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**Water resources of Ukraine: assessment based on the FAO AQUASTAT database***V. K. Khilchevskyi (Taras Shevchenko National University of Kyiv)***SUMMARY**

The purpose of the study is assess the water resources of Ukraine for the first time on the basis of the database of the international organization of the United Nations (FAO), which integrates information on water resources in all countries of the world. In this study, statistically processed materials of the global information system FAO AQUASTAT for the period 1988-2017 were used.

The following results were obtained for Ukraine: internal renewable water resources are - 55.1 km<sup>3</sup>; total renewable water resources - 175.3 km<sup>3</sup>. In terms of total renewable water resources per person (3964 m<sup>3</sup>/year/person), as of 2017, Ukraine ranked 27th among 50 European countries. In terms of internal renewable water resources per person (1246 m<sup>3</sup>/year/person), Ukraine ranked 37th in Europe.

Almost all figures for individual components of water resources in Ukraine, which are given in FAO AQUASTAT, differ to a certain extent from those in Ukrainian publications. This methodological problem should be paid special attention to by Ukrainian specialists.



## Introduction

When we talk about water resources, we mean any of the entire range of natural waters that occur on the Earth, regardless of their state (i.e., vapor, liquid, or solid) and that are of potential use to humans and that are life media. Among them the most valuable is freshwater containing less than 1,000 mg/dm<sup>3</sup> of dissolved solids. In some countries, water with more than 500 mg/dm<sup>3</sup> dissolved solids is already considered unacceptable for drinking and for many industrial applications. Human water usage refers to use in agriculture, industry, energy production, and households (drinking water), and also fishing, recreation, or transportation (Khil'chevskiy, 1994; Khilchevskiy et al., 2020).

In terms of water resources management, a distinction should be made between renewable and nonrenewable freshwater resources. Renewable freshwater resources are those resources replenished by average annual natural river flow. Nonrenewable water resources are represented by groundwater bodies (deep aquifers) that have a negligible rate of renewal on a human time scale. In addition, freshwater is distributed very unevenly on the Earth, and therefore most such water is inaccessible for any use.

According to the Water Code of Ukraine (1995), water resources are the volumes of surface, ground and sea waters of the corresponding territory (Water Code, 1995). In practice, both in Ukraine and in many countries of the world, the concept of "water resources" is interpreted in a narrower sense - these are fresh surface and underground waters that are in water bodies and are used or can be used by humans. Information about the water resources of Ukraine appears in many works of Ukrainian authors (Stashuk et al., 2014; Khvesyuk, 2016; Khvesyuk, Levkovska, 2019; Obukhov, 2019). Information is also available in sources of international organizations. For example, data for Ukraine can be found in the Country Comparison: Total Renewable Water Resources section of the CIA World Factbook, which is issued in the United States (The World Factbook, 2017). The most voluminous and detailed information on water is concentrated in the database of the Food and Agriculture Organization of the United Nations (FAO) - AQUASTAT. AQUASTAT is the FAO global information system on water resources and agricultural water management. FAO deals with the problem of water resources because 69% of the world's water is used in agriculture, 19% - in industry, 12% - domestic (household) water use (Khilchevskiy, Karamushka, 2021).

## Materials and research methods

*The purpose of the study* is to assess the water resources of Ukraine for the first time on the basis of the database of the international organization of the United Nations (FAO), which integrates information on water resources in all countries of the world.

In this study, statistically processed materials of the global information system FAO AQUASTAT for the period 1988-2017 were used, on the basis of which the results were obtained for Ukraine (FAO, 2017). Development and Management Service of the UN's Food and Agricultural Organization (FAO) initiated in 1993 AQUASTAT, the organization's information system on water and agriculture. (Eliasson et al., 2005).

## Results

The modern quantitative characteristics of surface water bodies on the territory of Ukraine are shown in Table 1.

The AQUASTAT database receives information on water resources from specialized government organizations around the world (reports, publications, official websites), as well as from information bases of other UN agencies or international organizations. Ukraine received full membership in the FAO in 2003, but before that it regularly submitted statistical data as a member of the UN.

The Water Resources section of the FAO Global Water Information System contains about 1998-2002; 2003-2007; 2008-2012; 2013-2017. We processed the database information and made samples for 1992,



2002, 2012, 2017 on water resources in Ukraine. 40 indicators. The database contains the average values of indicators for the periods of years: 1988-1992; 1993-1997;

**Table 1** Number of surface water bodies on the territory of Ukraine; source: own elaboration

| Water body | Number | Note  |
|------------|--------|---|
| Rivers     | 63,119 | Large (> 50,000 km <sup>2</sup> ) - 8 rivers: Dnipro, Dniester, Danube, Desna, Pripjat, Southern Bug, Siverskyi Donets, Tisa. Medium (2,000-50,000 km <sup>2</sup> ) - 82 rivers. Small (< 2,000 km <sup>2</sup> ) - 63,029 rivers (99.87%)   |
| Lakes      | 20,000 | Very large (> 100 km <sup>2</sup> ) - 1 lake: Yalpus. Large (10-100 km <sup>2</sup> ) - 21 lakes; medium (1-10 km <sup>2</sup> ) - 70 lakes. Small (0.5-1.0 km <sup>2</sup> ) and very small (<0.5 km <sup>2</sup> ) – all other lakes (99.54%)                                       |
| Reservoirs | 1,054  | Very large (10-50 km <sup>3</sup> ) and large (1.0-10 km <sup>3</sup> ) - 0.7%: 6 reservoirs on the Dnieper river and one reservoir on the Dniester river. Medium (0.1-1.0 km <sup>3</sup> ) - 1.0%, small (0.01-0.1 km <sup>3</sup> ) - 8.4%, small (<0.01 km <sup>3</sup> ) - 89.9% |
| Ponds      | 50,793 | Very large and large - 13%; medium - 29%; small and very small - 58%  |

The following indicators were selected from the FAO AQUASTAT section "Water resources": precipitation; internal river flow; internal groundwater; groundwater hydraulically connected with river flow; internal groundwater available for use; internal renewable water resources; internal renewable water resources per person; river flow entering the country from outside (from the territory of Russia, Belarus); total flow of the transboundary Danube River; accounted inflow of the transboundary Danube River; taken into account the total inflow from outside; river runoff from Ukraine to other countries; total renewable surface water; general renewable water resources; dependency ratio; total renewable water resources per person; total volume of reservoirs; the volume of reservoirs for 1 person. According to the FAO AQUASTAT global information system, the following distribution of water resources is observed in Ukraine (Table 2).

**Table 2** Characteristics of the average annual indicators of renewable water resources in Ukraine based on data from the global information system FAO AQUASTAT, 2017

| Type of water resources | Separate components of water resources    | Volume, km <sup>3</sup> | Note  |
|-------------------------|---|-------------------------|---|
| Surface water           | Internal river runoff                     | 50.1                    |   |
|                         | External river runoff (inflow to Ukraine) | 120.2                   | From Russia and Belarus - 36.1 km <sup>3</sup><br>From Romania - 84.1 km <sup>3</sup> , (50% of the flow of the Kiliya arm of the Danube) |
|                         | Total river runoff                        | 170.3                   |   |
|                         | River runoff outside Ukraine              | 28.9                    | To Poland, Slovakia, Hungary, Romania, Moldova  |
| Groundwater             | Forecast resources                        | 22                      | Of these, 17 km <sup>3</sup> are hydraulically connected with river runoff  |
|                         | Available for use                         | 5.0                     |   |
| Inland water resources  | Surface and groundwater                   | 55.1                    | For 1 person: 1246 m <sup>3</sup> /person /year   |
| Shared water resources  | Surface and groundwater                   | 175.3                   | For 1 person: 3964 m <sup>3</sup> /person /year   |

*Surface water resources:*

- internal surface water resources or local river runoff, which is formed on the territory of Ukraine - 50.1 km<sup>3</sup>/year;



- inflow from adjacent territories - 120.2 km<sup>3</sup>/year (36.1 km<sup>3</sup>/year - from Russia and Belarus, 84.1 km<sup>3</sup>/year - from Romania);
- total surface water resources are: 50.1 + 120.2 = 170.3 km<sup>3</sup>/year.

*Groundwater resources:*

- internal predicted underground water resources - 22.0 km<sup>3</sup>/year, of which 17 km<sup>3</sup>/year are hydraulically connected with river runoff, therefore, they cannot be extracted;
- underground water resources available for use - 5.0 km<sup>3</sup>/year.

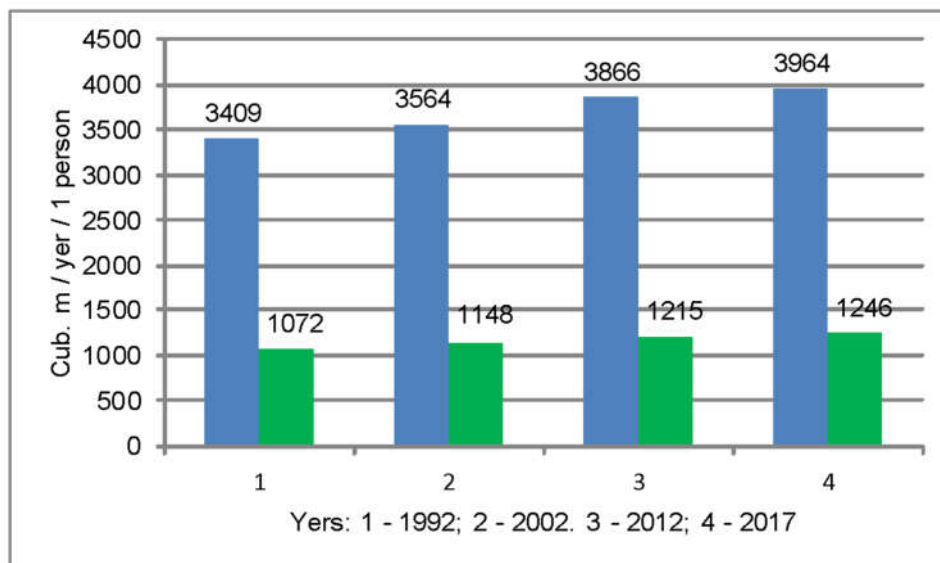
*Renewable water resources of Ukraine (surface water together with groundwater):*

- internal renewable water resources: 50.1 + 5.0 = 55.1 km<sup>3</sup>/year;
- total renewable water resources: 170.3 + 5.0 = 175.3 km<sup>3</sup>/year.

*Water availability per person:*

- internal renewable water resources - 1246 m<sup>3</sup>/person /year;
- the total visible water resources in Ukraine - 3964 m<sup>3</sup>/person /year.

The dynamics of the availability of water resources per person over a certain period of years is directly related to the dynamics of the population in Ukraine. Figure 1 shows an upward trend in indicators of total and internal renewable water resources during 1992-2017. Thus, the indicator of inland water resources is growing from 1072 m<sup>3</sup>/person /year in 1992 to 1246 m<sup>3</sup>/person /year in 2017 (Figure 1). Total water resources are increasing from 3409 m<sup>3</sup>/person /year in 1992 to 3964 m<sup>3</sup>/person /year. In 2017, the number of the population in Ukraine, accordingly, decreases - from 52.1 million people to 42.4 million people.



**Figure 1** Dynamics of the provision of general (blue row) and internal (green row) water resources per person in Ukraine, 1992-2017, m<sup>3</sup>/year/1 person (source: based on FAO AQUASTAT data).

The processing of data from the global information system FAO AQUASTAT made it possible to rank 50 European countries in terms of the provision of total renewable water resources per person and to determine the place of Ukraine. The results are summarized in the conclusions.



### Conclusions

- 1) The performed assessment of water resources based on the database of the global information system FAO AQUASTAT showed the following results for Ukraine: internal river runoff is - 50.1 km<sup>3</sup>; inflow from adjacent territories - 120.2 km<sup>3</sup>; total river runoff - 170.3 km<sup>3</sup>; available groundwater reserves - 5.0 km<sup>3</sup>; internal renewable water resources are 55.1 km<sup>3</sup>; total renewable water resources - 175.3 km<sup>3</sup>.
- 2) In terms of total renewable water resources per person (3964 m<sup>3</sup>/year/person), as of 2017, Ukraine ranked 27th among 50 European countries.
- 3) In terms of internal renewable water resources per person (1246 m<sup>3</sup>/year/person), Ukraine ranked 37th in Europe.
- 4) In terms of total renewable water resources (175.3 km<sup>3</sup>), Ukraine ranked 6th in Europe.
- 5) In terms of the volume of internal renewable water resources (55.1 km<sup>3</sup>), Ukraine ranked 14th.
- 6) Ukraine has a high coefficient of external dependence of water resources ( $K = 66.8\%$ , of which 46.8% - dependence on river runoff from the territory of Romania, 20% - on runoff from Russia and Belarus).
- 7) Almost all figures for individual components of water resources in Ukraine, which are given in FAO AQUASTAT, differ to a certain extent from those in Ukrainian publications. This methodological problem should be paid special attention to by Ukrainian specialists.

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