

WATER RESOURCE POTENTIAL OF THE WORLD ECONOMY: PROBLEMS OF USE AND PROTECTION

A. P. Golikov,

Doctor of Geogr. Sciences, Professor,

N. A. Kazakova,

Phd (Candidate of Geogr. Sciences), Professor

V.N. Karazin National University of Kharkiv

kazakovan@ukr.net

The paper considers water–resource potential of the world economy which is suggested to be thought of as the aggregate capacity of all freshwater sources, expressed in physical terms (cubic meters, cubic kilometers), or in money terms per unit time. Water–resource potential of the world economy is limited. Fresh water resources that with reasonable cost could be involved into economic use are close to depletion. Humanity already uses 1/10 of their total volume and more than 1/4 of the objectively available volume. Whereas deadweight losses of water account for more than 1/2 of its total consumption. Population growth, the rise of the productive forces and the improvement of quality of life in developing countries will lead to increase of water consumption norms for each their inhabitant of the planet. Hence, the need for water resources will increase and the possibility of meeting them will decline. There is a danger of complete depletion of the water resource potential of the world economy in 80–90 years. There is a global water problem caused by objective (spatial disparity in the water demand and its availability) and subjective (the development of wet industries, the limited use of in–plant recycling, pollution and depletion of water sources) reasons. Water transforms from the economic category into a political, causing international conflicts. It raises a question of training of diplomats– expert in the field of water law.

Key words: water resources, water resource potential, depletion of the water resource potential, global water problem, water law

ВОДНО-РЕСУРСНЫЙ ПОТЕНЦИАЛ МИРОВОЙ ЭКОНОМИКИ: ПРОБЛЕМЫ ИСПОЛЬЗОВАНИЯ И ОХРАНЫ

Рассматривается водно-ресурсный потенциал мировой экономики, под которым предлагается понимать совокупную производительность всех источников пресной воды, выраженную в натуральных показателях (куб м, куб км), или в денежном исчислении за единицу времени. Водно-ресурсный потенциал мировой экономики ограничен. Ресурсы пресной воды, которые могли бы с приемлемыми затратами быть вовлечены в хозяйственное использование, близки к исчерпанию. Человечество уже использует 1/10 их общего объема и более 1/4 реально доступного. При этом безвозвратные потери воды составляют более 1/2 ее суммарного потребления. Рост численности населения, подъем производительных сил и улучшение качества жизни в развивающихся странах приведет к увеличению норм расхода воды на каждого жителя планеты. Следовательно, потребность в водных ресурсах будет возрастать, а возможности их удовлетворения – уменьшаться. Существует опасность полного истощения водно-ресурсного потенциала мировой экономики через 80–90 лет. Сложилась глобальная водохозяйственная проблема, обусловленная объективными (пространственная диспропорция в потребностях в воде и ее наличии) и субъективными (развитие водоемких производств, ограниченное использование замкнутых систем водоснабжения, загрязнение и истощение водных источников) причинами. Вода из экономической категории превращается в политическую, вызывая международные конфликты. Поднимается вопрос о подготовке дипломатов – специалистов в области водного права.

Ключевые слова: водные ресурсы, водно-ресурсный потенциал, глобальная водохозяйственная проблема, истощение водно-ресурсного потенциала, водное право

ВОДНО-РЕСУРСНИЙ ПОТЕНЦІАЛ СВІТОВОЇ ЕКОНОМІКИ: ПРОБЛЕМИ ВИКОРИСТАННЯ ТА ОХОРОНИ

Розглядається водно-ресурсний потенціал світової економіки, під яким пропонується розуміти сукупну продуктивність усіх джерел прісної води, виражену в натуральних показниках (куб м, куб км) або в грошовому обчисленні за одиницю часу. Водно-ресурсний потенціал світової економіки обмежений. Ресурси прісної води, які могли б з прийнятними витратами бути залучені в господарське використання, близькі до вичерпання. Людство вже використовує 1/10 їх загального обсягу і більш 1/4 реально доступного. При цьому безповоротні втрати води становлять понад 1/2 її сумарного споживання. Зростання чисельності населення, підйом продуктивних сил і поліпшення якості життя в країнах, що розвиваються, призведе до збільшення норм витрат води на кожного жителя планети. Отже, потреба у водних ресурсах буде зростати, а можливості їх задоволення – зменшуватися. Існує небезпека повного виснаження водно-ресурсного потенціалу світової економіки через 80–90 років. Склалася глобальна водогосподарська проблема, обумовлена об'єктивними (просторова диспропорція в потребах у воді і її наявності) суб'єктивними (розвиток водомістких виробництв, обмежене використання замкнутих систем водопостачання, забруднення і виснаження водних джерел) причинами. Вода з економічної категорії перетворюється в політичну, викликаючи міжнародні конфлікти. Піднімається питання про підготовку дипломатів – фахівців у галузі водного права.

Ключові слова: водні ресурси, водно-ресурсний потенціал, глобальна водогосподарська проблема, виснаження водно-ресурсного потенціалу, водне право.

Table 1

Components of the hydrosphere

Component	Water Volume		Water Exchange Activity (years)
	Thousands of cubic km	%	
World Ocean	1 338 000	96,5	2500
Groundwater including unleavened	23 400 10530	1,7 0,76	1400
Glaciers	24 000	1,7	8600
Lakes	230	0,016	20–30
Soil moisture	75	0,005	0,9
Moisture in the atmosphere	13	0,001	0,027
The volume of water in rivers	2,12	0,0002	0,067

Compiled by the author [2, 9]

Relevance of the research problem. World economy is facing numerous challenges in a globalizing world. One of them is the increasing scarcity of water resources, contributing to the global water problems. This problem among all global problems can be put on the 2nd place after the problem of "war and peace", as namely water resources determine the possibilities of development and functioning of all spheres of human activity, and its very existence on the planet.

Until the middle of the XX century it was believed that the water reserves in the world are practically inexhaustible, so special attention to their management and rational use, in most countries, it has not been given. However, aggravated symptoms of water shortages in arid zones of the planet, its shortage of water supply large settlements and industrial centers in its other locations, a marked decrease in river flow with incipient shallowing and drying of large bodies of water of the world have forced humanity to reconsider their views on water resources of the Earth and their use. From the inexhaustible "free good nature" water has become a factor limiting the development of the national economies of many countries, and pre-existing regional water problems were transformed into a worldwide problem, representing now a serious threat to human life and activity. Began to emerge international conflicts for the right management of water resources and their use. Evidence of this are the events taking place in our time in the Middle East. Water began to acquire not only an economic, but also political importance.

Above provisions indicate the relevance of the topic in the scientific and practical aspects.

The purpose of the work is to conduct a comprehensive study of the state of the water resources of the world economy, the possible limits of its use, as well as measures to regulate its use and protection.

To achieve the outlined goals the following targets have been set:

- to conduct a quantitative and qualitative assessment of the current water – resource potential of the world economy;
- to implement spatial analysis features of its location and security of the countries and peoples of the world;
- to justify the need for the consideration of water management as a specific sector of the world economy, the functioning of which is acquiring a global character;
- to consider ways that increase the wise use of water resources potential in terms of increasing the symptoms of the struggle for water, possession and management of its resources.

Water–resource potential of the world economy.

It is more than enough water on the planet. The total volume of the hydrosphere of the planet is about 1,458 – 10 6 km³ [2].

The largest amount of water is concentrated in the oceans. In addition, much of it is in gaseous form in the atmosphere, as well as in the solid state of polar ice in the Arctic, Greenland, Antarctica, glaciers, mountain ranges on the continents of the world (see Table 1).

With regard to fresh water, ie, substances, which are essential for human existence on Earth, there are just 2.7% of the total water resources of the planet [2]. More than half of the volume is in the polar caps and the earth virtually unavailable for use. Therefore, only a small part of the water resources of the planet at the present stage of technological development can be used directly in the production of material and spiritual wealth of society. These include surface runoff water (rivers, lakes), freshwater aquifers, glaciers and mountain ranges that feed the river. In other words, water human right to consider sources of fresh water available for the management and economic use, now or in the foreseeable future. This can be attributed to the natural water – resource potential of the modern world economy.

Water – resource potential (WRP) of the world economy can be understood as the aggregate performance of all fresh water sources (surface runoff, groundwater horizons of ice masses of mountain ranges), expressed in physical terms (cubic meters cubic kilometers), or in monetary terms (through their use value) per unit of time (day, year). The main component of the WRP and the source of meeting the needs of mankind in the fresh water have been and remain the river bed of water, the share of which in the hydrosphere system is extremely low. According to specialists and the total river flow is only 2100 cubic km [5]. Such a large number of fresh water even now would not be enough for human life, if it did not exist a natural circulation. However, due to the fact that the duration of the conditional the hydrologic cycle of the rivers, according to experts, an average of 16 days, during the year the volume of water in them is renewed on average 23 times. Therefore, the resources of river flow, ie, their real WRP natural calculation can be quantified in the 48 thous. cubic km / year. This amount can be characterized as "water rations" of the world economy. However, there need some reservations, because more than half of fluvial water flows into the seas and oceans, so the actual use of the resources available for such treatment, according to scientists, does not exceed 15 thous. cubic km [5].

Besides the fact that the WRP of global economy is limited, placing its components on a global cross – section is very uneven, with largely inversely proportional to the needs of the main water consumer – population and its economic activities (Table 2).

Table 2

Water–resource potential and the population of the Earth's continents

Continents	Water–resource potential, cubic km / year	Population, million people
Asia	13200	4366
South America	9600	418
North America	6400	566
Europe	6200	742
Africa	4000	1201
Australia and Oceania	1600	39

Compiled by the author according to sources [11,16].

Calculated using the formula Pearson correlation coefficient presents

$$r = \frac{\sum_{i=1}^n (X_i - \bar{X}) * (Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^n (X_i - \bar{X})^2 * \sum_{i=1}^n (Y_i - \bar{Y})^2}}$$

where X – WRP, Y – population, relationship between these components was found to be 0,74 ($r = 0,74$) in the context of the planet's continents. This relatively large value. The reason for this situation, as shown in Figure 1, is the presence of significant spatial distortions between population and water – resource potential in the context of the planet's continents.

The most difficult situation with respect to the natural water supply is the population of Asia and Africa. Here one person accounts for nearly half of water resources compared with the average of the specific water availability of the world population. In the context of each of the continents, in turn, there is also significant differentiation in providing WRP. At the same time there are areas that suffer from an excess of it.

Among all the countries in the world has the largest Brazil WRP. It is followed by: Russia, Canada, China, Indonesia, the United States, Bangladesh, India, Venezuela, Myanmar (Figure 2).

Correlation analysis of the relationship between population and natural water availability of their inhabitants, made by us in the context of 10 countries with the largest fresh water resources, has shown its complete absence ($r = -0,07292$). A similar situation can be detected in other countries environment.

In addition to the unequal distribution of the world's water resources in the spatial aspect of the case and the irregularity of their distribution in time. In particular, in the middle latitudes of the northern and southern hemispheres of the planet up to 50 – 70% of the annual river flow falls on the short spring period. The main part of water consumption – in the summertime.

Water management as a specific sector of the world economy. Throughout its history, humanity on a large scale water management carried out work related to the implementation of water supply of settlements, industrial centers, irrigation construction, transport and hydroelectric development of rivers, regulation and redistribution of river flow. This resulted in a specific sphere of its activity in the form of water management, acquiring currently in force the internationalization of production processes, global.

Unfortunately, a common approach to the definition of "water management, does not exist in the scientific literature. According to Kritsky and Menkelyu water management is a set of measures aimed at the study, recording, conservation and use of water resources for the needs of the country, as well as to fight the damage is caused to the national economy destructive actions of water [8, p.157]. Zuzik, Tichotsky [7, p.177], Yavorovsky [14, c.99] consider water management as a branch of the national economy, responsible for reviewing, considering, planning, integrated water resources management, protection of surface water. Such an interpretation of this concept is given in Bolshaya Encyclopedia, where water management is considered as a sector of the economy concerned with the study, taking into account, planning, integrated water resources management, protection of surface and groundwater from pollution and depletion and transporting them to their destination (consumption) [4, s.234] Levkovsky and Padun define water management as a set of sectors of the economy (water users), who use the water [9, p.272].

Water management is considered in another way in foreign sources. In particular, in the Anglo – Saxon terminology, the closest to his understanding – "Water resource management is the activity of planning, developing, distributing and managing the optimum use of water resources", ie planning activities, development, distribution and management of the optimal use of water resources. At the UN website "water management" has a somewhat broader interpretation. Its definition includes resource management, water supply and to maintain a balance between supply and demand. From this is derived the concept: "Integrated water resources management" which are the integrated efforts of various institutions for water management [15].

In our opinion, the above definition is somewhat simplified view of the water sector. From a scientific point of view, it is probably not a sector of the economy, and not "integrated efforts of various institutions for water management" and, in accordance with the set theory is a specific, cross – cutting sector (sphere) of the economy as a set of different types of primary activities, secondary and tertiary areas of management, based on the use of water resources. In this sector include water supply, sewerage (with cleaning and disposal of waste), irrigation, drainage, hydropower, water transport, freshwater fishing, water recreation, which are its terms (Fig. 3).

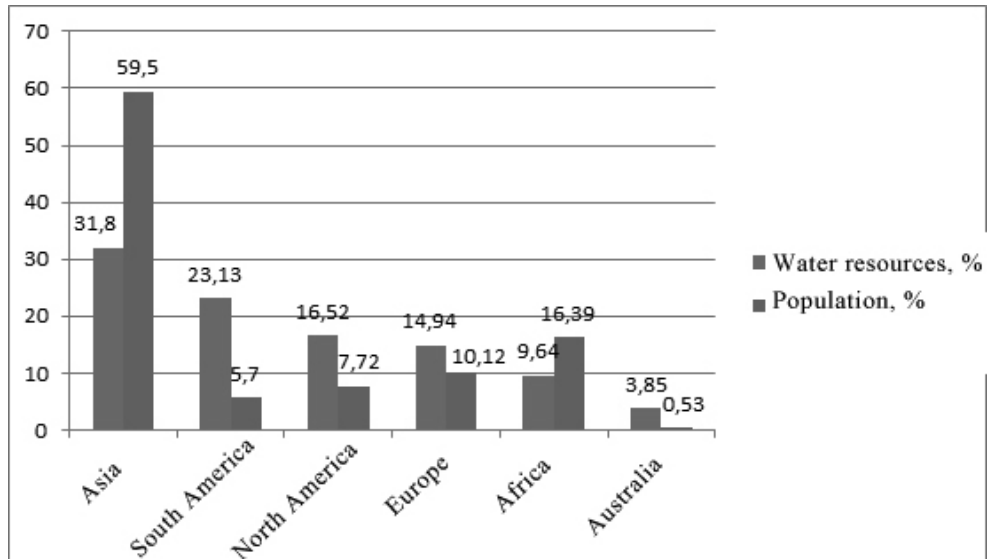


Fig. 1. The disparity in the nature and placement of the WRP and population by continents of the planet
Compiled by the author [11, 16]

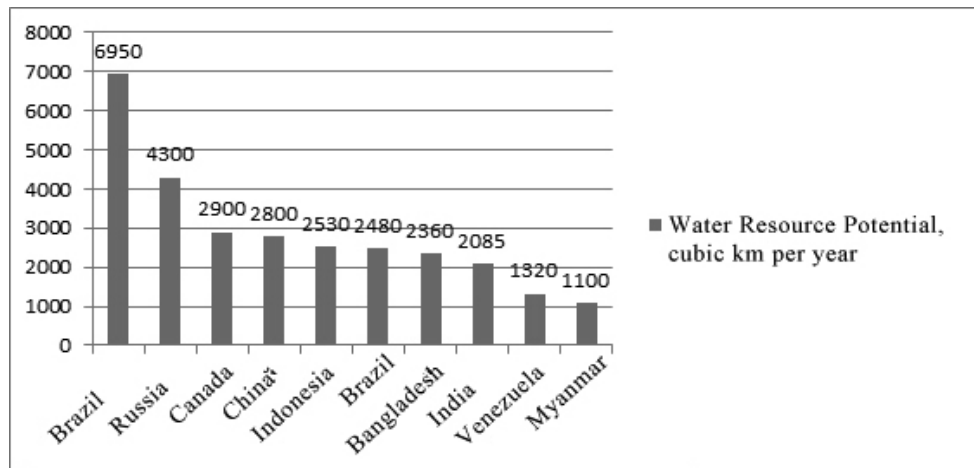


Fig. 2. Countries with the largest water–resource potential
Compiled by the author [2.11]

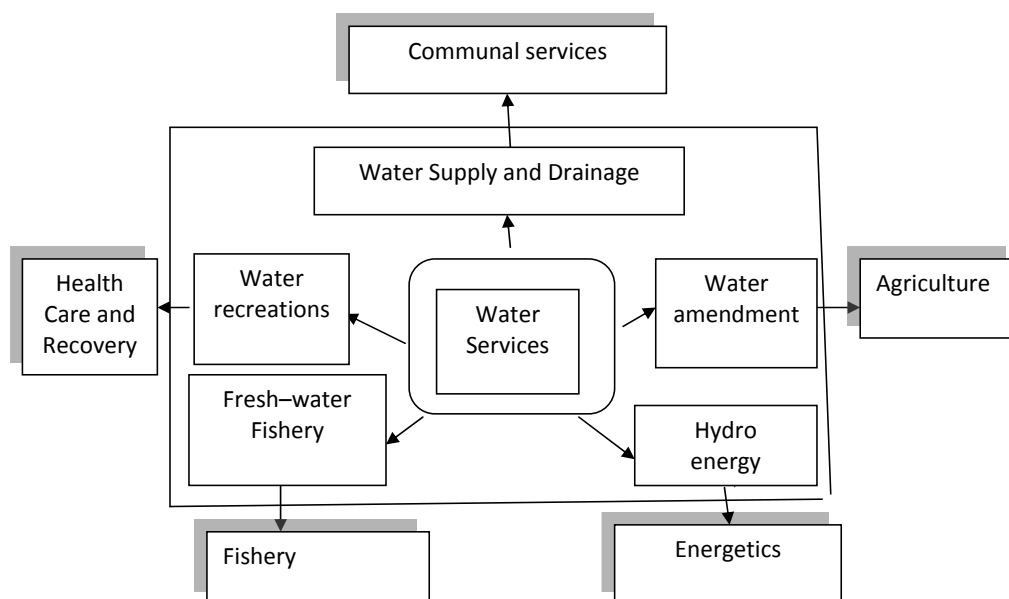


Fig. 3. Water management and its components
Compiled by the author

In accordance with the theory, all the components of the water sector of the economy (in today's conventional presentation – water industry) have a common manufacturing base (water sources with a variety of hydraulic structures), their unique production process for regulation and management regime of water resources to ensure the continuity of their use in economic activity. The end result of the latter is prepared to use various kinds of water, which can be considered products of water conservancy [13, p.54]

To some extent, the water sources are the kind of economic activity integrator for various sectors of national economies, causing the emergence and development of complex water management structures in the form of water management systems.

The water complex is a set of interrelated uses of water resources in the interests of economic entities of the national economies, based in its functioning and development on a particular water source.

Among its participants, there are complex interactions, sometimes pursuing opposite goals (Fig. 4).

In line with the scale, the inner connectedness, HHC structure through the use of a water source can form water management districts, creating an appropriate system of spatial organization of water management regional, national and transnational levels. There is a significant amount of water management zoning definitions. In our view, most fully reveals its essence

VP Zakharov and SI Chokina that water management under the regionalization offer to understand "... the identification, delineation and classification of objectively existing territorial – water systems, which are characterized by common use of water sources, water management specialization and domestic production constraints" [6, p.14]

Based on the understanding of water management zoning of the above, it is possible to make the definition of "water management area". The water district – a complex territorial water management education interrelated forms of economic use of water resources and occupies a certain position in the spatial organization of water management.

Geographically, the water management area coincides with the area occupied by the base water source is surface water or groundwater, ie river or, in the case of the lack of river flow, artesian basin of a State. Since in some cases the river and artesian basins in the territory of several countries, water management districts may acquire the status of international. In this case, water is determined by the mode of inter – state agreements.

Based on the predominant purpose of use of water resources within the water management districts can develop a certain specialization – irrigated agriculture, freshwater fish farming, hydropower, and so on.

Specialization tier may be determined using the formula:

<table border="1" style="display: inline-table; vertical-align: middle;"> <tr><td>1</td><td>2</td><td>3</td></tr> <tr><td>4</td><td>5</td><td>6</td></tr> </table>	1	2	3	4	5	6	Irrigation	Water supply			Hydro Energy	Water transport	Fishery	Water recreations
	1	2	3											
4	5	6												
Communal	Industrial	Agricultural												
Irrigation	■	■	■	■	■	■	■	■						
Communal water supply	■	■	■	■	■	■	■	■						
Industrial water supply	■	■	■	■	■	■	■	■						
Agricultural water supply	■	■	■	■	■	■	■	■						
Hydro Energy	■	■	■	■	■	■	■	■						
Water transport	■	■	■	■	■	■	■	■						
Fishery	■	■	■	■	■	■	■	■						
Water recreation	■	■	■	■	■	■	■	■						

Fig. 4. The ratio between the components of the water complex
 Symbols: Positive impact on: 1 – volume, 2 – mode 3 – quality; Negative: 4 – volume; 5– mode; 6 – quality.
 Compiled by the author

$$K_{\text{spec}} = \frac{p}{P} : \frac{v}{V}, \text{ where}$$

p – GDP of leading sector of water management area, using the basic water source

P – GDP of the industry in the country

V – GDP in the total area of the water – on – year

V – the country's GDP

Ways to improve stewardship in the use of water–resource potential. Water–resource potential of the world economy is used in a wide spectrum: in water supply of the population, industry and agriculture; transport communication (navigable rivers and lakes); in electricity (hydroelectric power); recreational, sporting and medicinal purposes. In addition, open waters, ie, rivers, lakes, reservoirs, in some cases serve as a water intake wastewater from numerous localities, industries, agricultural enterprises.

Global water consumption is growing very rapidly (Fig. 5).

The trend analysis of the dynamics of the global water consumption over the past 70 years indicates an accelerating growth. Suffice it to note that the total amount of water consumed in the analyzed period increased by more than 7 times, almost overtaking the growth of the world population is 2.5 times. Due to the high operating pressure on water sources is their depletion and pollution. In this regard, according to the UN, it is already almost 1.2 billion. People have no access to clean drinking water. In the future, the situation will only worsen. According to UN forecasts, universal access to relatively clean water will be able to provide: in Asia – only until 2025, in Africa – up to 2050. [12]

To characterize the state of water consumption, in addition to general quantitative indicators, it is

important to structure of water use sectors of the global economy. According to the UN currently about 70% of all water consumed is spent on agriculture, followed by industry – 20% and domestic services to the population – 10% [12] This ratio is quite understandable and natural, but from the point of view of water resources economy, according to experts, is quite profitable, especially because agriculture (especially in irrigated agriculture) has very large deadweight loss of water in the form of unproductive evaporation. Besides irrigation water is difficult to clean and re–use. This is why countries with irrigated agriculture – . Turkmenistan, Uzbekistan, Kyrgyzstan, Kazakhstan, Tajikistan, Azerbaijan, Iraq, Pakistan, Egypt, and others are characterized by the highest rates of water consumption per capita.

Water scarcity is now recognized as one of the main causes of the war in Syria, and certainly will create more conflicts and increase the number of refugees in the Middle East. While acknowledging that fresh water can no longer be considered a renewable resource, the United Nations in 2010 established the access to clean water and sanitation as human rights and included them in the goal of sustainable development of the United Nations with the consent of all 193 Member States. To ensure universal access to safe drinking water by 2030, according to World Bank estimates, will require more than \$ 1.7 trillion [3]

By 2025, according to experts the World Resources Institute, two – thirds of the world's population will live in areas with depleted water resources. The problem of water shortage is particularly acute rise in the Middle East, North Africa and Western Asia. Regional water problems Preexisting become in our time global.

One of the reasons for the global water problem is the deterioration of freshwater quality, caused by anthropogenic pollution. In the first place – is

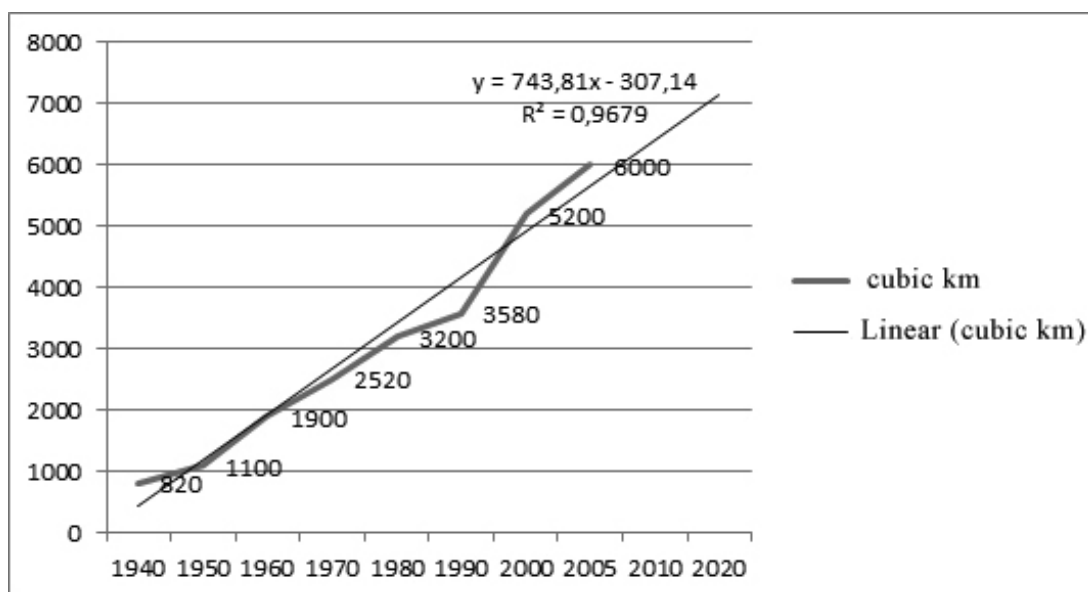


Fig. 5. Dynamics of the world's water consumption, cubic km / year
Compiled by the author according to the source: [12]

the direct discharge of untreated wastewater into surface waters. This is followed by wash various pollutants (fertilizers, pesticides, herbicides) flood and precipitation from the soil. Fall into open water and petroleum products, heavy metals, radionuclides and other ingredients.

Theoretically, water bodies have the property of self – purification. However, according to scientists, it is permissible, provided that the amount of waste dumped in them does not exceed the ratio of 1:10 ie maximum allowable concentration effluent (MPC = 1:10) [10] Unfortunately, in many cases, it is conditionally permissible MPC violated. In addition, there are toxic components that require increasing the multiplicity of their dilution in the tens and hundreds of times.

A special problem is runoff of livestock farms. Although their total volume is relatively small on a global scale, they are extremely overloaded with organic compounds, it is difficult to recover and cause particularly rapid water pollution.

Every year in the world is polluted from 12 to 17 thousands cubic km of surface water, which is about half of the available fresh water [15] . That is why, according to experts of the World Commission on Water of the United Nations (World Commission on Water), water pollution is currently serving as the main cause of water scarcity and water use volatility to the middle of the third decade of the XXI century. According to FAO forecasts, the number of people living with permanent water shortage will exceed 4 billion. [12] .

Currently, more than half of the world's major rivers are seriously depleted and polluted, degrading and poisoning the surrounding ecosystems, threatening the health and economic activities depending on their population. With population growth, economic development, especially the underdeveloped countries, the volume of water consumption and the amount of contaminated water sources will increase. With this in mind, as well as the increase in irreversible consumption is 4–5% per year, it can be assumed that by 2050 the world economy can exhaust the capabilities of its water – resource potential (Fig. 6).

Economic development of national economies is largely dependable on the skilful use of synergies. Accordingly, if the product is a deficit in their prices rise, then stimulated investment in production of these products. Unfortunately, this principle does not work practically with water scarcity, as its reproduction is ensured not so much man – made as natural processes. With increasing exploitation of the water source comes into effect the law of diminishing the effectiveness of a natural object. Supply of water from the new, distant water sources (if any), is associated with an increase in transport costs, and, consequently, a rise in price of produced material and spiritual wealth. Only one way out – higher efficiency level in the use of available natural resources potential. In reality, there are alternatives that do not.

The variety of uses of water resources, combined with the variety of sectors of the economy in need of water, raises the question of the complex, the most rational use of water through the establishment of water management systems, based on specific water sources. However, there are complex interactions among the participants of water systems, sometimes pursuing conflicting goals. Therefore, in practice, have to make the best decisions in terms of the ratio of capacity of water facilities, taking into account the maximum demand for water and protection of water sources from pollution and depletion. To do this, there is a large list of measures: building cleaning and detoxifying plants, the introduction of closed water cycles in industry, the use of drip irrigation in agricultural production, the use of treated wastewater in irrigation systems, etc., which contribute to increase the degree of protection of water sources from pollution and depletion.

A difficult water situation prevailing in many parts of the world makes it necessary to develop and implement comprehensive schemes for the rational use and protection of the water resources of the world economy. Their implementation must be preceded by a special water management zoning of the continents, in this connection, under the auspices of the UN countries in the world it is advisable to adopt an agreement

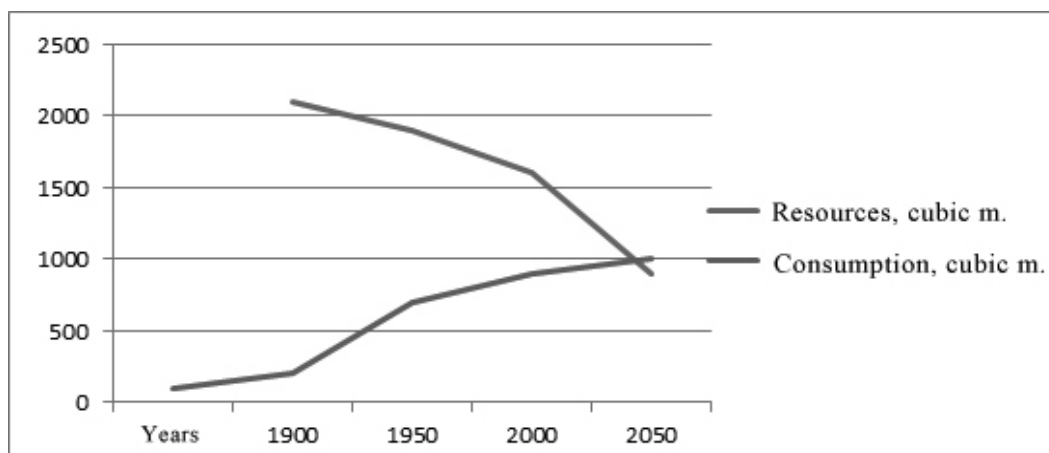


Fig. 6. Dynamics of the world's water consumption and reduction of water–resource potential opportunities
Compiled by the author [11, 12]

on water resources, similarly to the Paris climate agreement. In its framework it is necessary to facilitate the implementation of water management measures for the wise use of water resources potential, taking into account the interests of all the countries whose territory is included in the limits of a water management district.

In order to avoid possible future international conflicts for the right of peoples to own and use certain water sources (surface and underground) in a number of countries it is useful to start training diplomats in the field of water law.

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