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CURRENT STATUS OF DRINKING WATER SOURCES IN THE WORLD

AKTUALNY STAN ŹRÓDEŁ WODY PITNEJ NA ŚWIECIE

Streszczenie: Pytania dotyczące wody mają szczególne znaczenie w kontekście wyzwań środowiskowych. Możliwość eskalacji napięć między jednostkami, grupami społecznymi, państwami lub grupami państw może być nawet większa w przypadku problemów związanych z wodą niż w przypadku innych problemów środowiskowych. Zgodnie z wieloma pesymistycznymi prognoząmi w ciągu XXI wieku dochodzi do konfliktów wodnych, które mogą mieć tragiczne konsekwencje. Mimo że takie konflikty nie osiągnęły jeszcze znaczącego wymiaru regionalnego ani globalnego, nie można wykluczyć ryzyka takiego konfliktu. Celem badań jest zidentyfikowanie innych potencjalnych obszarów ryzyka, w których sytuacja wody najprawdopodobniej się pogorszy, co może skutkować groźbą przemocy, konfliktami. W tym samym czasie porównaliśmy stan odnawialnych zasobów wodnych w poszczególnych krajach świata.

Słowa kluczowe: źródła wody, woda pitna, odnawialne źródła wody

Abstract. Questions regarding the water have a specific position in the context of environmental challenges. The possibility of escalating tensions between individuals, social groups, states or groups of states may even be higher for water-related issues than with other environmental problems. According to many pessimistic forecasts in the course of the 21st century water conflicts occur, which can have tragic consequences. Even though such conflicts have not yet reached a significant regional or global dimension, the risk of such a conflict cannot be ruled out. The aim of the research is to identify other potential risk areas where the water situation will most likely worsen, which may result in a threat of violence, conflict. At the same time, we were comparing the state of renewable water resources in individual countries of the world..

Key words: water resources, drinking water, renewable water resource.

Received: 06.2018

Accepted: 08.2018

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Introduction

At present, there is approximately the same amount of water on Earth as at the time of its formation. Very simply, the number of molecules of water that our planet was "gifted" has been except for a certain negligible deviation¹, relatively constant since the beginning of its existence. These molecules in nature are still rotating and changing not only their position but also their external appearance, respectively state. Physical properties of water predetermine its dynamic character, which is manifested by water cycle, respectively water or hydrological cycle powered by solar radiation and gravity².

Since water is an indispensable component of every ecosystem on our planet, its undisturbed circulation in nature is a prerequisite for achieving equilibrium and stability, while its dynamic nature can fulfil one of its fundamental functions at the global level, which is to be the force of life on Earth. Despite the fact that disturbances and changes in the water cycle have occurred many times in the past, both locally, regionally, and globally, and due to the impact of various factors they will most likely occur also in the near or far future, changes in the total amount of water on our planet are not assumed (M. BLACK, J. KING, 2009).

Research analyse

According to majority of available data, this amount is estimated at around 1.386 billion km (I. SHIKLOMANOV, 1993, pp. 13-24). This is an approximate estimate of the water found on the Earth's surface, respectively in the uppermost part of the Earth's crust, but in the scientific community, there is an increasing awareness (on the basis of researches and experiments) that the water in certain form is located also deeper under the earth's surface, especially in the so-called Lower Mantle³, but also in the

¹ Under certain circumstances, water molecules can be washed into the universe, but this is a negligible amount.

² Over the course of 100 years, the average water molecule is 98 years in the ocean, 20 months in the form of ice, about 2 weeks in rivers and lakes and less than 1 week in the atmosphere (Annual Water Quality Report, 2011).

³ The Earth's mantle is the area of the earth's interior located between the earth's crust and the Earth's core. The top mantle extends to a depth of approximately 400 km, where the so-

transition region between the top and bottom of the mantle. Estimates of the amount of water in the Earth's interior are different, but it is not to be negligible. According to scientific findings published in the journal *Science* in 2014, the Earth's mantle could conceal up to three times more water than the oceans on the surface. At the same time, according to the authors of the study, their research suggests that this water inside the Earth is part of the so-called "whole-planetary" water cycle, and this discovery can help answer the question of how much water is on Earth (B. SCHMANDT – S. JACOBSEN – T. BECKER et. al. 2014, pp. 1265-1268).

However, it is worth noting that we still know little about the interior of the earth so that the experts can be quite sure about its composition. At the same time, the current technical possibilities do not allow this water to be examined and processed at all, and therefore this discovery has no impact on research on drinking water global problems and their impact on international relations in terms of our scientific monograph.

Of the total amount of 1.386 billion km³ of water on the Earth's surface, up to 96.5% is found in the seas and oceans, and about 0.9% belongs to the salt water, which is found especially in salt lakes, as well as in saline groundwater⁴. The remainder, just over 2.5%, or about 35 million km³, belongs to the so called fresh water, potentially suitable for meeting human needs. Of this, however, up to 69.5% occurs permanently in the solid state, i. e. in the form of ice, especially in the form of glaciers in Polar Regions or in mountainous environments, as well as in a permanent snow cover or in a frozen state in the soil, such as so called permafrost. However, the use of such permanently frozen water is currently only considered purely on theoretical level, particularly in view of technical difficulty, cost, and possible negative environmental impacts. However, it should be noted that, in order to mitigate global drinking water problems, professional circles consider the

called „transition area“ starts, and at a depth of about 650 km to 2900 km, the lower Earth's mantle is located.

⁴ The average salinity of sea water is about 3.5%, which means that 35 g of mineral substances are dissolved in 1 liter (or 1 kilogram) of water. There is no general consensus on the determination of the minimum limit for the designation of salt water, with variations in the range of 0.05% to 3%. However, it is valid that water with a salinity of less than 0,05% is considered to be sweet water, in principle suitable for consumption

possible use of these rich drinking water sources as one of the possible solutions for the future.

In order to meet human needs, about 30.5% of the total amount of fresh water is present, which is approximately 10.7 million km³. In total, it is less than 1% of all water on Earth, with the vast majority of this amount being underground water (10.53 million km³) and the rest is water in lakes (91000 km³), soil (16500 km³), atmosphere (12900 km³), marshes (11470 km³), rivers (2120 km³) and so-called biological water, i.e. water in living organisms (1120 km³)⁵. The above figures are summarized in the following table.

Table No. 1: Water distribution on Earth

	Volume [1000 km ³]	% of total water	% of the total amount of fresh water
Total water	1 385 984	100	-
Salt water		97,5	-
Sea and oceans	1 338 000	96,5	-
Salt groundwater	12 870	0,93	-
Salt lakes	85,4	0,006	-
Fresh water	35 029	2,5	100
Solid state	24 364		
Icebergs and a permanent snow cover	24 064	1,74	68,7

⁵ All figures are only approximate estimates. The initial resource for this information, which several publications devoted to this issue are based on, is GLEICK, P. H. 1993. Water in a Crisis: Guide to World Freshwater Resources.

Permafrost	300	0,022	0,86
Liquid state	10 652		
Underground water	10 530	0,76	30,1
Freshwater lakes	91	0,007	0,26
Water in the soil	16,5	0,001	0,05
Swamps	11,47	0,0008	0,03
Rivers	2,12	0,0002	0,006
Other water	14,02		
Water in the atmosphere	12,9	0,001	0,04
Biological water	1,12	0,0001	0,003

Source: custom processing based on SHIKLOMANOV, I. 1993. World fresh water resources. In GLEICK, P. H. 1993 (ed.) Water in Crisis: A Guide to the World's Freshwater Resources.

Note: The figures and percentages in this table are rounded so their sum may not be 100. The red colour highlights water resources unsuitable for human needs, orange colour highlights sources potentially suitable for consumption (subject to certain assumptions), and green sources that are currently available.

The data in the table therefore show that the total volume of water present in a global hydrological cycle in a form suitable for satisfying primary human needs (such as fresh water in the liquid state) is estimated at 10 652 000 km³. According to the most recent UN estimates lived on our planet about 7,349,472,000 people on July 1, 2015 (UN DESA. 2015).

From these two data, it is possible to calculate that one person, after rounding, accounts for approx. 0,00145 km³ of water, which is 1,450,000 m³

respectively. 1 450 000 000 litres. This is purely theoretical data, based on simple mathematical calculations. From the point of view of the real provision of the needs of individuals, it is of no practical significance, as the water in nature is constantly circulating, this mechanism is very complicated and shows significant fluctuations both in terms of time and space. It expresses, however, the present maximum permissible capacities that the amount of available water on Earth provides to people, that is, a certain imaginary boundary, the overrun of which would mean exceeding the "capacities" of our planet.

In the literature, it is possible to draw on several concepts dealing with the question of minimal amount of water necessary to ensure the basic needs of the individual as well as the overall functioning of the society, and this issue will be the subject of another part of the monograph. At this point, however, it is possible to take a value of 10,000 m³ of water per person per year, which is 145 times less than the value of 1,450,000m³ mentioned above, as the starting point of sufficient amount of water for which no major water resource management problem should occur. Consequently, in order to overcome the absolute capacity of drinking water resources in the world, the Earth's population would have to increase by 145 times, which does not even predict the most pessimistic population growth scenarios.

It follows from the above that in absolute figures there is currently enough water on Earth to meet the needs of all people, with the population of the planet far from reaching the maximum population limit in terms of the amount of water that can be potentially exploited. This, of course, does not mean that every individual can really, according to the above calculations, use the amount of water that could be available to him from the global drinking water supply. This would have been the case if the drinking water sources on Earth were evenly distributed, but this is far from being true. The unevenness of the occurrence of water is one of its basic characteristics, which has a fundamental influence on the question of the actual availability of drinking water resources to the population in individual localities, countries or regions. At the same time, when analyzing the available amount of water to meet human needs, it is necessary to take into account the dynamic element, i.e. the circulation of water in nature, or hydrological cycle.

As has been mentioned above, water is circulating in nature and constantly *"passing from one form to another and moving from ocean to land and back, under the influence of solar energy and gravity"* (I. SHIKLOMANOV, 1993, p. 15).

From the point of view of drinking water sources, is in the scope of "Water balance"⁶ most important the relationship between the amount of water that evaporates from the oceans and in the form of precipitation reaches the land and the amount of water that flows through the rivers back into the ocean. In order to maintain the sustainability of the available drinking water sources, it is crucial to maintain equilibrium between the two opposite directions of the water cycle. The total surface water flow from the land to the ocean is estimated at around 44,800 km³ per year⁷, compensated globally by the same amount of water that evaporates from the surface of the World Ocean and falls to the mainland in the form of precipitation⁸.

The water drainage has, as one component of the water, respectively hydrological balance, great importance for assessing the quantity of available drinking water because it represents a dynamic element characterizing the potential of water resources recoverability (I. SHIKLOMANOV, 1993).

The figure of 44,800 km³ is also important in view of the fact that it basically represents the total amount of water that will occur in the form of precipitation on land for one year. These precipitations are a key prerequisite for renewable water resources, as they compensate for water losses due to evaporation and runoff through rivers. At the same time, it is the total amount of water that can be, due to the functioning of the hydrological cycle, used in one year, with water being returned to the system and "re-stored"⁹.

⁶ Hydrological balance in hydrology means the sum of water in the hydrological system (most often in the river basin), which is expressed by the relationship between the inputs to this system (especially precipitation) and its outputs (so-called evapotranspiration and total drainage).

⁷ Data are different in hydrological literature, the presented data is from BLACK, M. - KING, J. 2009. *The Atlas of Water: Mapping the World's Most critical resource*.

⁸ Annually, approximately 502,800 km³ evaporates from the ocean surface, of which about 458,000 km³ falls back into salty water in the form of rainfall.

⁹ Of course, such a description is very simplified, but given the focus of this monograph, it is neither necessary nor meaningful to analyze more closely the hydrological cycle issues detailed in hydrology.

When we divide the amount of 44,800 km³ per inhabitant of the planet, we get 6096 m³ after rounding. This figure represents the amount of available renewable water resources in the form of rainfall per capita per year. Compared with the above figure of 10,000 m³ per person per year as an optimal amount of water per person per year, it is clear that, at the current state of the population on Earth, this limit is not reached. This does not mean, however, that there is not enough water on our planet for its inhabitants because, as mentioned above, the total amount of fresh water is sufficient in absolute numbers. On the other hand, most of this is found in the form of groundwater, often in large depths, they are unconventional water resources of non-renewable nature, or partly renewable, but only in the long run (B. CHELLANEY, 2013).

From a practical point of view, surface runoff is the main and most accessible renewable source of drinking water usable for securing the biological and economic needs of the population. Together with water found in soil and underground water at low depths¹⁰, it is a component of a significant indicator of water availability in a given area, which is referred to in the literature as so-called "total renewable water resources"¹¹. The advantage of this indicator is the fact that, besides the quantitative assessment of the quantity of available drinking water sources in individual areas of the Earth, it also takes into account the dynamic element that is typical for the circulation of water in nature, as a result of which is data about the availability of water resources converted to a certain time unit, usually a year.

Looking at the data on the amount of renewable water resources in individual parts of the planet, it is clear that considerable variation is already at the highest comparator level, by which we mean the continental level in this case. In addition, available quantities do not cope with demographic data on population numbers, resulting in significant differences in the per capita volume of water conversion. The comparison of these data is presented in the following table.

¹⁰ This must be distinguished from the underground water concealed at greater depths, which is also called "Fossil water" and is generally regarded as a non-renewable water source.

¹¹ This indicator is used in many analytical and statistical reports, one of the most important being the AQUASTAT database of the United Nations Organization for Agriculture and Nutrition (FAO).

Table No.2: Number of renewable water resources according to continents

Continent	Population in 2015 (mil- lions)	Renewable water resources (km ³ /year)			Renewable water re- sources per person (km ³ /year)
		Average	Max	Min	
Europe	738	2900	3410	2254	3,92
North Amer- ica	574	7890	8917	6895	23,98
Africa	1186	4050	5082	3073	3,41
Asia	4393	13510	15008	11800	3,07
South Amer- ica	418	12030	14350	10320	28,78
Australia and Oceania	39	2404	28080	1891	61,64

Source: customprocessingbased on UN DESA, 2015 data. *World Population Prospects: The 2015 Revision. Volume I: Comprehensive Tables*. and KOWALCZAK, P. 2007. *Konflikty o wodę*.

From the point of view of the research on the impact of drinking water problems on the behaviour of actors of international relations, it is undoubtedly necessary to compare the data on availability of water resources for the needs of the population at the level of the basic geopolitical unit, i.e. at the level of the state. The following tables present the most up-to-date data on the total amount of renewable water resources, the population, the amount of renewable water resources per capita, as well as the dependency ratio. This indicator shows in percentage terms the share of renewable water resources coming from behind of the country's borders. Theoretically, it can acquire values from 0 to 100%, where 0% means that the country does

not accept any water resources from the surrounding countries, that it is absolutely self-sufficient in this respect, and 100% means that the country is absolutely dependent on the inflow of water from the surrounding countries located geographically higher along the river. The extent of dependence is one of the key indicators that indicate where (or among which countries) potential conflicts of water can potentially occur.

For convenience, the individual countries are grouped in the tables according to the continents and are also colour-differentiated according to the colours of the corresponding groups, of which, given the amount of renewable water resources per inhabitant, they belong. Countries are divided into seven groups, resulting from the most commonly used water deficit indexes in professional literature.

One of such basic broadly accepted indicators is the so-called “Falkenmark water stress index”, a water stress index created by the Swedish expert on water resources, Malin Falkenmark. The basis for determining the water situation in a given country is the conversion of a quantity of renewable water resources per capita for one year, and where this is less than 1700 m^3 , the country is in the so-called “water stress”. In line with this methodology, if the value is less than 1000 m^3 , the country is experiencing water scarcity and under 500 m^3 it is an absolute water scarcity. On the other hand, if the result of the conversion is greater than 1700 m^3 , the country is in the so-called “no stress” condition (A. BROWN – M. MATLOCK, 2011).

However, given the differences in water consumption between countries and the increasing trend, the 1700 m^3 limit does not appear to be the definitive limit for determining that there is no water problem in the country. From this point of view, we also rely on further delimitation of higher limit values for assessing the state of water resources, based primarily on modifications and additions to the Falkenmark index. Due to the large number of different modified indices, we have chosen to take into account a certain compromise model, according to the Polish hydrologist Piotr Kowalczak, whereas the higher limit values are fixed numerical data of 5000 m^3 , $10\,000 \text{ m}^3$ and $100\,000 \text{ m}^3$. The resulting distribution, along with the colour resolution used in country comparisons, is presented in the following table.

Table No.3: Index of water deficits created according to M. Falkenmark and P. Kowalczak indexes

Group	Quantity	Description
1	0 – 500	absolute shortages of water
2	500 – 1000	shortages of water
3	1000 – 1700	water stress
4	1700 – 5000	possible problems with the management of water resources
5	5000 – 10 000	possible partial problems with the management of water resources
6	10 000 – 100 000	without major problems with water resource management
7	100 000+	abundant amount of water

Source: custom processing

In accordance with the above index, are in the following table's no. 4, 5, 6, 7, 8 and 9 states colour-coded according to their inclusion in one of the seven groups. Such spreadsheet provides a comprehensive view of the comparison of state of water resources at the level of States as actors of international relations.

Data on the amount of renewable water resources comes from *The World's Water: The Biennial Report on Freshwater Resources, Volume 8*, issued by the authors' team under Peter H. Gleicka and the FAO-AQUASTAT database, where the most recent estimates were taken into account. This database also includes data on the rate of dependence, i.e. the percentage of the proportion of water coming from outside the country. On the other hand, population figures come from the most recent estimates of the *UN DESA Population Division*, published in 2015 as part of the regularly updated series of documents -*World Population Prospects*. Based on the calculation

of the data obtained, it is possible to reach the key final value of the amount of renewable water per capita per year.

In some countries, we have failed to get the relevant numerical data on the amount of renewable water resources or the extent of dependence, but they are primary small island states, archipelagic states or micro-states whose position in the world political system is very weak, or negligible. This does not mean, however, that the population of these countries can not feel water problems, but absence of these data does not have a greater importance for our research.

Table no. 4: Comparison of the state of renewable water resources in the different countries of Africa

State	Renewable water resources (km ³ /year)	Number of inhabitants (thousands)	Renewable water resources per capita (m ³ /year)	Dependency (%)
Algeria	11,6	39 667	292,43	4
Angola	148,0	25 022	5914,79	0
Benin	25,8	10 880	2371,32	61
Botswana	12,2	2 262	5393,46	80
Burkina Faso	12,5	18 106	690,38	0
Burundi	12,5	11 179	1118,17	20
Cape Verde	0,3	521	575,82	0
Central African Republic	144,4	4 900	29469,39	2
Chad	43,0	14 037	3063,33	65

Comoros	1,2	788	1522,84	0
Congo	832,0	4 620	180086,58	73
Democratic Republic of Congo	1283,0	77 267	16604,76	30
Djibouti	0,3	888	337,84	0
Egypt	57,3	91 508	626,17	97
Equatorial Guinea	26,0	845	30769,23	0
Eritrea	6,3	5 228	1205,05	56
Ethiopia	122,0	99 391	1227,48	0
Gabon	164,0	1 725	95072,46	0
Gambia	8,0	1 991	4018,08	63
Ghana	53,2	27 410	1940,90	43
Guinea	226,0	12 609	17923,71	0
Guinea-Bissau	31,0	1 844	16811,28	48
Ivory Coast	81,0	22 702	3567,97	5
Kameron	285,5	23 344	12230,12	4
Kenia	30,7	46 050	666,67	33
Lesotho	3,0	2 135	1405,15	0
Liberia	232,0	4 503	51521,21	14
Libya	0,6	6 278	95,57	0
Madagascar	337,0	24 235	13905,51	0

Malawi	17,3	17 215	1004,94	7
Mali	100,0	17 600	5681,82	40
Morocco	29,0	34 378	843,56	0
Mauritania	11,4	4 068	2802,36	96
Mauritius	2,8	1 273	2199,53	0
Mozambique	217,1	27 978	7759,67	54
Namibia	17,7	2 459	7198,05	65
Niger	33,7	19 899	1693,55	90
Nigeria	286,2	182 202	1570,78	23
Rwanda	9,5	11 610	818,26	0
São Tomé and Príncipe	2,2	190	11578,95	0
Senegal	38,8	15 129	2564,61	34
Seychelles	---	96	---	0
Sierra Leone	160,0	6 453	24794,67	0
Somalia	14,2	10 787	1316,40	59
South Africa	51,4	54 490	943,29	13
South Sudan	49,5	12 340	4011,35	66
Sudan	37,8	40 235	939,48	96
Swaziland	4,5	1 287	3496,50	41
Tanzania	96,3	53 470	1801,01	13

Togo	14,7	7 305	2012,32	22
Tunis	4,6	11 254	408,74	9
Uganda	66,0	39 032	1690,92	41
Zambia	105,2	16 212	6489,02	24
Zimbabwe	20,0	15 603	1281,80	39

Source: custom processing based on research done

At first glance, it is clear from the table that the African continent is characterized by a large number of countries that are in a state of water deficit. Among the countries, Libya is the worst one, with only 95.57 m³ of water per inhabitant per year, which is about 261.8 litres of water per inhabitant per da¹².

Together with Libya, Algeria, Djibouti and Tunisia they belong to group 1 (0-500 m³ / year). For these countries it is also characteristic that they show no or very low values of the rate of dependence, at most 9% in the case of Tunisia. In the 2nd group (500-1000 m³ / year) there are 8 countries, namely Burkina Faso, Egypt, South Africa, Cape Verde, Kenya, Morocco, Rwanda and Sudan. From the point of view of the degree of dependence, the scattering of values is greater than in the case of the 1st group, with alarming data for Egypt - 97% and Sudan - 96%, which are also the absolute highest values of the rate of dependency ratio among all African countries. We can include the following 11 states in the 3rd group (1000-1700 m³): Burundi, Eritrea, Ethiopia, Comoros, Lesotho, Malawi, Niger, Nigeria, Somalia, Uganda and Zimbabwe. The highest rate of dependence is reported by Niger with 90%.

In the range of 1700 - 5000 m³, is in the 4th group, there are 12 countries: Benin, Chad, Gambia, Ghana, South Sudan, Mauritius, Mauritania, the Ivory Coast, Senegal, Swaziland, Tanzania and Togo. Although the values in

¹² 95,57 m³ = 95570 l / 365 days = 261,8356 l/day

this band do not represent a state of water shortage or water tension, these countries are still vulnerable to possible water problems, with the risk factor being particularly high levels of dependence reaching up to 96% for Mauritania. Only 5 states (5,000 to 10,000 cubic meters) include Angola, Botswana, Mali, Mozambique, Namibia and Zambia. The highest rate of Botswana dependence is as high as 80%.

Although Africa is generally considered to be the dry respectively even arid continent, up to 11 countries belonging to the 6th group (10,000 - 100,000 m³) are relatively rich in water resources. These are the following countries: Gabon, Guinea, Guinea-Bissau, Cameroon, Democratic Republic of Congo, Liberia, Madagascar, Equatorial Guinea, Sierra Leone, Central African Republic and São Tomé and Príncipe. In addition to Guinea-Bissau (48%) and the Democratic Republic of Congo (30%), these countries have a relatively low degree of dependence. The absolute richest country in terms of the amount of renewable water per inhabitant per year in Africa is the Congo, the only representative in the 7th group (100,000 m³). However, it should be remembered that up to 73% of these resources come from behind their borders, which represents a relatively high degree of dependence.

Table No. 5: Comparison of the state of renewable water resources in the individual states of North and Central America

State	Renewable water resources (km ³ /year)	Number of inhabitants (thousands)	Renewable water resources per capita (m ³ /year)	Dependency (%)
Antigua a Barbuda	0,1	92	1086,96	0
Bahamas	0,02	388	51,55	0
Barbados	0,1	284	352,11	0
Belize	18,6	359	51810,58	14

Canada	2902,0	35 940	80745,69	2
Costa Rica	112,4	4 808	23377,70	0
Cuba	38,1	11 390	3345,04	0
Dominican Republic	21,0	10 528	1994,68	0
Dominika	0,2	73	2739,73	0
Grenada	0,2	107	1869,16	0
Guatemala	111,3	16 343	6810,26	2
Haiti	14,0	10 711	1307,07	7
Honduras	95,9	8 075	11876,16	0
Jamaica	9,4	2 793	3365,56	0
Mexico	457,2	127 017	3599,52	11
Nicaragua	196,7	6 082	32341,34	4
Panama	148,0	3 929	37668,62	0
Salvador	25,2	6 127	4112,94	30
St. Kristof a Nevis	0,02	56	357,14	0
St. Lucia	0,3	185	1621,62	0
St. Vincent a Grenadines	0,1	109	917,43	0
Trinidad a Tobago	3,8	1 360	2794,12	0
United States of	3069,0	321 774	9537,75	8

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Source: Custom processing based on research done

Within the North and Central American region, according to available data, in the worst situation are the small island states, with Bahamas having the first place, with 51.55 m³ of renewable water per capita per year, or about 141 litres of water per person per day. In group 1 there are Barbados and Saint Kitts and Nevis and the 2nd group has only one representative - St. Vincent and the Grenadines. In a little better situation, in the 3rd group, are Antigua and Barbuda, Haiti and Saint Lucia. Given that, they are all island states, the rate of addiction is zero, with the exception of Haiti, for which part of the water resources come from the neighbouring Dominican Republic.¹³ This one, together with Dominica, Grenada, Jamaica, Cuba, Mexico, El Salvador and Trinidad and Tobago belongs to the 4th group. From these countries have the highest degree of dependence El Salvador, 30%, which is also the highest value across the region. The 5th group has only two representatives, namely Guatemala and the United States of America, whose rate of dependency is 2% and 8%. 6 countries, which is more than one quarter, are in the 6th group. They include Belize, Honduras, Canada, Costa Rica, Nicaragua and Panama, with Canada having the largest amount of renewable water resources in the area. The second is Belize, but with a 14% degree of dependence. There is no representative from the 7th group in this region.

Table No. 6: Comparison of Renewable Water Resources in South American States

State	Renewable water resources (km ³ /year)	Number of inhabitants (thousands)	Renewable water resources per capita (m ³ /year)	Dependency (%)
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¹³ Haiti and the Dominican Republic are two sovereign states that are located on one island called Hispaniola. Sometimes the name of the whole island is also used in Haiti, but it is necessary to distinguish it consistently from the name of one of the two state units on the island.

Argentina	814,0	43 417	18748,42	66
Bolivia	622,5	10 725	58041,96	51
Brasilia	8233,0	207 848	39610,68	34
Chile	922,0	17 948	51370,63	4
Columbia	2132,0	48 229	44205,77	1
Ecuador	424,0	16 144	26263,63	0
Guyana	241,0	767	314211,21	0
Paraguay	336,0	6 639	50610,03	72
Peru	1913,0	31 377	60968,23	16
Surinam	122,0	543	224677,72	28
Uruguay	139,0	3 432	40501,17	58
Venezuela	1233,2	31 108	39642,54	41

Source: own processing based on research done

South America we can uniquely identify as the region with the most renewable water resources per capita, and all countries can be grouped into the 6th and 7th groups according to the data, i.e. in the zone with no or only minimal drinking water problems at the national level. Because of the low population, the highest values can be seen in Guyana and Suriname, which are the only representatives in the 7th group. Other countries are in the 6th group, with Argentina having the worst results, although these values are still higher than in other parts of the world.

The specificity of South America, which may play a role as a destabilizing factor to some extent, is the interdependence of individual countries with water resources coming from neighboring countries. This reflects the relatively high numbers of dependence rates for most countries, with the exception of Ecuador, Guyana and Colombia. Paraguay has the highest rate

of dependence with 72%, followed by Argentina with 66%. At the same time, most of the water resources in the area come from the Amazon basin¹⁴, which receives the bulk of water from the rainforest area at its upper reaches, as well as from its inflows, which explains the relatively higher rate of dependence of Brazil (34%).

Table No. 7: Comparison of Renewable Water Resources in Individual States of Australia and Oceania

State	Renewable water resources (km ³ /year)	Number of inhabitants (thousands)	Renewable water resources per capita (m ³ /year)	Dependency (%)
Australia	336,1	23 969	14022,28	0
Fiji	28,6	892	32062,78	0
Kiribati	---	112	---	0
Marshall Islands	---	53	---	0
Micronesia	---	104	---	0
Nauru	---	10	---	0
NewZeeland	397,0	4 529	87657,32	0
Palau	---	21	---	0
Papua-New Guinea	801,0	7 619	105131,91	0
Samoa	---	193	---	0

¹⁴ The Amazon is also river with the world's largest flow - an average of 6930 km³ / year, which is more than 7 other rivers together, and therefore it has the largest amount of renewable water resources (GUPTA, 2008).

Solomon Islands	44,7	584	76541,10	0
Tonga	---	106	---	0
Tuvalu	---	10	---	0
Vanuatu	---	265	---	0

Source: custom processing based on research done

For Australia and Oceania, data are collected for only five out of 40 countries. Within these five states, they all report sufficient amounts of renewable water per capita for one year. Australia, Fiji, New Zealand, and Solomon Islands are included in the 6th group and Papua New Guinea belongs with its water wealth as the only representative to the 7th group. Because of their island character, these countries do not show any degree of dependence.

One of the main reasons for which data are not available for other countries is the fact that these are very small islands, which depend to a large extent mainly on the total sum of precipitations that are subject to high fluctuations and which are not yet sufficiently long-term examined. It is not excluded that the islands may have groundwater supplies, but in this case they are no longer renewable water resources. Given the high vulnerability of these countries to the effects of climate change, in particular weather fluctuations in relation to long-term average and rising ocean levels, it can be assumed that they are already struggling or, in the near future, will be struggling with drinking water problems. Threats stemming from water scarcity are likely to be fully demonstrated in these countries, but their capacity to influence the international dimension within the world political system due to their small size and the relatively low weight of their voice in foreign policy issues, is very limited.

Table No. 8: Comparison of the state of renewable water resources in individual Asian countries

State	Renewable water resources (km ³ /year)	Number of inhabitants (thousands)	Renewable water resources per capita (m ³ /year)	Dependency (%)
Afghanistan	65,3	32 527	2007,56	29
Armenia	7,8	3 018	2584,49	12
Azerbaijan	34,7	9 754	3557,51	77
Bahrain	0,1	1 377	72,62	97
Bangladesh	1227,0	160 996	7621,31	91
Bhutan	78,0	775	100645,16	0
Brunei	8,5	423	20094,56	0
China	2738,8	1 383 925	1979,01	1
Philippines	479,0	100 699	4756,75	0
Georgia	63,3	4 000	15825,00	8
India	1911,0	1 311 051	1457,61	31
Indonesia	2019,0	257 564	7838,83	0
Iraq	89,9	36 423	2468,22	61
Iran	137,5	79 109	1738,11	7
Israel	1,8	8 064	223,21	58

Japan	430,0	126 573	3397,25	0
Yemen	2,1	26 832	78,26	0
Jordan	0,9	7 595	118,50	27
Cambodia	476,1	15 578	30562,33	75
Qatar	0,1	2 235	44,74	3
Kazakhstan	107,5	17 625	6099,29	40
Kyrgyzstan	23,6	5 940	3973,06	1
Democratic People's Republic of Korea	77,1	25 155	3065,00	13
Korea	69,7	50 293	1385,88	7
Kuwait	0,02	3 892	5,14	100
Laos	333,6	6 802	49044,40	43
Lebanon	4,5	5 851	769,10	1
Malaysia	580,0	30 331	19122,35	0
Maldives	0,03	364	82,42	0
Myanmar	1168,0	53 897	21670,96	14
Mongolia	34,8	2 959	11760,73	0
Nepal	210,2	28 514	7371,82	6
Oman	1,4	4 491	311,73	0
Pakistan	247,0	188 925	1307,40	78

Palestine	0,8	4 668	171,38	3
Saudi Arabia	2,4	31 540	76,09	0
Singapore	0,6	5 604	107,07	0
United Arab Emir-ates	0,2	9 157	21,84	0
Sri Lanka	52,8	20 715	2548,88	0
Syria	16,8	18 502	908,01	72
Tadzhikistan	21,9	8 482	2581,94	17
Taiwan	67,0	23 381	2865,57	0
Thailand	438,6	67 959	6453,89	49
Turkey	211,6	78 666	2689,85	2
Turkmenistan	24,8	5 374	4614,81	97
Uzbekistan	48,9	29 893	1635,83	80
Vietnam	884,0	93 448	9459,81	59
East Timor	8,2	1 185	6919,83	0

Source: custom processing based on research made

On the Asian continent, there are countries that have the absolute smallest quantities of renewable water per capita per year within the framework of a global comparison. First place holds Kuwait, with 5.14 m³ of water per capita per year, which is only about 14 litres per person per day, with a dependency ratio of 100%, so all renewable water resources come from behind its borders. We also include 11 other countries, namely Bah-

rain, Israel, Yemen, Jordan, Qatar, Maldives, Oman, Palestine¹⁵, Saudi Arabia, Singapore and the United Arab Emirates. Among these countries, shows high degree of dependence especially Bahrain (98%) and Israel (58%). What is also significant is the fact that the vast majority of these countries are located in the Middle East region, which can be considered one of the worst regions in the world in terms of water problems. Likewise, two states of the 2nd group, namely Lebanon and Syria, are located in this region, with Syria showing a relatively high degree of dependence at 72%. On the other hand, the third group includes four countries, none of which are part of the Middle East. They are in particular, India, Korea, Pakistan and Uzbekistan, of which the latter two have a high degree of dependence, namely 78% and 80%. Although this figure for India is only 31%, it is relatively high for this large country (in terms of population and area) and needs to be taken into account clearly.

There are up to 15 countries in the forth group which are above the level of water stress: Afghanistan, Armenia, Azerbaijan, China, the Philippines, Iraq, Iran, Japan, Kyrgyzstan, the Democratic People's Republic of Korea, Sri Lanka, Tajikistan, Taiwan¹⁶, Turkey and Turkmenistan. In terms of dependence, high values are particularly in Turkmenistan (97%), Azerbaijan (77%) and Iraq (61%). Another seven countries, namely Bangladesh, Indonesia, Kazakhstan, Nepal, Thailand, Vietnam and East Timor can be ranked in the 5th group, of which alarmingly high dependence (given the number of inhabitants and the population density) has Bangladesh, up to 91%. Relatively high values are also reported by Vietnam (59%) and Thailand (49%).

Countries belonging to the 6th group, namely Brunei, Georgia, Cambodia, Laos, Malaysia, Myanmar and Mongolia, are not affected by the water shortage at national level. High level of dependence shows Cambodia with 75%, but higher rates of dependence are characteristic for the entire Indochina region, with the exception of Myanmar (14%). The only representative of the 7th group is Bhutan, which has absolute primacy in a number of re-

¹⁵ Although Palestine, respectively the Palestinian State is only partially an internationally recognized state, for the purposes of this monograph we consider it an actor of international relations in the Middle East, especially in view of the geopolitical situation in the region.

¹⁶ As in the case of Palestine, we consider Taiwan (or the Republic of China) to be a member of the international community with a specific status for the purposes of this monograph.

newable water resources per capita per year on the Asian continent and also with a zero degree of dependency.

Table No. 9: Comparison of the state of renewable water resources in individual countries of Europe

State	Renewable water resources (km ³ /year)	Number of inhabitants (thousands)	Renewable water resources per capita (m ³ /year)	Dependency (%)
Albania	41,7	2 897	14394,20	35
Andorra	0,3	70	4285,71	0
Austria	84,0	8 545	9830,31	29
Belarus	58,0	9 496	6107,83	36
Belgium	20,0	11 299	1770,07	34
Bosna and Hercegovina	37,5	3 810	9842,52	5
Bulgaria	107,2	7 150	14993,01	1
Croatia	105,5	4 240	24882,08	64
Cyprus	0,3	1 165	257,51	0
Czech republic	16,0	10 543	1517,59	0
Denmark	16,3	5 669	2875,29	0
Estonia	12,3	1 313	9367,86	1
Finland	110,0	5 503	19989,10	3

France	186,3	64 395	2893,08	5
Germany	188,0	80 689	2329,93	31
Greece	72,0	10 955	6572,34	22
Hungary	116,4	9 855	11811,26	94
Ireland	51,0	4 688	10878,84	6
Island	170,0	329	516717,33	0
Italy	175,0	59 798	2926,52	5
Latvia	33,7	1 971	17097,92	53
Lichtenstein	---	38	---	---
Lithuania	24,5	2 878	8512,86	38
Luxemburg	1,6	567	2821,87	68
Macedonia	6,4	2 078	3079,88	16
Malta	0,07	419	167,06	0
Moldova	11,7	4 069	2875,40	91
Monaco	---	38	---	---
Montenegro	46,3	626	73961,66	---
Netherlands	89,7	16 925	5299,85	88
Norway	384,0	5 211	73690,27	0
Poland	63,1	38 612	1634,21	13
Portugal	73,6	10 350	7111,11	45

Romania	42,3	19 511	2168,01	80
Russia	4508,0	143 457	31424,05	4
San Marino	---	32	---	---
Serbia	162,2	8 851	18325,61	---
Slovakia	80,3	5 426	14799,12	75
Slovenia	32,1	2 068	15522,24	41
Spain	111,1	46 122	2408,83	0
Sweden	186,2	9 779	19040,80	2
Switzerland	53,5	8 299	6446,56	24
Ukraine	139,5	44 824	3112,17	62
United Kingdom	164,0	64 716	2534,15	1
Vatican	---	1	---	---

Source: custom processing based on the research made

Although Europe is generally not considered to be a continent that would be acutely endangered by drinking water shortages, even in this region, we will find countries with a number of renewable water resources per capita a year under the level of water stress, i.e. 1700 cubic meters per person per year. The smallest values that put them in group 1 have two island states - Cyprus and Malta, with the second one having only 167.06 m³ of water per person per year, or about 458 litres per person a day, which is less than in the case of several African and Asian countries suffering from water scarcity. Although there is no representative in Europe in the second group, there are two other countries, namely the Czech Republic and Poland, belonging to the 3rd group, below the water stress limit, although only tightly. Out of all four of these states, only Poland shows a dependency rate and it is 13%.

Other countries in Europe are above the water stress limit, with Belgium being the closest to this limit value. Together with other 12 countries, namely Andorra, Denmark, France, Luxembourg, Macedonia, Moldova, Germany, Romania, the United Kingdom, Spain, Italy and Ukraine, it belongs to the 4th group. High values of the rate of dependence are reported mainly by Moldova (91%) and Romania (80%), which draw most of their renewable water resources mainly from the Danube and its tributaries. In the 5th group there are a total of 9 countries, namely Belarus, Bosnia and Herzegovina, Estonia, Greece, the Netherlands, Lithuania, Portugal, Austria and Switzerland. Dependency rates for these countries are somewhere in the range of 22 to 45%, with the exception of the Netherlands, which receives up to 88% of the water from external sources. On the contrary, Estonia (1%) and Bosnia and Herzegovina (5%) have the lowest dependence among this group.

The largest number of countries, up to 14, is in the 6th group. These are the following countries: Albania, Bulgaria, Montenegro, Finland, Croatia, Ireland, Latvia, Hungary, Norway, Russia, Slovakia, Slovenia, Serbia and Sweden. With regard to the degree of dependence, high values are shown in particular in the Danube River Basin, headed by Hungary (up to 94%), Slovakia (75%) and Croatia (64%). The only representative of the 7th Group in Europe with the absolute highest amount of renewable water resources per person per year, not only in Europe but also globally, and at the same time with a zero dependency ratio is Iceland.

Conclusion

Water problems are currently at the forefront of scientific discourse on global environmental issues and their impacts on various aspects of human activity. One of the analytical approaches to this issue is the place and importance of water issues in international relations, with particular emphasis on their conflicting potential and negative implications for national and international security. Based on our analysis, we can conclude that the current state of drinking water resources in the world is very uneven, unbalanced, and so in many cases highly dependent, which can pose a major safety risk.

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