Journal of Social Sciences; ISSN: 2233-3878; e-ISSN: 2346-8262; Volume 5, Issue 2, 2016

Geography of the Hydro Resources and Its Impact on the World Economy

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Abstract

The importance of the water resources – as a main natural resource in the world is analyzed in this research. The location of the fresh water in different regions and countries of the world, differences among the regions related to the water consumption, major problems, related to the water shortages and ways for their resolution are among the topics discussed in the article.

Keywords: consumption, environment, fresh water, hydropower station, resource, water.

Introduction

The most important global problems have been emerging from the second half of the XX century. On the one had, in the beginning of the XXI century, the development of the modern society reached the new high level but on the other hand, the scientific-technological revolution, postindustrial development and rapid growth of the world population have required increase in the exploitation and production of the natural resources.

The global problems (ecological, disarmament, peace and security, demographic, energy, food, poverty, etc.) concerns the whole humanity and their resolution needs the efforts of all countries and nations. Each global problem is interconnected and creates the entire chain, in which the interrelations between environment and population`s social and economic development is determined.

One of the most important global problem is represented by the relations of the humanity with water resources.

Water as a Major Natural Resource in the World

Water, like the earth, is an indispensable condition for the human life, which satisfies its physiological and sanitary needs. It is well known that people can stand much longer without food than without water. No less water is needed for a variety of businesses, which is largely based on the "wet" technology. It refers to the production of food, energy and industrial products.

Although fresh water resources in the world are only 2.5% of the entire hydrosphere, this corresponds to 35 million km3 (Neidze, 2004). However, the basis for optimism related to this fact is not so great. The fact is that almost 70% of the fresh water`s volume, is conserved in the ice sheets of Antarctica and Greenland, the Arctic ice and mountain glaciers. The remaining 30% comes on groundwater, but it is used in relatively small quantities. It turns out that the available, free fresh water in the rivers, lakes, wetlands, atmosphere - is only 0.3% of all fresh water on the Earth. At the same time, about 1/5 of the consumed water comes on the share of groundwater (Beruchashvili, Davitashvili & Elizbarashvili, 2015). But even with this approach, the most reasonably available resources are considered to be the most dynamic part of the fresh water - the river (river bed) water flowing into the oceans. Their lump sum amount in rivers is negligible - only 2,100 km3. Nevertheless, since this volume is renewed during the year on average for 23 times, in fact the available resources of the river waters rise to 48,000 km3 (Maksakovsky, 2009). Apparently, this number characterizes the "water ration" of humanity that can (to some extent) be withdrawn for economic activity.

In terms of the geographic distribution of fresh water resources leading positions are occupied by Russia (1/5 of the World`s supply), Latin and North America (Maksakovsky, 2009). Considering the resources of river flow, then Asia and Latin America are high on the list. In the river systems, the leading positions belong first to Yangtze, Brahmaputra, Ganges, Mekong, and the second to the Amazon, Orinoco, Paraná. Consequently, there are several changes in the order of the leading countries (Table 1).

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Journal of Social Sciences; ISSN: 2233-3878; e-ISSN: 2346-8262; Volume 5, Issue 2, 2016

Table 1: The first five countries in the world in size resources stream flow in the beginning of the XXI Century. Source: Maksakovsky, 2009.

Country	Resources, km^3
Brazil	6950
Russia	4300
Canada	2900
China	2800
USA	2500

This is the situation related to the fresh water resources, available to the humankind from the nature. However, from the standpoint of geographic distribution of the water resources, that is not enough – the patterns of water consumption, which is constantly increasing, should be taken into account. Only within the last half of the century, the global water consumption has increased five times (Beruchashvili et al., 2015) and has reached almost 3000 km3 per year (Nitti, 2011). Some experts believe that almost half of the total available amount of the fresh water has already been used. Moreover, almost 70% of it goes to agriculture and is lost forever (Nitti, 2011). The industry and utilities are respectively at the second and third places. However, water recycling is much more used in these fields.

Of course, for large regions of the world water consumption rate also varies greatly. Non-competitive first place among them belongs to Eastern part of Asia, where water consumption is dominated by agriculture, although in some countries (China, Japan) an appreciable proportion of water is also consumed by the industry (Fry, 2005). Agricultural use is also prevalent in Africa, Australia and Oceania, a large part of Latin America, while industrial and municipal use of water is the leading way of consuming water - in North America, and Europe.

Finally, what is the main issue with fresh water is the availability of it, which is calculated per capita. The average per capita freshwater availability is constantly decreasing, even though these resources are growing. However, the rate of growth of fresh water is lower than that of the world population. If this indicator is put at stake, the picture of distribution of fresh water will be different from the one discussed above.

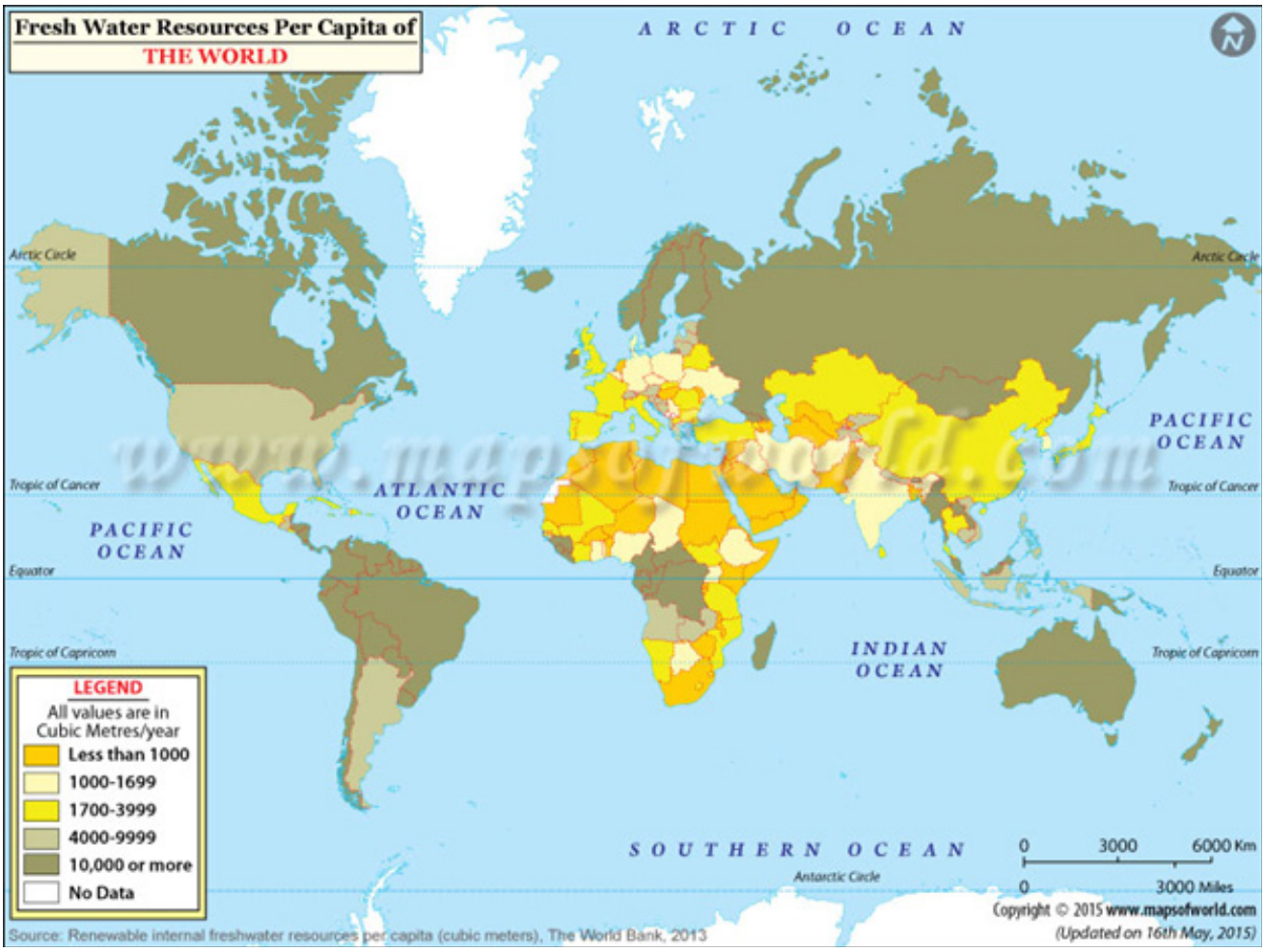

Figure 1: Availability of fresh water per capita. M3 Annually. Source: Maps of World, 2015

Journal of Social Sciences; ISSN: 2233-3878; e-ISSN: 2346-8262; Volume 5, Issue 2, 2016

It immediately struck by the presence of two well-defined zones of sufficient and excess moisture. The first of these is in the range of temperate and subtropical climate zones of the Northern Hemisphere and includes Canada, the United States, the Nordic countries, Russia. However, countries of Europe, located in this zone, are already experiencing a lack of fresh water. The second zone extends within the equatorial and tropical climate zones, mainly in the Southern Hemisphere. And between them extends arid belt with the biggest shortage of the fresh water.

ning of the XXI century, about 1.2 billion people lacked the access to safe drinking water and more than 2.4 billion to improved sanitation (UN, 2004). In these underdeveloped countries in Asia and Africa, such as Nepal, Cambodia, Ethiopia, Chad, Mauritania secured access to the drinking water is now available for less than one third of all residents. It needs to be taken into account that in most developing countries the problem is not just a shortage of water, but also the quality of it is low. In these countries, the consumption of contaminated water is a source of two thirds of all diseases. According to UN projections, universal access to

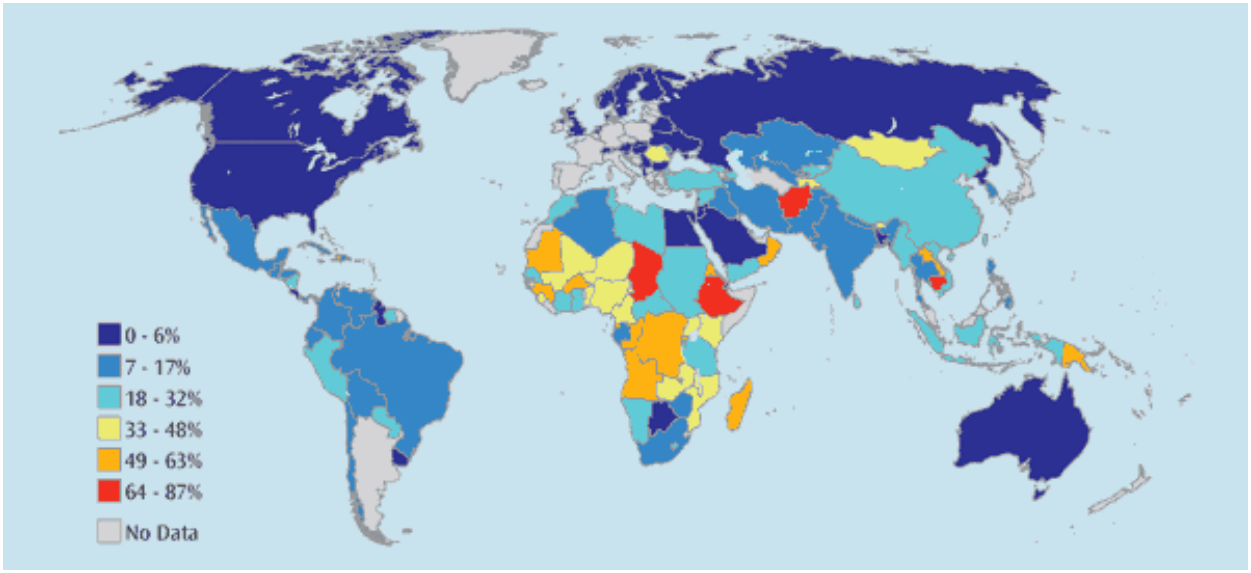

Figure 2: Percentage of Population without Reasonable Access to Safe Drinking Water. Source: A Graphic Look at the State of the World, n.d.

The champions of excess fresh water per capita are French Guiana (over 800 thousand m3 per person) and its neighboring Guyana and Suriname (300 thousand), DR of Congo (about 300 thousand) and Iceland (250 thousand). On the other hand, the most scarce water supply is in Kuwait (10 m3), the UAE and Qatar (less than 100 m3), Saudi Arabia and Libya (slightly more than 100 m3). This means that in French Guiana shower provision of such resources are higher for 80 thousand times than in Kuwait (Maksakovsky, 2009).

The problem of the fresh water - as farmland - in fact has already become global. According to the UN, at the beginsafe drinking water will be provided: in Asia - by 2025, in Latin America - by 2040, and in Africa – by 2050 (Glenn, Gordon & Florescu, 2012)

Hydropower Resources of the World

Another important indicator of water resources is economic hydropower. Measured as the volume of river flow, here leading positions are occupied by Asia and Latin America. Similar to the data in Table 1, the five richest countries by hydropower resources include the following (Table 2):

Table 2: The first five countries in economic size of hydropower. Source: Maksakovsky, 2009.

Country	Hydro energy potential. Billion K/h	The degree of its exploitation (%)
China	1260	16
Russia	850	19
Brazil	765	37
Canada	540	65
India	500	16

Journal of Social Sciences; ISSN: 2233-3878; e-ISSN: 2346-8262; Volume 5, Issue 2, 2016

It is important to note that almost half of all global economic hydropower comes on these five countries. As for the extent of the degree of exploitation of economic hydropower, the world average is below 1/3, but for Europe and North America it is 70%, whereas for Africa - 18% (Maksakovsky, 2009).

Examples of countries where this potential is almost fully mastered include France, Italy, Switzerland, and almost completely - Japan and the United States.

Commercial Importance of the Water Reserves

Thus far OPEC calculate world oil reserves and make appropriate forecasts. However, the real authority will be concentrated in the hands of the cartels, which master "water market" and ways of the export of drinking water.

In this regard the passage of the resources of fresh water into private hands might be a frightening but a possible future scenario. Situation can develop by the already worked-out "petroleum" scenario, when oil fields and processing resources were concentrated under the control of the private persons and companies.

At the end of the 1990s, "Aquarius Water Transportation" was the first company on the world market, which marked the beginning of the new type of economy - the export of usual H2O. The company on the commercial basis supplied drinking water to the Greek islands. In 2000, another firm, "Nordic Water Supply", began to transport flasks with the volume of more than 20 million liters, having been filled with the fresh water, from Turkey to North Cyprus. Today, Turkey is also intended to sell water to Israel, and the negotiations about the delivery of the water were conducted between the two countries (Besttopennews.com, 2005)

Thus, privatization within the framework of the new market segment partly has already begun. It is known that some companies have already obtained rights to the transport and sale of water, which is obtained from Alaska glaciers. Certainly, there are methods of processing water from the marine (sea) into the fresh one. However, they will not solve the whole problem.

The fresh water represents the significant interest from the point of view of the extraction of profit. It has high demand in both in the Third World Countries and in the developed Western states.

The industry of sales of drinking water is gradually developing. Annual circulation comprises of more than 100 billion liters (Besttopennews.com, 2005). The main players on the market are already appearing. First of all, those, who are ready to pay, and those, who possess the surplus of water. However, it is not worth forgetting that when it comes to the instinct of self-preservation, gentlemen's agreements are shattered and force begins to be dominant.

Several Facts and Future Forecasts Related to Water Consumption

• The gap between the water supply and demand on it constantly grows, as it is expected, it will reach 40% by 2030.

• By 2025, a third of population of the world will depend on the shortage of water.

• By 2050, more than 70% of population of the planet will live in the cities.

• In many developing countries, the attrition rate of water comprises of more than 30%, after reaching even 80% in some cases.

• More than 32 billion cubic meters of drinking water are leaking from the urban water-supply systems in the entire world, only 10% of leakage is seen remaining leakages unnoticeably and noiselessly disappear underground (VIGOR Consult, 2009).

The development of humanity is accompanied by an increase of the population of the Earth and also by growing demands with respect to the economic resources. One of such resources is fresh water, whose shortage sufficiently sharply is perceived in a number of the regions of the Earth. In particular, more than third population of planet, i.e., more than 2 billion people do not have a constant access to the drinkable water. It is expected that in 2020 the shortage of water will come out as one of the basic problems, which will impede the further development of humanity. To the highest degree this relates to the developing countries, which are characterized by the following:

• Intensive increase of the population,

• High level of industrialization, which is accompanied by the environmental pollution and water in particular,

• Absence of water-cleaning infrastructure,

• Essential need for the water for the agricultural purposes,

• Average, or low level of social stability, and the authoritarian structure of the society (VIGOR Consult, 2009).

Conclusions and Recommendations

Resolution of the problem of water consumption can be divided into the major and minor factors.

First of all it is necessary to reduce water consumption in the production processes and decrease the deadweight loss of water. In industry, the production of 1 ton of synthetic fibers consumes 3,500 tons of water, nickel (800), iron and steel, paper (200). In agriculture the cultivation of cotton consumes 10,000 tons of water, rice (7000). Sparingly water should be consumed in everyday life. In the economically developed countries an average urban resident consumes at least 300-400 liters of water per day

Journal of Social Sciences; ISSN: 2233-3878; e-ISSN: 2346-8262; Volume 5, Issue 2, 2016

(Neidze, 2004). Receiving a shower only for a few minutes requires 100 liters of water (Maksakovsky, 2009).

The second most important measure is the construction of reservoirs for river regulation. It is estimated that with their help the global river flow could be increased by 1/4. Over the past half century the number of reservoirs around the globe has increased by about five times. Now, there are more than 60 million of them with total useful volume of 6600 km3. Together, they occupy 400 km2 (Maksakovsky, 2009).

As in the case of land resources, many programs for the conservation and restoration of freshwater resources are directed by the UN, which in 2002 announced the "Decade of Water", and in 2003 proclaimed the "Year of Freshwater". This has stimulated the increased public attention to the problem of water supply of the world, by its individual regions and countries, not only in the present but in the future. Some politicians are already predicting the possibility of "water wars" - acute conflict over the water resources (Simon, 2005).

Water also has hydro-energetic potential, which has three grades. The theoretical hydropower potential implies the potential resources of river flows and reservoirs. Usually it is estimated at 35-40 trillion kWh. Next comes the technical hydropower potential, which is the part of the theoretical capacity, which can be technically mastered. Most often it is estimated at 15 trillion kWh. Finally, the economic hydropower potential is the total energy resources of the rivers, the use of which includes the cost of construction of hydroelectric power station and the cost of electricity that is economically feasible. It is estimated at 8 trillion kWh (Maksakovsky, 2009).

For the development of the market for water regulating, UN in 2000 adopted the Millennium declaration, according to which the international community took upon itself the obligation to reduce a quantity of people, deprived of access to the clean drinking water by half in 2015, and to finish the irrational use of the available water resources.

The relationship between the poverty and available water resources is obvious: numbers of people, who live for less than to $1.25 during the day, approximately coincides with the number of those, who are deprived of access to the safe drinking water.

Since 2001, the available water resources has been main priority direction of the sector of the natural sciences of UNESCO. While the problem of water is one of the sharpest problems for not only the developing countries but also the so-called First World.

The Benefits of the Investment into the Available Water Resources

According to some estimates, each dollar, inserted in an improvement in water supply and sanitation, brings income from 3 to 34 dollars. The sum total of the losses, carried only in Africa for lack of access to the safe water and lack in the sanitary-engineering construction, is approximately $28.4 billion per year or about 5% of GDP (WWAP, 2016)

The inspection of the countries, representing the Middle East and North Africa region, showed that the exhaustion of underground available water resources, as it is represented, led to the reduction the GDP in some countries (in Jordan by 2.1%,Yemen — by 1.5%, Egypt — by 1.3%,Tunisia — by 1.2%) (VIGOR Consult, 2009).

Keeping the Water Resources

Water reservoirs ensure the reliable sources of water for irrigation, water supplies and also in hydro energy and for the regulating the floods. For the developing countries, it is not the exception, when from 70 to 90% of annual reserves are accumulated in the reservoirs. However, in the countries of Africa it remains only 4% of the renewed drain (VIGOR Consult, 2009).

Virtual Water

All countries import and export water in the form of its equivalents, i.e. in the form of agricultural and manufactured products. The calculation of the water consumption is determined by the concept of “virtual water”. Theory of “virtual water” in 1993 became the beginning of the new epoch in the determination of the policy of managing agriculture and available water resources in the regions, which experience the scarcity of water, accompanied by the campaigns, directed toward the savings of the available water resources. Worldwide, agriculture accounts for 70% of all water consumption, compared to 20% for industry and 10% for domestic use. In industrialized nations, however, industries consume more than half of the water available for human use. Belgium, for example, uses 80% of the available water for industry (Worldometers, n.d).

Approximately 16% of the consumption of water reserves and their pollution is connected with the production of the export goods. Prices of the sold goods, however, rarely reflect expenditures for the use of the water resources in the producing countries. For example, Mexico imports wheat, maize and sorghum from the USA. For production of these crops 7.1 Gm3 of water is consumed in the USA. If Mexico produced them itself, 15.6 Gm3 of water would be necessary. The general savings of water, obtained as a result of international trade in virtual water in the form of the agricultural products, is equivalent to 6% of the total volume of the water, utilized in the agriculture (VIGOR Consult, 2009).

Processing Water

The use of urban effluents in the agriculture remains limited, with the exception of several countries with the very poor availability of water resources (40% of drainage water repeatedly is used in the Palestinian territories of the Sector Gaza, 15% - in Israel and 16% - in Egypt). The demineralization of water becomes ever more accessible. It is used,

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mainly, for the production of drinking water (24%) and satisfaction of the needs of industry (9%) in the countries, which exhausted the limits of its renewed sources of water (Saudi Arabia, Israel, Cyprus and others) (VIGOR Consult, 2009).

Projects of Water Resources Management

Approaches to the solution of the problem of the shortage of the water:

• Removal of the agricultural crops, resistant to the drought and salty soils,

• Distillation of water,

• Storage of water.

Today there are political decisions, regarding the reduction of the losses of water, and the improvement of the water resources, as well as the reduction of the needs for them. In many countries there are laws already for the conservation of and the effective use of water, however, these reforms have not yet given perceptible results.

Participants in the Venetian forum (The Future of Science, 2008) propose to the leaders of the largest international organizations and governments of the leading countries of the world to begin large-scale investments into the research, connected with the solution of the problems of the developing countries to fight with hunger and malnutrition. In particular, they consider necessary to begin major projects as soon as possible for converting marine water to fresh water, for the irrigation of deserts, especially in the tropical countries, and to create special fund for the support of agriculture (The Future of Science, 2008).

The structure of the consumption of water with the predominance of its agrarian consumption implies that a search for the methods of solution of the scarcity of water must be achieved through introduction of the agro-technologies, which make it possible to use atmospheric precipitations to the full capacity, to seek the reduction of losses with the irrigation and an increase in the productivity of the fields.

Specifically, in the agriculture the unproductive expenditures of water are highest and it is calculated that about half of those resources are spent in vain. This composes 30% of the total volume of the world resources of fresh water, which is the enormous reserve of savings. There are many methods, which help to reduce the expenditure of water. Traditional irrigation is a matter of little effectiveness. In the developing countries adopt, in essence, the surface form of irrigation, for which the weirs are built. This method is simple and cheap, adopted, for example, in rice growing, but the substantial part of the utilized water (about half) is lost due to the infiltration and evaporation.

To sufficiently simply attain savings, a drop method of irrigation can be used: a small quantity of water should reach directly each plant, through small tubes laid above the earth (but better underground). This method is economical, but its installation is expensive.

If judged by the volumes of the losses of water, existing water-conducting and irrigational systems are acknowledged as extremely ineffective. It is calculated, that in the region of the Mediterranean the losses of water in the urban water pipes compose 25%, and in irrigating channels 20%. At least, it is possible to partially avoid these losses. In cities such as Tunisia (Tunisia) and Rabat (Morocco), it was possible to reduce the losses of water to10%. At the present time, programs of fight with the losses of water are being introduce in Bangkok (Thailand) and Manila (Philippines) (VIGOR Consult, 2009).

Under these conditions of the growing scarcity, some countries already began to include strategy of control of water resources in their plans of development. In Zambia the policy of the integrated Water Resources management covers all sectors of economy. The result of this Water Resources management, correlated with the national plans of development, and many sponsors have started to join in the general plan to the aid to Zambia investing into the water sector.

In the desert regions the method of distillation of sea water is used. It is designed for obtaining drinkable and industrial water in the countries such as Saudi Arabia, Israel, Cyprus and others.

Because of the using of the contemporary appropriate technology, the cost of the distillation of water was reduced to 50 cents for 1000 liter, but this is nevertheless very expensive taking into account the volumes of water, necessary for the industrial or agricultural use. Therefore, distillation is more suitable for the production of drinking water or for the use in the food industry, where the surplus value is sufficiently high. But if it becomes possible to attain further reduction in the cost of the distillation of water, then the sharpness of problem with water consumption will considerably decrease.

The Desert fund prepared the development plan, which called to combine into one system distillation units and thermal power plants of the solar energy, capable of producing cheap electric power on the coast of North Africa and in the Middle East. For these zones, which are considered as the most arid in the world, this solution would be one way out of the problems related to water consumption.

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