex scientific researches on the possible consequences of the transfer of part of the Danube river runoff, transformation of its quality, etc .;

- development of the Water Supply Scheme (Scheme) for improving the water supply of certain areas of Odessa region by the waters of the Danube River;

- development of the appropriate feasibility study, its coordination with local communities, environmental organizations;

- coordination of proposed measures, such as infrastructure projects, with the Danube river basin management plan.

The proposed measures are not exhaustive and can be supplemented and specified, and their realization under the current economic conditions is a rather difficult task, but only a gradual increase in the volumes of water resources in the Danube River, including through the use of groundwater in the Danube deposit, will allow in the future to create favorable conditions for the life of the population, efficient use of land, improve the water-ecological and social situation in the southern region of Ukraine.

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**М.И. Ромащенко, А.Н. Шевченко, С.Н. Лютницкий**

**Состояние и пути повышения водообеспеченности южного региона Украины водными ресурсами реки Дунай**

*Рассмотрены современный уровень обеспеченности юга Украины местными и транзитными водными ресурсами, прогнозный территориальный и отраслевой дисбаланс между их наличием и потребностью, а также целесообразность и возможность повышения водообеспеченности населения и отраслей экономики, водной безопасности региона путем использования вод реки Дунай.*

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**Стан і шляхи підвищення водозабезпечення південного регіону України водними ресурсами річки Дунай**

*Розглянуто сучасний рівень забезпеченості півдня України місцевими і транзитними водними ресурсами, прогнозний територіальний і галузевий дисбаланс між їх наявністю і потребою, а також доцільність і можливість підвищення водозабезпеченості населення і галузей економіки, водної безпеки регіону шляхом використання вод річки Дунай.*