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Scarcity of Natural Resources With Focus on Water in Middle East Region

Bachelor Thesis

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BACHELOR THESIS ASSIGNMENT

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Scarcity of Natural Resources With Focus on Water in Middle East Region

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Objectives of thesis

The aim of the thesis is to conduct analysis and to examine the problem of shortage of fresh drinkable water and consideration of ways to solve it throug a system of innovative, state-backed policy on the example of the State of Israel as a country that depends on the limited natural recource of water.

Methodology

The thesis will contain descriptive and comparative methods and logical inference methods.

The proposed extent of the thesis

40 – 60 pages

Keywords

Natural Recources, Water, Scarcity, Israel, Solutions.

Recommended information sources

Barlow M. Blue Covenant. The Global Water Crisis and the Coming Battle for the Right to water. New York, London: The New Press, 2007.

Danilov-Danilyan, V.I. The global problem of fresh water shortage // The age of globalization. №1/2008. URL.: http://www.socionauki.ru/journal/articles/129824/

Kislev, Y. Real and ideal water rights: the prospects for water-rights reform in Israel, Gaza, and West Bank. University of California working paper. Berkeley, 2008.

Shilova N.V. The innovative factor as a means of overcoming the shortage of fresh water: the example of Israel. Dissertation of candidate of economic Sciences. – Moscow, 2011. – 160 p.

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Prague on 10. 03. 2017

Declaration

I declare that I have worked on my diploma thesis “Scarcity of Natural Resources With Focus on Water in Middle East Region“ by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any third person.

In Prague, March 5, 2017

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Mikhail Kozin

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SUMMARY

This bachelor thesis deals with the analysis of water scarcity and possible ways to deal with it on the example of Israel. The theoretical part intends to describe the degree of the scientific awareness of the problem. Theoretical and methodological basis of this paper is the work of economists, environmentalists and policymakers from different countries, who are interested in the problem of water shortage in the world. On the example of Israel, we show that the practical implementation of theoretical models of reimbursement of scarce resources is really possible, even if the conditions are tough, though full substitution of water does not exist. The results are clarified by data and graphs.

Key words: Natural Recources, Water, Scarcity, Israel, Solutions.

ABSTRAKT

Tato bakalářská práce se zabývá analýzou nedostatku vody a možných způsobů, jak se vypořádat s ní na příkladu Izraele. Teoretická část má v úmyslu popsat stupeň vědecké povědomí o problému. Teoretická a metodologická východiska této práce je práce ekonomů, ekologů a tvůrci politik z různých zemí, kteří mají zájem o problému nedostatku vody ve světě. Na příkladu Izraele, ukážeme, že praktická realizace teoretických modelů náhradu omezených zdrojů je skutečně možné, i když jsou těžké podmínky, i když úplná substituce vody neexistuje. Výsledky jsou objasněny data a grafy.

Klíčová slova: Přírodní Recources, Voda, Nedostatek, Izrael, Reseni .

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INTRODUCTION

In today's world there is a significant increase in the importance of environmental factors in the lives of people, their economic activity, in the relations between nations and world politics. Scientists working in the sphere of geopolitics notice gradual depletion of natural resources, competition for which may eventually lead to interstate conflicts and even full-scale wars.

The beginning of the 21st century was marked by the increase of anxiety of environmentalists, politicians and public figures about the world's environmental problems. Environmental issues are recognized as the major challenges of different countries' security (Al Obaidi, 2011: 115). Solution to the questions concerning a shortage of natural resources becomes particularly relevant.

One of the central places in the paradigm of these problems is the question of water resources. No doubt, water is the most essential element of human life, as well as the development of states in economic and social terms. National security is inconceivable without water security, which implies the presence of sufficient quantity and quality of water consumption.

Water is the source of all life on Earth and the most important resource for sustaining life. However, it is unevenly distributed in different countries and on different continents that have repeatedly led to economic crises and caused social disasters. The deficit of fresh water is one of the major global problems. As the world's population grows, water consumption significantly increases and leads, respectively, to an even greater water scarcity. Subsequently, this leads to a deterioration of living conditions and slowing of the economic growth (Zygmunt, 2007).

We can make a list of the main reasons which would inevitably become a cause of the deficit of the seemingly inexhaustible natural resource of water. Among the key ones is the constant growth of population, industrial pollution, over-exploitation of water resources, intensification of agricultural production, the uncontrolled use of water in urban areas, global climate change, as well as the limitations of the natural freshwater resources.

According to the analysis done by A. Kushnarenko (2015), Earth's natural resources of fresh drinking water is 3.5% of the total water resources (the

water mass in the oceans makes up 96.5%) (Kushnarenko, 2015). According to other sources, the volume of fresh water is even smaller and accounts to only 2,5% of the world's water (Nikitin, 2013).

Water as the main resource of life affects all areas of human activity – agricultural, industrial, political and humanitarian processes. The lack of water is having a devastating impact on agriculture, which is the main consumer of water resources (70% of the total water withdrawal). Annual water consumption for industrial needs in the world, is 725 cubic kilometers in 1995, is expected to grow up to 1170 cubic kilometers by 2025 and amount to approximately 24% of total water consumption (Nikitin, 2013).

Another serious problem associated with the need for significant usage of water is providing sewage and overflow pipes. At the beginning of the second decade of the 21st century cities became home to half of the world's population, but by 2030 this figure will have risen to two thirds of the planet's population. In the social and health aspects not only the security and the amount of drinking water are important, but also the quality of its recovery and purification.

Water has become one of the main limiting factors of the economic development of many countries and particular regions, because growth of the global consumption of water along with the increasing levels of pollution lead to an increase in the number of countries in which availability of water resources is decreasing. Climatic changes will also enhance contrasts, especially droughts and floods, which will become more intense. All this will give rise to new conflicts over water, both domestic and international.

On average, each person on Earth consumes 24 646 m^3 (approximately 24.650.000 liters) of water per year.

Very few countries in the world, rich in water resources, can boast of what is called water "at their disposal". Many countries have to share large rivers, because the river basins are separated by territorial borders. An example is the largest tributary of the Ob, Irtysh, which flows for more than 500 km through the territory of China, crosses the border, flows through the territory of Kazakhstan about 1800 km, has about 2000 km on the territory of Russia, and then it flows into the Ob. In accordance with the international agreements, China can take away half the annual flow of the Irtysh river for their needs, Kazakhstan half of what

remains. As a result, the water abstraction strongly affects the richness of the Russian part of the Irtysh river (including for hydropower). Currently, China annually deprives Russia of two billion km³ (http://рос-мир.рф/node/2538). Water availability of the countries depends on whether the sources of the rivers or parts of their channels are inside or outside of the country.

The report of the UNO development Program notes that the Republic of Moldova, Romania, Hungary, Turkmenistan, and a dozen more countries obtain over 75% of their water resources from external sources. The online magazine "Expert" claim that Azerbaijan, Latvia, Slovakia, Uzbekistan and Ukraine receive 50 per cent of their water from abroad (http://expert.ru/2006/11/13/voda/). The authors of the report draw attention to the fact that in the modern world there is enough water on the Earth to meet the needs of all humanity, but 1.1 billion people lack access to clean drinking water and 2.6 billion to sanitation.

The authors emphasize that the lack of providing people with water is partly related to the fact that water resources are unevenly distributed. The population of the Middle East faces severe water shortage. The fact that the population of Canada has much more water than it can use does not improve this situation. Nowadays, about 700 million people in 43 countries have water resources in the amount below the minimum human need. By 2025, this figure could be up to three billion people, because the water demand will increase in China, India, countries of Africa to the south of the Sahara. About 540 million people in Northern China already live in the conditions of water shortage. According to experts, a person must have at least 20 liters of water per day. However, 1.1 billion people in developing countries use no more than five liters per day. The people of Europeconsume up to 200 litres of water per person, including the industrial use, and the population of the United States – up to 400 liters (http://рос-мир.рф/node/2538).

The authors of the UNESCO report "Water in a changing world" emphasize that the level of water consumption per capita is growing from year to year. Between 1990 and 2000 the world population grew four times, and the water consumption – seven and a half times.

A shortage of fresh drinking water in the world, which mankind has experienced since ancient times, is regarded as one of the global problems of modernity in recent decades. Every year the water crisis is further aggravated by the reasons of various character – demographic, environmental, economic (Hoekstra, 2006). Therefore, the study of the

problems involving the shortage of drinking water, and the search for possible solutions to these problems, is relevant at the present stage of development of economic and ecological science and requires careful study.

The scientific novelty of the qualification work lies in the fact that the author will give a detailed analysis of the Israeli economy as a country dependent on fresh water resource and will also describe and analyze Israel's experience in overcoming its deficit due to the intensive scientific and technical policy. The paper examines the economic system of Israel as a system of production and ensuring of a high quality life with the limited, partially renewable natural resource – fresh water – in the conditions of innovative development of the country. It studies the history of political and economic measures taken in Israel for overcoming hindering the country's development constraints of an important natural resource - fresh water. The paper identifies and analyzes the institutional conditions, including the inflow of highly skilled part of the immigrants, the availability of an advanced system of technical education and effective combination of private and public investment in the innovative economy as factors, ensuring the possibility of overcoming resource scarcity.

Theoretical and practical significance of the work is determined by the obtained results, showing the complexity of the situation with the shortage of fresh water in the world, particularly in Israel. The main issues of the paper contain a description of the possible principles of solving problems of freshwater scarcity in the world on the example of the state of Israel.

OBJECTIVES

The qualification work is devoted to the study of the scarcity of fresh water resources in the world and analysis of solutions to this serious problem in the state of Israel.

The purpose of the research is to examine the problem of the shortage of fresh drinking water in the world, and consider ways of solving this problem using a system of innovations supported by government policy on the example of the economy of the state of Israel, which is a country dependent on a limited natural resource of water.

Proceeding from this purpose, the following tasks are solved in the work:

• to prepare an upcoming study, giving an overall assessment of global water resources;

• to study the factors influencing the growing problem of water availability in the world;

• describe the global problem of scarcity of fresh water resources;

• to analyze the main models of economic development in the countries with the conditions of limited natural resources and to identify the factors that allow to overcome these limitations;

• to investigate the possibility of applying such models for the development of the Israeli economy that provide developing with the shortage of natural supplies of fresh water;

• to study and analyze the innovative potential of the country as a means of solving the problem of limited natural resources;

• to explore the experience of the state of Israel in the use of innovative capabilities for sustainable development in the context of scarcity of natural resources.

LITERATURE REVIEW

Before starting the research of our own the author intends to describe the degree of the scientific awareness of the problem. Theoretical and methodological basis of this paper is the work of economists, environmentalists and policymakers from different countries, who are interested in the problem of water shortage in the world: M. Barlow (2001, 2007), V.N. Zyryanov (2007), D. Chandler (2008), V.I. Danilov-Danilyan, K.S. Losev (2008), I.A. Makarov (2013), A. Kushnarenko (2015) and others. In numerous publications researchers

reviewed general issues of gathering, transportation and consumption of fresh water. A significant number of scientific works is devoted to studying the problems of water pollution and economic incentives (e.g. taxes and subsidies designed to cope with the deterioration of drinking water quality). In this paper, we based on the fundamental researches of such authors as V.I. Danilov-Danilyan, N.V. Kozlov, A.A. Fridman, as well as on the works having direct relevance to the study of the situation in Israel: A.V. Fedorchenko (1996), Y. Kislev (2001) N.V. Shilova (2011), and others.

Causes of growing of the acute problems of security of water and food in the world economy are described in works by P. Anaid, M. Barlow, L. Brown, P. Westhoff, V.I. Danilov-Danilyan, E.V. Kovalev, J. Cribb, V.I. Nazarenko, D. Pfeiffer, P. Rogers, L.L. Fituni, etc. Such economists as B. Bates, S.N. Bobylev, R. Mendelson, T.Y. Migaleva, W. Nordhause, B.N. Porfiryev, G.V. Safonov, N. Stern and others study the effect of climate change on the world economy in general and the problem of water and food availability in particular.

Features of the modern system of international institutions in ensuring global water and food supply and mitigation of global climatic change are the subject of research by M. Barlow, G. Beddington, D. Victor, I. Dombrowski, A.O. Kokorin, B. Lomborg, N. Maccioni, B.N. Porfiryev, etc.

The analysis of theoretical economic aspects of interaction of man and environment is fulfilled by the author, relying on the conclusions of the representatives of the neoclassical school (W. Beckerman, E. Neumayer, R. Solow, J. Hartwick), of institutional economics (E. Ostrom, J. Platye, B. Paul), of ecological economics (X. Delhi, M.S. Kato).

The analysis of the theoretical and economic aspects of international cooperation in the field of providing the population with water and food and the mitigation of global climatic change are thoroughly described in the works by K. Bakker, D. Victor, I. Dombrowski, J. Naya and R. Keohane, U. Nordhause, M. Olson, E. Ostrom, and others.

Consideration of the impact of trade on the solution to the mentioned above problems is thoroughly conducted by G. Allan, D. Wichelns; M. Kumar and O. Singh; R. Muradian and X. Martinez-Alier; A. Hoekstra; X. Yang, L. Wang and A. Zehnder, and other researches.

Finally, the assessment of the role of ecological innovations in dealing with the problem of providing the world population with water and food in the context of global climatic change

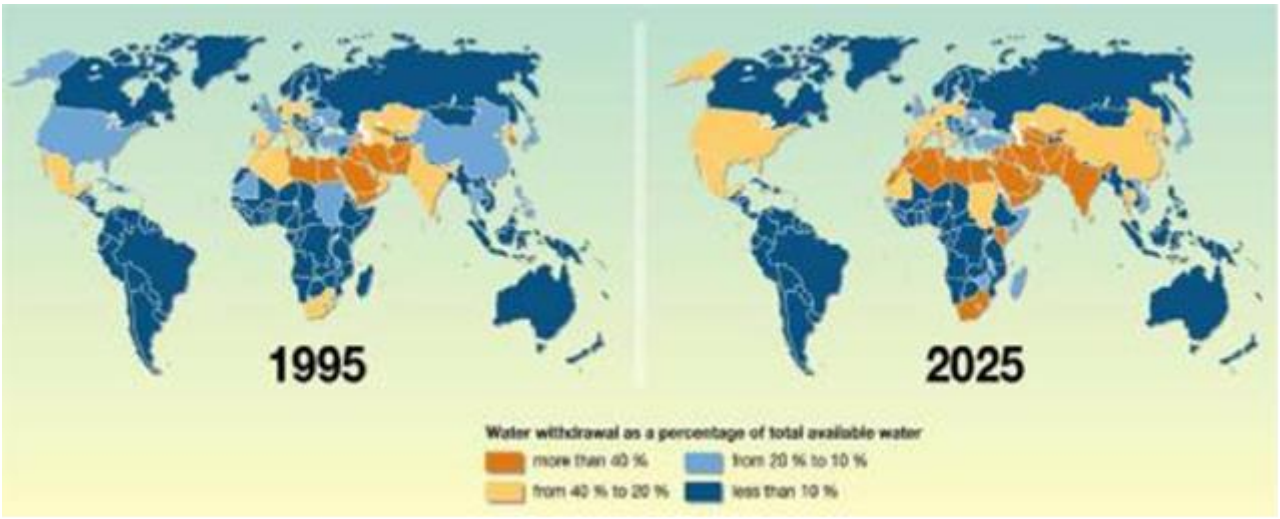
is based on the theory of innovative development by Y. Schumpeter, complemented by modern scholars, among whom there are N.A. Piskulova, M. Porter and M. Kramer, P. Ekins, N. Shilova and others.

Now let's get more deeply and in details on this reserches, which describe the problem of water deficit in details.

According to the database of the International Water Management Institute, all the more threatening becomes the problem of providing the world economy with fresh water. Currently, 1.2 billion people live in regions where the rate of water usage exceeds the rate of its renewal (Molden, 2007: 62), and by 2030 this figure will grow by 1.5 times (UN-Water).

As OECD (Organisation for Economic Co-operation and Development) observes, in 2009 2.8 billions of people live in regions experiencing water stress, that is, a situation of water shortage of a satisfactory quality and quantity to meet the needs of the population and the environment (Danilov-Danilyan, Losev, 2008: 59), and by 2030 this figure will grow up to 3.9 billion. (shttp://www.europeanwaternews.com/download/WaterlnitiativeFutureWaterNeeds.pdf: c. 10).

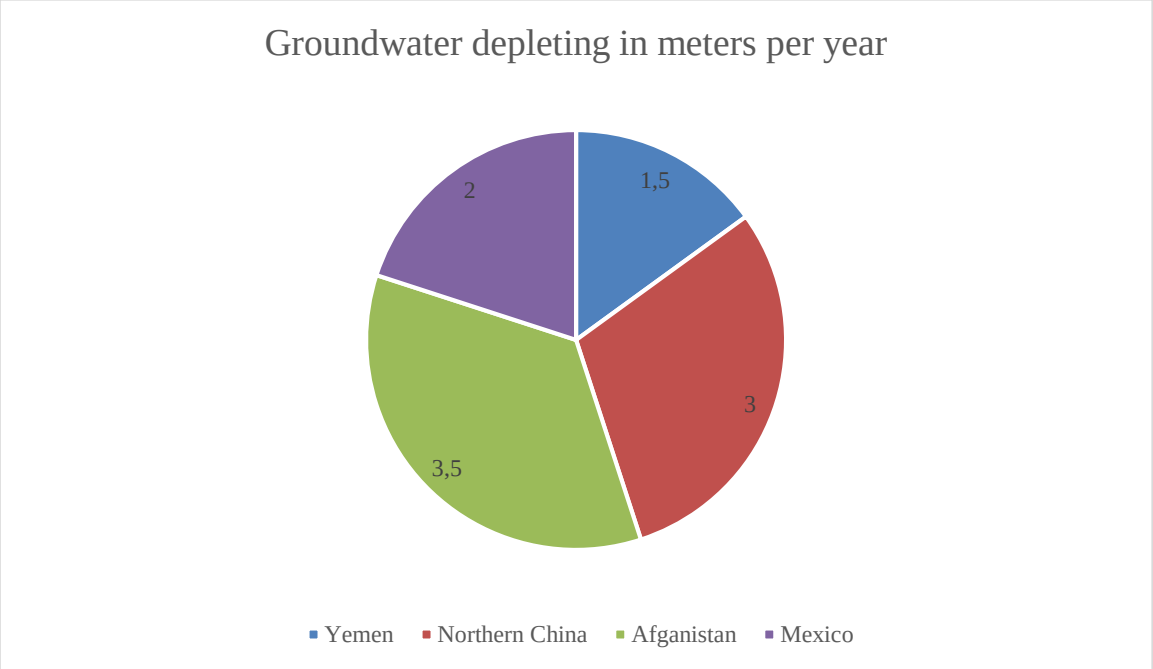
In this regard, interesting data have been reported by Beddington J., where the author compares the world situation with the fresh water shortage in 1995 and 2025 (Picture №1). The colour shows the changes, indicating the percentage of deficiency of water consumption (Beddington, 2009: 4).



Picture 1 – Water withdrawal as a percentage of total available water

Many of the major water sources that used to supply water to a huge area, run out. The most famous environmental disasters include the Aral sea, the Dead sea, lake Chad, the Colorado river (Danilov-Danilyan, Losev, 2008: 56). To make the situation worse, in recent decades there has been a gradual drying of many other large bodies of water. For instance, the Hwang Ho (the Yellow river) first dried up in 1972, since then it turns into a dry riverbed almost every year, as well as another great Chinese river, the Chang Jiang (the Yangtze) (Hays, 2009). In 2007, for the first time in history, the river Po dried up in Italy (Spiegel International, 2007). The level of water in the largest freshwater reservoir in the world – Superior Lake – shows decreasing water level in recent decades (Barlow, 2007: 4).

Groundwater reserves are rapidly depleting. In Yemen, their level is falling at a rate of 1.5 m per year, in Northern China it is 3 m per year, in Afghanistan - 3.5 m, Mexico - 2 m per year. In the United States in an underground pool beneath the Great Plains, the water level fell 30 m since its first usage (Brown, 2010: 55-57).



The severity and acuteness of the global problem of freshwater availability is determined not only by the amount of available water resources, but also by their quality. In the world there is a constant increase in the pollution of freshwater sources. Chemical pollution is mainly caused by the extensive development of industry and agriculture, and bacteriological

contamination - lack of conditions to perform basic hygiene standards, primarily, sewer infrastructure (Danilov-Danilyan, Losev, 2008: 100-103), which currently 2.6 billion people do not have (World Water Assessment Problem, 2012: 196).

The problem of water security of the world's population is becoming more acute every year. However, it is considered premature to talk about the water deficit on a planetary scale (Makarov, 2013: 20). The total renewable water resources of the planet constitute about 42-44.000 km³ per year (Annand, 2007: 30), that is, one person has just over 6000 m per year, which is 5-6 times higher than the minimum acceptable norm.

Countries of the world are provided with the water resources extremely unevenly. The best provided with the water resources countries are: Brazil (8 233 km³), Russia (4 508 km³), the USA (3 051 km³), Canada (2 902 km³), Indonesia (2 838 km³), China (2 830 km³), Columbia (2 132 km³), Peru (1 913 km³), India (1 880 km³), Congo (1 283 km³), Venezuela (1 233 km³), Bangladesh (1 211 km³), Burmah (1 046 km³), and others.

39 countries of the world get most part of the required water from abroad. This is stated in the report of the United Nations development Programme (UNDP) on human development for 2006, which was devoted to the problem of access to water. Among others dependent on the water sources are close to Russia countries, such as: Azerbaijan, Latvia, Slovakia, Uzbekistan, Turkmenistan, Ukraine, Croatia, Moldova, Romania.

Taking into consideration the uneven distribution of water resources and that of the population of the countries, according to the database Allbest, the best situation with water resources per capita, is in French Guiana (609 091 m³), Iceland (539 638 m³), Guyana (315 858 m³), Surinam (236 893 m³), Congo (230 125 m³), Papua New Guinea (121 788 m³), Gabon (113 260 m³), Bhutan (BTN) (113 157 m³), Canada (87 255 m³), Norway (80 134 m³), New Zealand (77,305 m³), Peru (66 338 m³), Bolivia (64 215 m³), Liberia (61 165 m³), Chile (54 868 m³), Paraguay (53 863 m³), Laos (53 747 m³), Columbia (47 365 m³), Venezuela (43 8463 m³), Panama (43 502 m³), Brazil (42 866 m³), Uruguay (41 505 m³), Nicaragua (34 710 m³), Fiji (33 827 m³), South African Republic (33 280 m³), Russia (31 833 m³). The least provided countries per person are Kuwait (6,85 m³), United Arab Emirates (33,44 m³), Qatar (45,28 m³), the Bahamas (59,17 m³), Oman (91,63 m³), Saudi Arabia (95,23 m³), Libya (95,32 m³), and some others (http://knowledge.allbest.ru/geography/2c0b65635b3bc78b5d43a89521316d36_0.html).

However, as it was previously mentioned, water resources on Earth are distributed extremely unevenly. In Iceland, a person has about 539 thousand m³ of water per year, in Canada – 85.7 thousand m³ per year, in Russia - 30.5 thousand m³ per year. At the same time, in the UAE, a person has only 33 m³ per year, in Egypt - 22 m³ per year, and in Bahrain - 5 m³ per year. Obviously, in these countries the population is forced to exploit fresh water sources for the survival much faster than they have time to recover. Among the countries where water abstraction is more than 20% of total renewable water resources (this value is considered to be the lowest threshold of water stress (Danilov-Danilyan, Losev, 2008: 60)), now include such large countries as India, Saudi Arabia, Mexico, Iran, Kazakhstan, Spain and others. According to the researchers in this field, in about a decade, this list will include also the USA (36 States will face water stress within the next several years (Barlow, 2007: 5)), and China (Beddington, 2009: 4). Currently, most cities with a population of over 10 million people, including Beijing, Mexico city, Calcutta, Cairo, Jakarta, Karachi, Lagos, etc., are located in regions experiencing water stress (Barlow, 2007: 5).

The importance of the aspect of water quality makes us include into the analysis the enumeration of the regions that are experiencing actual or potential water shortage. Among them there are many countries in Africa, Asia and Latin America. In populous countries such as India, Bangladesh, Pakistan, Indonesia only a few percent of the population have access to sanitation, which leads to a discharge into water bodies of large volumes of untreated domestic waste water. In India in the area of Mumbai, there is only one toilet for 5540 inhabitants (Barlow, 2007: 5). The situation is only slightly better in Latin America where, with all the richness of water resources, only 15% of the population have access to clean drinking water (Barlow, 2007: 9).

In Russia, for example, the situation with the endowment of fresh water is generally more favourable than in most regions of the world. This is due to the huge amount located on the territory of the country water resources: Russia's streamflow ranks second in the world after Brazil. At the same time, water resources are distributed across the country unevenly. Despite the fact that in Russia on average intake is only 3% of the average annual flow of rivers, for some large reservoirs, located primarily in the North Caucasian Federal district, this figure has already exceeded the ecologically permissible limits (for the rivers as the

Kuban and the Terek, it is 80% and 68%, respectively) (Klaptsov, 2009). In addition, the quality of available water resources is unsatisfactory: 40% of the surface and 17% of underground sources of drinking water do not meet the standards of quality. Most of them are located in the European part of Russia (Klaptsov, 2009).

Water scarcity in a particular region happens due to the discrepancy of the dynamics of the demand and supply of this resource. For example, the demand for water increased 6 times during the XX century (Danilov-Danilyan, Losev, 2008: 64), and the supply of water resources is steadily declining in connection with the depletion and pollution of available water sources.

Among the factors influencing the demand, we can distinguish, firstly, the demographic factor. The demographic factor has a great impact on the growing problem of freshwater availability: annual population growth by 80 million people generates an annual increase in demand for water in the amount of 64 billion m^3. (World Water Assessment Programme, 2009: 30). A large part of the population growth is in developing countries where presently there is a scarcity of water, and in these countries the demographic growth is an important factor in the exacerbation of the problems under consideration.

Secondly, it is possible to select a group of socio-economic factors influencing the demand for fresh water. Continued economic growth leads to increasing of the demand for water resources. It is important to note that in today's world high economic growth is primarily characteristic of developing countries where the economic structure is dominated by water-intensive agricultural and industrial sector. There, industry and agriculture are not equipped adequately by water-saving technologies, and the service sector, which does not require significant amounts of water, is less developed than in developed countries (Makarov, 2013: 24).

The influence of resources endowment of the country on the emergence of technological innovation and its overall economic growth has been actively discussed in the economic literature. There are several areas of the study of this issue, one of them is the so-called "endogenous" or "new" growth theory.

One of the features of these works is that their authors claim that technological innovation is determined endogenously through private and public choices, but not exogenous (as it is

assumed in the neoclassical growth model). Empirical research on this topic is mainly trying to answer the question of why economic growth in poor countries cannot catch up with the growth in the rich ones. The school of endogenous growth argues that the answer is quite simple. Poor countries can't achieve higher growth rates, because they are unable to generate and use new technological ideas to enhance their economic benefits and opportunities. In particular, P. Romer (1993) pointed out that the quality of public institutions is the main characteristic feature which increasingly remotes geographical areas (or countries or cities) from each other from the economical point of view. The most successful regions will be those ones, where the most suitable and effective mechanisms work to support shared interests, particularly in the area of the emergence of new ideas (Romer, 1993). In this case, in his opinion, the inability of poor countries to move forward most often can be attributed to poor political decisions and weak institutions.

According to another approach, for example, that of E. Barbier (1994), in many poor countries the depletion and degradation of natural resources (such as arable land, forests, fresh water) contribute to institutional instability and prevent the occurrence of conditions necessary for the production and use of new ideas. Besides, they hinder the perception of knowledge from the outside world. It is alleged, for example, that in many cases it is resource security of the country which seriously influences the economies of developing countries, but not directly on economic growth, but indirectly, affecting the innovation potential of the country. Basing on the macro data, the researcher shows that in many countries with low and lower middle income - particularly those which at some time were dominated by very low growth or stagnation, there is an extremely acute problem of dependence on natural resources. These countries do not just live at the expense of direct use of the resource base (e.g. agriculture, forestry, fishing, etc.), but more than half of their export earnings comes from the sale of several types of primary products. Cutting down forests for arable land, low productivity in agriculture, land and groundwater degradation accompany such countries, weakening further their position (Barbier, 1994).

As for the countries with a shortage of natural resources, neoclassical growth model basically comes to optimistic results: even under conditions of exponential population growth and limited reserves of non-renewable natural resources required for production, steady growth and a stable level of consumption per capita is achievable (P. S. Dasgupta and J. Uh.Hilo, 1979; John.Stiglitz, 1974). Thus, E. Barbier (1994), in order to determine the way limited

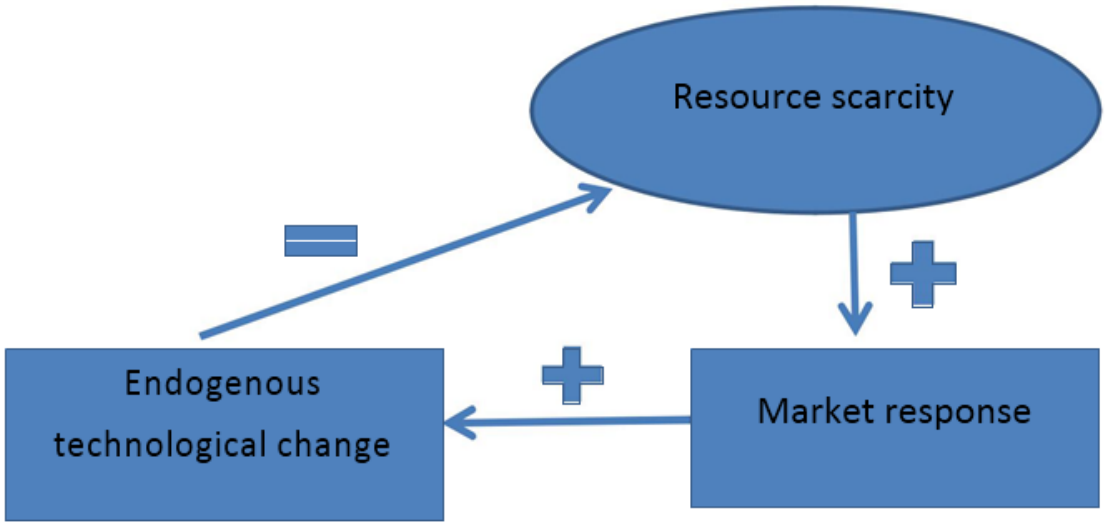
natural resources affect the growth of the economy, matched the model of exhaustible resources by J. Stiglitz and the model of endogenous growth by P. Romer, and came to a quite optimistic result: in spite of the endogeneity of technical progress in the model, it still effectively contributes to the enhancement of natural resources. This is because the use of human capital in innovation ensures that in the long term, "depletion" of resources can be postponed indefinitely.

T.E. Homer-Dixon (T. F. Homer-Dixon, 1995) also indicates a potential link between innovation and resource availability. He introduces the term "ingenuity", and shows that the proposal of "ingenuity" itself can be limited by lack of resources, especially in countries with low income levels. T.E. Homer-Dixon defines ingenuity as "ideas, aimed at solving applied social and technical problems" (Homer-Dixon, 1995). The ingenuity in his interpretation differs from the innovative potential of the population. The latter (innovative potential of the population) is basically the level of "technical" ingenuity, and this aspect is implied, in his view, in most papers on the topic of when innovation resource provision and economic growth. "Social" ingenuity is something that is commonly overlooked, despite the fact that, according to T. E. Homer-Dixon, this aspect of social activities is crucial for the development of the country.

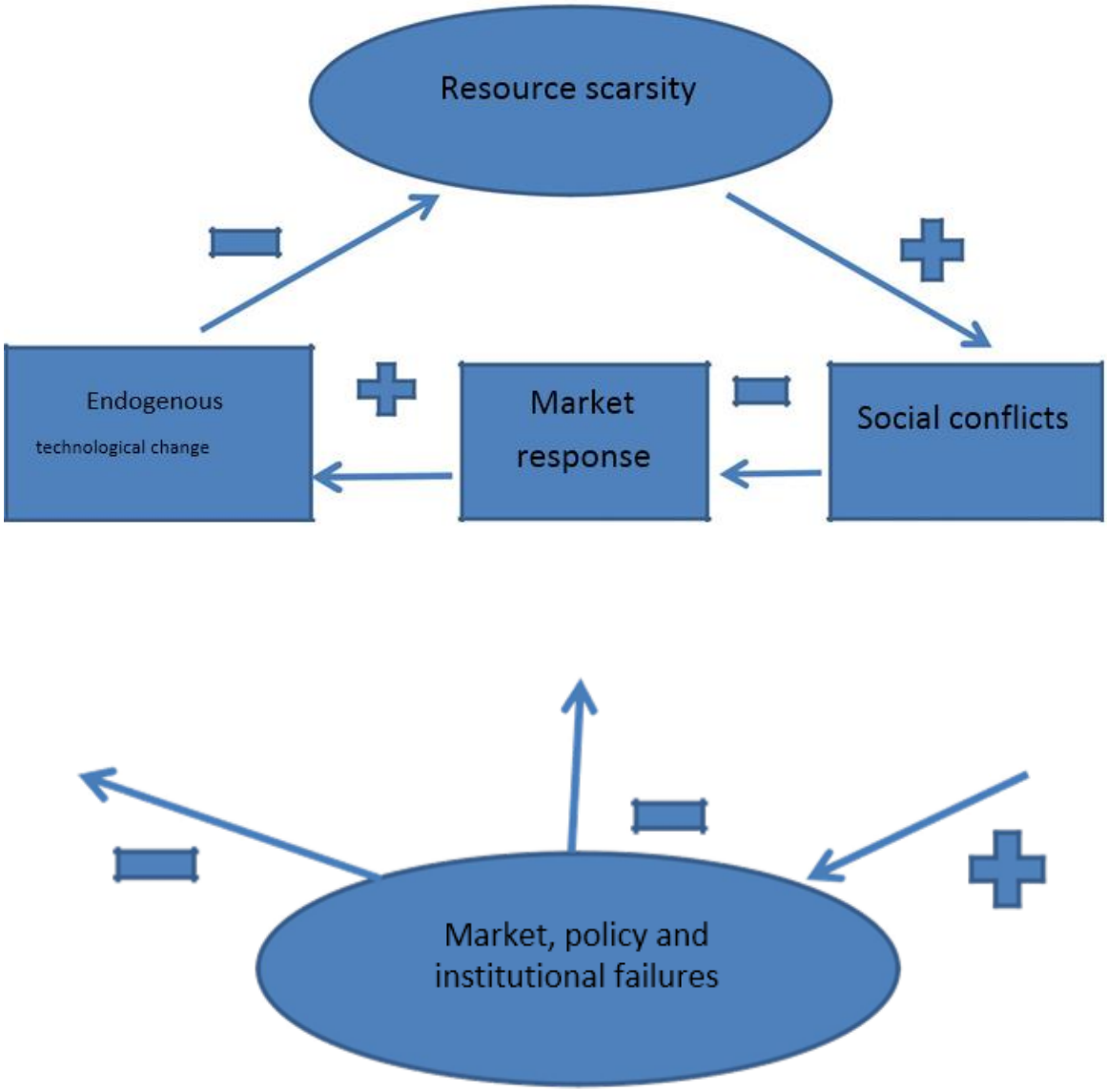
As Thomas Homer-Dixon states, "social" ingenuity implies availability and development (diversity) of ideas relevant to creation, reformation and support of social institutions. If the institutional structure of society is effective, such a system would provide psychological and material incentives to technological innovators and entrepreneurs, to help establish regular contacts and exchange of information between researchers, and their efforts will be more likely a success.

Th. Homer-Dixon also describes the specific mechanisms by which the lack of resources may affect the offer of ingenuity. Firstly, the lack of resources makes it an object of interest for small groups of people trying to get their rents from its use. Their rent seeking often involves violence and the use of power to reduce civil liberties, and in such situations, the human potential, which otherwise could be used for innovative purposes, is spent on the fight against "social tensions» (social friction). Secondly, according to the theory of endogenous growth, capital (fund) is a necessary factor in the development of innovative activities. In the case of the shortage of investment resources distribution of investments will

inevitably shift away from long-term goals, including innovative, to short-term ones, such as the solution of control problems and mitigating the deficit consequences. According to Th. Homer-Dixon's theory, the deficit of resources contributes to changes in local and central economic and political spheres. The scientist studies the situation with poor or developing countries in particular, claiming that the shortage of resources leads to social tensions and finally results in the insufficient use of ingenuity in the social sphere. This situation hinders the functioning of markets and contributes to political failures and institutional failures. The circle is closed. These ideas are illustrated by Th. Homer-Dixon in the following schemes:



Picture 2. Endogenous technological changes and resource scarcity (traditional approach



Picture 3. Endogenous technological changes and resource scarcity (alternative approach)

In light of these observations, we are extremely interested in the example of Israel as a nation, faced with the scarcity of natural resources. In particular, we are interested in the shortage of fresh water and its impact on the development of "ingenuity" in the sense that Homer-Dixon invests in this term, and on the overall economic development of the country.

We assume that in the case of Israel, the scarcity of water as a resource, played a completely opposite role - he has contributed to economic growth of the country. Moreover, it became one of the factors of its development.

The notion of economic growth is quite ambiguous and there is no theory of economic growth, which would be universally accepted and applicable to all the countries of the world. Moreover, as it was noted by V.A. Melyantsev (1996), lack of reliability of complex models is determined by significant losses of meaningful information. Therefore, using indicators of economic growth, driven on the basis of the system of national accounts adopted by the UN, the IMF and the World Bank, we must make allowances for the fact that, for example, in Israel, the so-called information sector which is not taken into account, is strongly developed, and, therefore, we will need to pay special attention to it in our study.

Innovations in the sphere of production and consumption of water and the institutional framework that allowed these innovations to occur and to be implemented, as well as "social" ingenuity, gradually changing the structure of the economy, "replacing" scarce resource by the sufficient one, allowed (and still allow) Israel to remain a developed country and show good growth even in conditions of severe shortage of fresh water.

Regarding water as an economic good has a long history. The main property of water that allows it to rank as economic goods, is that it really has a great economic value. Moreover, consumers in poor water regions compete for access to water source, including countries with arid climate, such as Israel.

Despite the fact that significant results are achieved in the scientific understanding of why the problems of climatic changes and water supply of the population with water are still not solved and how to make significant progress in their mitigation, economic science still has many urgent tasks in this sphere. Further efforts are needed on the linkages between the problems and approaches to their solution at the national and regional levels to develop coordination mechanisms between certain states and international institutions in order to reduce health risks and economic activities of the people and sustainable development of the world economy in the long term. Therefore, we attempt to investigate the situation of water scarcity on the example of the state of Israel, in which, despite the natural and climatic constraints to fresh water, there is a stable economic and social growth.

METHODOLOGY

Analysis of the problem of water security in conditions of global climatic changes was built on the results, achieved by the representatives of a number of scientific fields, among which there were the following ones: neoclassical Economics of the environment (in the study of relations of international trade and environmental issues), institutional Economics (in the analysis configuration of international institutions working in the sphere of ensuring global water and food supply and climate change mitigation), ecological Economics (in considering the concept of sustainable development), dynamic analysis of economic processes (in the study and evaluation of the role of innovation in mitigating problems of water security under global climate change).

Methodological and theoretical foundations of the research included microeconomic study of the water sector of Israel, the modelling of water pricing options and features of vertical-privatization monopoly of supplying fresh water by the company-monopolist, methods of international Economics, development Economics and Macroeconomics. The research was also based on the theory of innovative processes in the framework of the enterprise theory, as well as General economic study, including analysis and theoretical generalization of the essence, role and structure of the innovation factor in the economy. The author widely used comparative analysis to compare the studied country with its neighbours.

When writing the paper, the works of scientists were used, as well as works of the scientific groups of Institute of Countries of Asia and Africa at Moscow state University, Institute of World Economy and International Relations at Russian Academy of Sciences, Institute of Oriental studies of the Russian Academy of Sciences. Among the used statistical data there is information from open websites of the Knesset of Israel, Water Commission, the company "Mekorot" and the Central Bureau of Statistics of Israel. The research benefitted from one of the important sources, periodically produced in Israel – a Report of the Water Commission of Israel, which gives a comprehensive analysis of the current situation with the water resources of the country, as well as future projections of its development. While working on the thesis were used the materials of the UN organization, the World Bank, the International Monetary Fund (IMF).

RESULTS

5.1. Geographical and climatic features of the state of Israel

Israel is a small country with distinct Mediterranean climate. However, due to the presence in its territory of plains, and (relatively low) mountains, the amount of precipitation varies greatly depending on certain districts. More than half of the territory of Israel (65%) is desert Negev, which annually receives not more than 35 mm of precipitation; the amount of precipitation in the North of the country is an average of 700 mm of rain per year (Y. Kislev, 2001).

The rainy season lasts from November to April, but in dry years it may not happen to be. The climate, however, gradually changed to more arid one. According to experts, the average temperature in the region is gradually rising and rains are becoming less frequent. It is estimated that by 2050, rainfall in Israel will be less by 20-25% in the summer season, by 10-15% in winter (from October to March), and the temperature will increase in 2-2.75° C in summer and 1.75-2° C in winter (Ragab, Prudhomme, 2002: 39).

The main reserves of fresh water in Israel are concentrated in the lake Kinneret (sea of Galilee) and a few underground aquifers that collect rainwater. The sea of Galilee is filled mainly by water brought by the Jordan river, major tributaries of the Dan river, the Hasbani, the Yarmouk and the Bania. The Hasbani brings in an average of 157 million cubic meters of water annually, the Bania - around 157 million cubic meters, the Dan river – around 258 million cubic meters, the Yarmouk - 400-500 million cubic meters (Morag, 2001).

The Hasbani flows from the Lebanese side of the Golan heights, the Bania, and the Dan flows in the territory, which became Israeli after 1967, and the Yarmuk originates in Syria and flows first along the Syrian-Jordanian border and only 10 km South of the sea of Galilee flows into the Jordan.

According to R. Sanders, this situation is not critical to Israel yet, however, if the exhausted Israeli neighborhoods will one day make a more successful attempt to improve their economic situation and will increase their demand for a controversial water, the situation can lead to tragedy (Sanders, 2009). In 1964 upon completion of Sluice-Israeli, Israel faced

the problem clearly. The conduit includes underground pipes, open channels, reservoirs and tunnels, and in order to fill the system with water, it was decided to divert water from several Arab settlements, and this caused discontent of the latter, so this project came to be regarded as part of Israel's aggressive expansion.

Soon after, the Syrians began the implementation of water project in the Golan heights, and in the course of work took some of the springs feeding the Jordan. The Palestinians have drilled approximately from 150 to 260 illegal wells in the North of the West Bank and in the area of Jenin, in spite of the water agreement signed between Israel and the Palestinian authority, in which Israel took upon itself the obligation to ensure the delivery of a sufficient amount of fresh water to Ramallah. Such a large number of wells that were swaying the water from underground tanks, led to its salinization.

In 2002, Lebanon rejected the U.S. demands to halt the diversion of the waters of the Wazzani river. This river is a tributary of the Hasbani river feeding the Jordan. The Israeli side insisted that the way Lebanon deprives it of 15% of all the freshwater, and does it deliberately - the Lebanese could use for their needs the waters of the river Litani, which flows into the sea.

Underground aquifers give Israel 58% of its fresh water. The largest of these are the so-called Mountain reservoir and Coastal reservoir. The mountainous part is located under the West Bank, and this is a big problem for Israel, as the drainage area from which the water is collected into Yarkon-Tennisistki, Northern, and Nablus-Jenin tanks, are entirely under the West Bank, but the natural flow of water from them comes down to the valleys belonging to Israel. Thus, based only on hydrological data, both the Israeli and Palestinian sides can rightfully declare these waters to be theirs (Moore, 1994).

Israel builds desalination plants, but there are at least two serious problems. First, desalination requires huge amounts of energy. Second, the salt remaining after the desalination requires disposal. Previously it was dumped back into the sea, which makes coastal waters even more saline and harms marine organisms.

The second way is to change prices on water. Prices cannot have an incentive to reduce consumption: they have an incentive to improve the efficiency of water use. Discussion about "fair" (efficient) price for water has been going in Israel for many years. Supporters

of lower water prices see it only as reducing their income, supporters of increasing prices show that the price increase will lead to increased efficiency of water use and, ultimately, to higher incomes (Arlosoroff, 2004).

Thirdly, it is possible to promote water conservation and prohibit to expend it for certain purposes. Both of these are used by Israel. In times of drought it is forbidden to consume the water allocated within the quotas for "garden" - gardening at houses. All these and other ways of dealing with water scarcity will be further discussed below.

However, in our opinion the main bet is made by Israel on a kind of "substitution" of diminishing scarce resource (water) by the resource available in the country in a much larger capacity (innovative potential). Understanding that there will not be more water than there is now, and that the existing stocks from the point of view of international law are controversial and there is practically no way to negotiate their rational use, led to the fact that another solution was found. It is necessary, first of all, to intensify the use of resources, especially in agriculture, consuming most of the fresh water, and, secondly, to develop technologies to use the same water several times.

Since the early 90-ies of the 20th century Israel has made a giant leap forward in the development of technologies to desalinate sea water, treat waste water and reduce water loss caused by the imperfection of its means of delivery. But even before it, the innovations connected with saving water in agriculture made the Israeli agricultural sector consisting of "95% science and 5% of the work" (Señor, Singer, 2009: 226). Thus, water scarcity spurred the development of high technology in this area, and finally becomes one of the factors in the development of the whole country.

T. Allan (2000) suggested one of the most foolproof approaches to count out the deficit of fresh water. According to his approach, you need to consider not only tap water but also the water required for the necessary production of food for everyone (so-called "virtual" water). The world average per person should be about 1,000 cubic meters of water every year. If the country's population is 7.5 million people, it makes 7500 million cubic meters per year. It is also necessary, according to T. Allan’s scheme, to add here the needs of households and industry in pure water, which comes up to 8300 million cubic meters per year (Allan T., 2000).

Rains fill up 1600 million cubic meters of this amount annually (except for dry years), about 2000 million cubic meters is available to Israel from underground and surface water sources subject to desalination and wastewater treatment. 500 million cubic meters of virtual water is extracted from this amount as it is exported abroad each year in fruits and vegetables, and we get that the total supply of water in Israel reaches 3100 million cubic meters. Accordingly, the water deficit will reach 5200 million cubic meters per year. Part of the deficit is covered up by import of food products, primarily grain. According to Allan's calculations, Israel imports annually 3800 million cubic meters of virtual water, which reduces the deficit up to 1,400 million cubic meters, but does not eliminate it. These figures are clearly shown in Picture 4 below:

Picture 4. Water requirements and replacing water in Israel according to T. Allan's approach (2000).

Water requirements (mln):

Food (1000 cubic meters per person per year)	7500
Household needs	650
Industry	150

Available water:

Filled up with rains	1600
The tanks, the pool of the Jordan, desalinated or obtained from	2000

drains water	
Export	-500
Import of “virtual” water	3800

Picture 4 illustrates, first of all, Israel's dependence on food imports, which is characteristic of all the Middle East countries: but for the import, they would have nothing to feed and water their people with.

It is noteworthy that the deficit in this calculation is higher than the deficit calculated simply by comparing the consumption in the country of fresh tap water and the volume of water contained in natural sources that can be consumed without harm to the environment.

According to Y. Kislev, in 2001 households and industry of Israel consumed 720 mln cubic meters of water per year, and agriculture consumed 1130 mln cubic meters of water per year. It is 500 million cubic meters more than the annual volume of fresh water available to Israel without violation of the water balance of the region) (Y. Kislev, 2001).

5.2. Structure of water consumption in Israel. Water price.

5.2.1. Agriculture of Israel.

Israeli agriculture currently consumes approximately 65% of all freshwater in the country (the world average is 70-75%), producing only a little over 2% of GDP, and in the past, its water consumption was even higher. Besides, 80% of the consumption value of this industry water is paid by the state. Urgent need to change something in this situation is clearly understood only by the conscious part of Israeli society. But it comes across mythological system of stereotypes of other parts of society, crystallized over many years of the domination of Zionist ideology in the country.

Even before the founding of the State, agricultural sector was considered as one of the priority sectors; it remains prior now. Introduction of new immigrants to rural labor had a symbolic meaning - it was, first, labor, forbidden to Jews in many countries of the Galut (exile), and, secondly, cultivating the land, the Jews thus claimed their rights to it, expanding the territory of the Yishuv (pre-state Jewish settlement).

"The transformation of the desert into a blooming garden" was of paramount importance: to late 60's of the twentieth years of 20th century Israel grew rapidly in green area; there appeared forests there, planted with the financial support from the specially created for this purpose Fund (Keren Kayemeth LeIsrael). This required a large expenditure of water, so the country developed state policy on agriculture and water resources, based on the following principles, described in detail by G. Menahem in his article “Policy Paradigms, Policy Networks and Water Policy in Israel” (Menahem, 1998):

1. The state is obliged to support the expansion of agricultural land as the basis of nation and state building;

2. To do this, one of the most important tasks of the state should be regulating and subsidizing the use of water in amounts necessary for the expansion of agriculture.

3. Exploration and commissioning of new water sources is also necessary for the growing agricultural sector.

5.2.2 Legal aspects

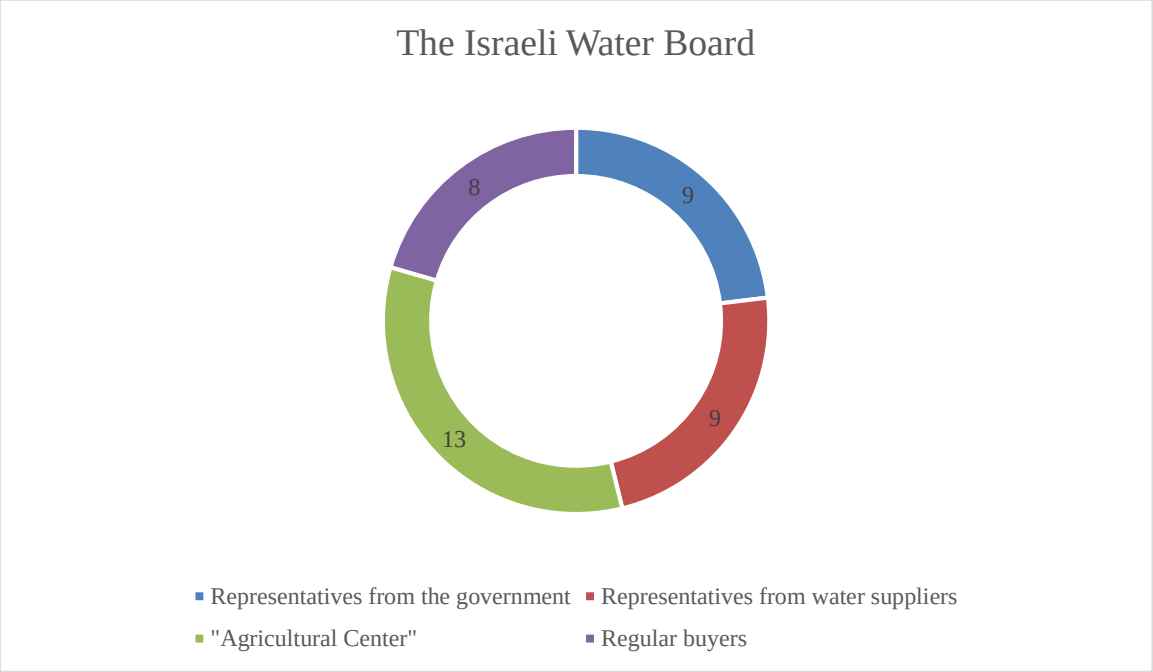
The law on water adopted in 1959, fully reflects these principles. Water is declared the property of the state (along with all other natural resources). The owner of the land cannot be the owner either of the water flowing through the site, or the water flowing under it (that is, he cannot be the owner of the water source).

In addition, the law establishes the order of water use separately for each sector of the economy. For example, in agriculture the consumption of water was installed in accordance with the type of cultivated crops, soil type, climatic characteristics of the area, and so on. At that time was also created the system of state bodies, responsible for regulation of the water system of Israel. This system remains completely agricultural.

The main body responsible for establishing norms and standards relating to the quality of water, quotas on its use, its price and other issues is the Ministry of Agriculture. The head

of the Water Commission appointed by the government on the recommendation of the Minister of Agriculture, is responsible for the development of new water resources, regulating the use of existing, as well as for continuous monitoring of water quality supplied to consumers. Water Commission itself acts as a parliamentary Committee comprising members of the committees on economic and financial policies.

The Water Board is an Advisory body to the government, which is obliged to coordinate their decisions on water the Minister of Agriculture, which he runs. 39 other members of the Board comprise 9 representatives from the government ministries, 9 representatives from water suppliers and 21 members from the buyers of water. 13 of these 21 representatives from the buyers of water are members of the so-called "Agricultural Center" - the unification of the majority of agricultural producers in Israel.



The Israeli agricultural sector traditionally supports the Labour party ("Ha-Avoda"), and this party is their representative in the Knesset. It also means that, as the Labor party is one of the largest and most influential parties of Israel, it usually guarantees it several Ministerial portfolios, some of those nine representatives from the ministries that are included in the Water Board also support agricultural producers.

5.2.3. Water supply

Y.Kislev (2001) distinguishes two more groups of interest, in addition to agricultural workers, whose effect on the economy of water in Israel can be called noticeable. One is the employees of the company Mekorot, the main supplier of fresh water in Israel. The other includes representatives of the "green" movement and their sympathizers.

Agricultural workers are interested to get large volumes of fresh water at the lowest price. Water is a key resource in agriculture, so agricultural lobby in Israel is well organized, and its impact on the pricing system is great. As the cost of water does not constitute a significant share in the budget of households and the industrial sector, the agricultural lobby is not experiencing from their side any visible counter.

Employees of the company Mekorot (about 2,200 people), united by the powerful Union, control the supply of water. They are interested, first of all, in growing their personal income and their salaries, as it has already been mentioned, are nearly the highest in the country. Constantly rising wages are, of course, recorded in costs of water production, but they do not seriously affect the water price: workers' support of a monopoly position of the company has the most significant impact on prices. The organized opposition of privatization of the company for more than ten years does not allow the state to make even slight reforming. Protecting the monopoly status of the company, the employees refer to the fact that it gives the company an opportunity to finance large and costly water projects that will not be mastered by a smaller company.

Representatives of the "green" movement interested in preserving water balance do not have a big influence on water policy of Israel. Their representatives are not included into the Commission on water and do not sit in the Knesset (on the contrary, one of the recent Chairmen of the Water Commission, for example, was a former chief engineer of the company "Mekorot").

As N. Shilova notices, in Israel, many ways of influencing the demand and supply of water, including its price, have been tested for several decades of its history. All of them are accompanied by changes in political views of society and were used as the tools in the political game. The specificity of water as an economic good, and all those characteristics that we have listed, played always an important role in the political discourse for a "fair" price for water. Israel is characterized by a significant degree of state centralization and

active participation of the state in all spheres of life. State control is exercised over the majority of national resources, in particular, ownership of land and water. Many companies are partially or fully owned by the government. Another important aspect of Israeli political and economic life is that the basic framework of the political system and structure, interest groups, and the concentration of economic resources in the public sector but basically repeat the political pattern that existed at the time of the founding of the state in 1948 (Shilova, 2011: 52).

Today the largest manufacturer and supplier of water in Israel, as already mentioned, is the state company monopoly Mekorot (2/3 of the total consumed water volume). And only a third of the water is swinging from wells located on private land supplied by municipalities and regional cooperatives. Mekorot provides water "to the gates of the city" and guarantees a uniform price for water supplied for all cities regardless of whether they are in the valley or in mountainous areas. This is because the price of water "at the gate" set by the government (prices must be approved by the Knesset) is not based on the study of cost structure for its delivery, but on the basis of many other factors, sometimes only indirectly related to water issues.

5.2.4. Pricing

The water price is annually reviewed and adjusted in accordance with changes in the cost of living in the country and the level of alleged subsidies. "Agricultural" lobby demands subsidies for agriculture, including for the payment of up to 80% of its value from the state pocket; they are often echoed by politicians seeking political gain at the expense of populist decisions. Therefore, water is supplied to the cities at a price of $0.35 per cubic meter, and for agricultural purposes farmers receive water at an average of $0.25 per cubic meter. Though, according to B. Portnov and I. Meir (2008), the average cost of production of one cubic meter of water in Israel is $1 (Portmov, Meir, 2008).

Thereafter, the municipality has the right, acting within certain predetermined limits, to set the price of water for households. As it often happens, the poor and large families have discounts on the payment of water, but the average payment plan is as follows:

For the first 16 cubic metres of water a household pays $0,61;

for the next 14 cubic metres - $0,89;

anything over this amount, a set fee equal to $1.27.

The city may additionally require households payment for "sewer tax" of between $0.2 and $0.6. A separate line of household expenditure is so-called "water for irrigation". It is supplied into the houses from April to November at a price of $0,61 per cubic meter in the volumes corresponding to the size of the "garden" belonging to this household.

Without exception, all the users of water additionally pay $0.03 per each consumed cubic meter of water in the "repair Fund" of the Ministry of Internal Affairs. This money should be spent on repairing and improvement of water infrastructure "to the city line", and inside the city the repairing is managed and performed at the expense of the city budget. That's why municipalities and given the right to set the price of water at a higher level than they bought it from Mekorot. However, municipalities may not invest in infrastructure, because as soon as the loss of water due to the poor condition of the pipes reaches 12%, the city comes under the state program according to which it receives money from the "repair Fund," allocated for engineering work and allocated consultants (Y.Kislev).

If the city has its own water sources, it pays to the State Treasury $0,13 for each cubic meter of water, if the source is underground and only $0.11, if the source is on the surface (only Tiberias pays this tax).

Hotels have to pay water rate of $0,42 per cubic meter, enterprises pay $0,36. Of course, not all municipalities are equal. In Israel 263 of the municipality, which differ in their status, including:

Big cities (ruled by City Councils) - 64 municipalities,

Towns (ruled by Local Councils) - 146 municipalities,

Regions (ruled by Regional Councils) - 53 municipalities.

Water supplied by regional councils is generally considered to be "water for agricultural purposes", although part of it is consumed by households. Municipalities vary significantly in the average level of income of their residents. Cities with a large proportion of the Arab population is usually much poorer. Typically, the population of more affluent municipalities use more water per person per year than the population of the poor ones, but the average water consumption for all regional municipalities per person per year is approximately 60,

5 cubic meters per year, for all urban municipalities - about 86,1 cubic meter per year per person.

Agricultural consumers pay $0.2 per cubic meter for water use, but can consume it only within the quotas, and the above price is only for the first 50% of the water consumed in the framework of the quota. The next 25% cost $0.25 per cubic meter, the remaining part of the quota of $32 per cubic meter (Y.Kislev, 2001). As it turned out, this pricing system was quite effective: the demand for water by the agricultural producers stopped its growth (from the households, as already mentioned, demand growth continued in absolute terms, however, the water consumption per household has decreased).

The quotas of water consumption proved effective in the sense that it really encourages customers to save water, but the lack of seasonal or regional differences in the payment of water is a constant criticism. On the one hand, discrimination at the place of residence seems socially unjust, and, on the other, you can't force people living on the plain, to sponsor the water consumption of the inhabitants of the mountainous areas. However, according to Y.Kislev, this problem is not as complicated as it seems: since water in Israel is a national property and belongs to all citizens of the state, they must recognize their shared responsibility for water resources, and in this case, the effectiveness of the pricing system even at the expense of the diversification of prices by regions will look like the recognition of necessity, not social injustice (Kilsev, 2001).

5.2.5. Water demand .

The excess of consumption over stocks of water is ensured through the use of treated waste water. Several factories were built, which desalinate and clean the used water. These enterprises use a fairly expensive technology of cooling (freezing) of water, so, even though Israel has sold hundreds of such plants around the world, they are not so frequent in the country: the largest of them work in Eilat and the North of Aqaba, producing daily 45000 cubic meters of fresh water per day, clearing drains, and 10,000 cubic meters a day, desalinating sea water (Drezin, Tenne, Hoffman, 2008).

In the mid-90s this amount of cleaned water became clearly insufficient, and Israel encountered a necessity in the transition to 1) less costly technology and 2) large-scale projects. It was decided to choose the construction site in such a way as to reduce the costs associated with

- the transportation of fresh water (to build closer to end users - populous cities);
- transport of water intended for processing (closer to the sea);
- the value of the land on which to stand and a plant (land close to large cities are very expensive);
- to reduce energy costs (to connect to existing power plants);
- try to incorporate plants into the existing grid infrastructure, which was built in 1964;
- avoid construction in areas of archaeological value.

As a result, Water Commission chose Ashkelon as a most suitable place for construction site and in 2005, the desalination plant began to operate, producing 100 million cubic meters of water per year. The next plant was built in Palmachim in 2007. It produces 30 million cubic meters of water per year. By 2020 it is planned to build more plants and to increase the volume of desalinated water to 650 million cubic meters (Drezin, Tenne, Hoffman, 2008).

Cities collect runoff and drainage water and recycle it so that the water could be reused. This water is sold to agricultural settlements located near the town for irrigation. It is tougher than drinking water, but quite suitable for plants. The price of this water is set by the city on the basis of costs in terms of production and size of government subsidies. Today, about 50% of agricultural land is watered with such water.

Collecting runoff and drainage water by the cities solves simultaneously several important tasks:

- Ecological problem: Before refineries were built, private homes in Israel had a separate sewage wells where sewage slowly trickled into the lower soil layers, including those aquifers. It must be noted that after construction of the plants waste from the water processing was discharged directly into the sea, and the waves were washed up on Tel Aviv beach. Today, however, the problem is almost solved - there are also waste recycling plants.

- The problem of water quality for agricultural purposes. For watering people can use water of somewhat lower quality than drinking, so Israeli farmers have complained that they are not willing to pay money for such a high degree of purification of water, which the company "Mekorot" offers for the urban population. Recycled water is really not of very high quality, and it is served in the agricultural settlements along with the "parallel" water network not to be confused with that intended for drinking.

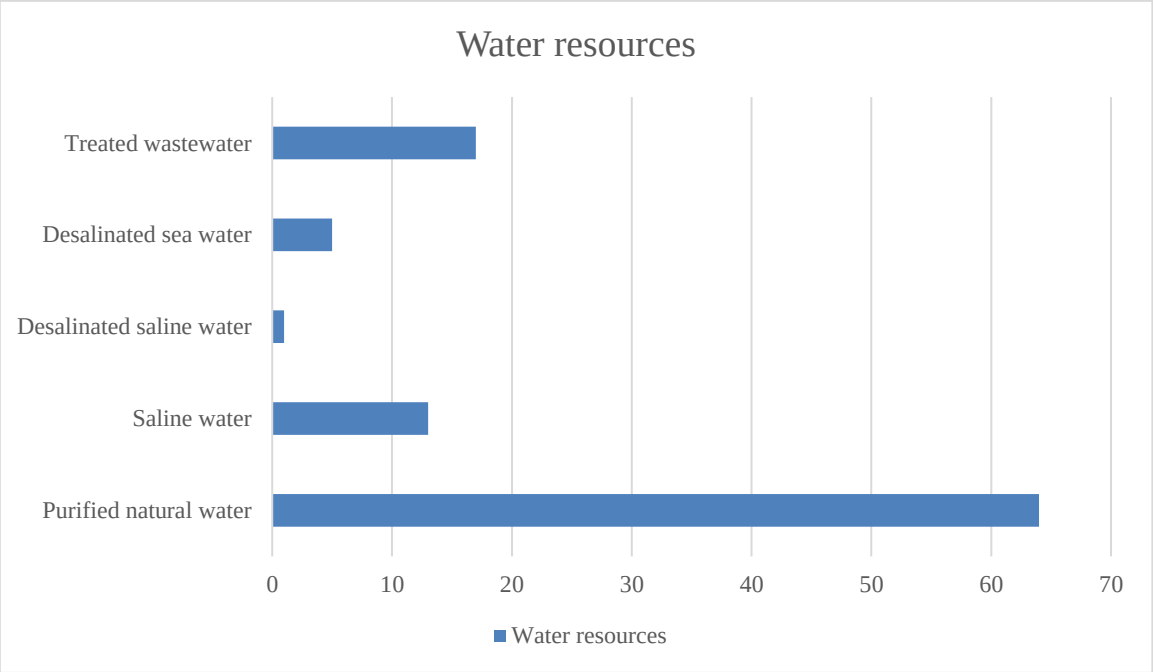
- The problem of water scarcity is partially solved. The volume of water produced from wastewater is constantly increasing as the state invests in the construction of the intended plants and pipelines; private investors, however, are unable to participate in the construction.

There are projects of improving the quality of water produced by the secondary treatment of sewage, and of creating the pipeline to merge the two systems into one (and that of avoiding the construction of new networks for recycled water by its running through existing pipe, which today gives drinking water), however, these projects face resistance from the agricultural sector, which does not need such a high-quality purification of water.

This scheme is not "a cycle" for several reasons: the water that was used (once or twice in the case of treated sewage), returns to this cycle only in very small amounts. Most of the water evaporates from the fields, some flows with wastes at sea, part of it exports in vegetables and fruits abroad, a part of it is absorbed into the soil, but not in the places where this would help to raise the level of water in aquifers.

In fact, there is no cycle of water in Israel: aquifers are filled only by rainfall, the Kinneret is completely dependent on the tributaries of the Jordan and the rainfall. Therefore, the decision about secondary processing of already used water was a successful attempt to return at least a portion of the water circulation. In total, returned to the circulation water is 17% of all fresh water consumed in Israel. This information is reflected in Picture 5:

Picture 5. Water resources (according to the site of the company "Mekorot" (mekorot.co.il):



Purified natural water

64%

saline water

13%

desalinated saline water

1%

desalinated sea water

5%

treated wastewater (sewage)

17%

In addition to changing the proposals, Israel has made constant attempts to influence demand. To reduce the consumption of fresh water, there have been made many different legislative steps: more than 20 years ago, it was forbidden to cultivate cotton in Israel,

because it require copious watering; severe restrictions were introduced on construction and operation of domestic pools; there was a special law prohibiting to water lawns during daylight hours, etc. Of course, these measures in some way contributed to the saving of fresh water, but they could not be the solution. At the same time with the introduction of these laws, the number of private homes surrounded watering gardens (front gardens) dramatically increased in the country. Besides, mass transition of Israeli Bedouins from a nomadic to a settled way of life required appropriate extensions of the existing water infrastructure.

The continuous population growth and the transition to higher living standards, nowadays remain the drivers of growth in demand from households throughout the state's history. In addition to this, there is another important factor: the burgeoning cities have reduced the area of open land, which was the source of water in the aquifers. It has been estimated that every square kilometer covered with concrete or asphalt, reduces the amount of the water entering he aquifers in the rate of 114,000 cubic meters per year (Morag, 2001).

Since 1999, the country has a system of taxes on extraction of water by private individuals. The tax rate is determined for each area based on calculations, performed with reference to the damage brought by this well to the overall water balance of the area, so the taxes are constantly being revised and changed. The obligation of paying a tax falls on the person who drains the water, but he can raise the necessary funds by selling water to other consumers. In this case he can't put a price on water himself: the price will be calculated for him based on his costs and data on the quality of water he supplies. If the person refuses to pay the tax, the Water Commission has the right to forbid him to use the well and “freeze” it. The state, on the contrary, financially supports private initiatives to develop new ways of water purification and desalination.

5.3. The solution of the problem of freshwater scarcity

5.3.1. Roots of a problem

Water crisis in Israel began in the 70-ies of the 20th century and repeated more and more often through the 70-ies, 80-ies and 90-iess. Despite this, the government continued to lay a large percentage of water for agriculture into planning of water consumption. Moreover, agricultural state authorities were unanimous in the opinion that water price cannot be a tool

for managing water demand in agriculture. This led to the government subsidizing water prices (up to 80% of the cost of water paid by the state).

During 1970-1990-s, water price for agricultural needs was more than three times lower than for households. The Ministry of Finance, being opposed to such a policy, has not approved of any fairly large project for development of water infrastructure, which has led to sharp deterioration of water reservoirs and salinization of water.

The rapid population growth caused by mass migration from the former Soviet Union, as well as several years of drought has caused a new crisis. In 1990, the State Comptroller published a report which referred to serious degradation of the aquifer (salinization), and the necessity to improve the quality of drinking water. The excessive water use in agriculture was named the main reason for those problems, accompanied by "low water prices for agricultural producers" (State Comptroller, 1990).

This report attracted the attention of the Israeli public. It was supported by many scientists, including economists, who insisted on the inadmissibility of such a policy, which helps to ensure growing of cultures, whose ultimate value does not even cover the cost of production of water for irrigation (Yaron, 1991).

Moreover, as Ran Mossenson, in particular, argued, in fact, the government thus subsidizes the export of Israeli water abroad in the form of sales of the crops, needing extra water (Mossensen, 1991).

5.3.2. Changes in consumption

Over the next few years, there has been a debate about necessary changes in the water consumption; amendments to the Law on water were made and cancelled again; a wide advertising campaign aimed at encouraging people to save water was conducted. Plans of major changes related to the privatization of water sources and infrastructure in Israel first appeared in the mid-90s, but still researchers agree that the foreign policy problem of uncertainty of water rights does not make it possible to privatize water. Another way to solve the problem was proposed by Y. Kislev, Professor of the Jerusalem University. It is the sale of unused quotas (Kiselev, 2008).

This method would help the transition to a more efficient scheme water use by final consumers. In addition, the cost of water should also include the cost of transportation (in

the mountainous areas the water should be sold more expensively than in low-lying), because there is no reason for some consumers to sponsor water consumed by others.

To make it possible, all the issues related to water were to be withdrawn from the authority of the Ministry of Agriculture and passed to the Water Commission, which would not have a majority of votes of the representatives of the agricultural sector and which would include not only them, but also representatives of the Ministry of Finance, Ministry of Industry and Trade, Ministries of Health and those of Environmental protection.

The same researcher, Y. Kislev, suggested another way to transfer the production and transportation of water in private hands, not contrary to the substantive content of the Law on Water: "water" franchise. Franchise as a special right to provide, for example, public services such as electricity, water or gas may be sold to a private company, in this case, firstly, the water itself does not become private, and, secondly, there is no need to lay the new private water pipe next to the state one. The concept of a franchise implies the existence of a certain "social contract", which includes the following elements:

- In exchange of receiving exclusive rights the company agrees to provide service to all the consumers without exception within the boundaries of the delineated areas, at an appropriate level and of an appropriate quality (for comparison: a farmer who grows tomatoes for sale in the market is not limited to any obligations: he chooses the volume and quality of the goods himself).

- A long-term commitment taken by the firm will require analysis of changes in demand, develop long-term plans for investment in infrastructure and equipment. The state is often not able to finance all the suggested projects of improving water supply, therefore, the activities of private firms, according to Y. Kislev, will be the most effective.

In order to prevent the abuse of monopoly power of the firms, the Law establishes public control, carried out in two ways:

- Monitoring of the implementation of the firm commitments on volumes, water quality and water supply to all users without exception.
- Control on the water price.

- Water prices are set according to the costs of the firm and a certain profit margin set by the state.

- The principle of "openness" of information about the activities of the franchise should be respected.

- The most important point in the franchise activity is the institutional (public) responsibility for the results of its operations.

5.3.3. Solutions

One of the most appropriate projects is the restructuring of the company "Mekorot". It involves the following:

Since water supplying infrastructure, for obvious reasons, cannot be "duplicated" by competing companies, it is planned to privatize all the remaining units of the company, dividing the company "horizontally". One of the options of privatization involves dividing it into three large parts:

1. Companies, delivering and distributing water in various parts of the sluice-Israeli (i.e. in different regions of the country - relatively speaking, the Northern, Central and Southern companies).

2. Company – the shareholder.

3. A company engaged in the planning and development of water network.

The company, which gets the right on pumping, will not receive rights to the water itself – the amount of pumping will be determined by the state for reasons of environmental safety.

The state has already taken a giant step forward, starting in 2007 and almost completing the reformation of the urban water and sanitation. Today we can state the steps which have been taken.

Since 2007, all local authorities were to gradually transfer the water supply and sanitation in the hands of private corporations. It was assumed that this will lead to the achievement of several important objectives:

• Ensuring of the level of quality and reliability of providing services at reasonable and fair prices.

• The direction of the income generated from the provision of water services and sanitation investments in water supply and sanitation operation and provision of services.

• Raising capital for investment in water and sanitation.

• Transition to commercial, efficient, professional management of water supply and sewerage at the municipal level.

• Encouraging of the conservation of water and other resources, protection of water resources, public health, environmental protection and landscape and the prevention of pollution of the sea and streams through the fault of the water and sanitation sector.

• Encourage competition in the provision of appropriate services.

All those objectives are reflected in the Principles of budget 2009 (Water management), published in Hebrew.

The Corporations, created in the framework of this reform, are in full possession of the local authority and operate under license issued by the Responsible Manager in the Israeli Ministry of Internal Affairs. The powers of the Responsible Manager include approval of creation of the Corporation and ensure proper service provided to the population. The establishment of tariffs and criteria by which the Corporation acts is run by the government office for water and sanitation.

The reform, according to its developers, should give great benefits to the consumers and the whole economy of the country. It is certainly assumed that the commercial professional management will be more effective than the state one, and that there will be third-party investors willing to invest in updating systems and improving service quality. It also meant raising independent capital without the support of the governmental and municipal funding sources.

To encourage the establishment of corporations and the reconstruction of infrastructure of water supply and sewerage, the government has provided substantial grants in the amount of tens of millions of shekels for those municipalities that create a Corporation. These subsidies are divided between the local authority where they go "for development", and the Corporation.

The important point remains, however, that "plug" of prices continue to be approved at the state level.

As one of the solutions to the problems of fresh water shortage in Israel, the projects of purchasing it in other countries were considered. Perhaps in the future Israel will be forced to implement such a project, as the construction of desalination and sewage treatment plants require large investments. Besides, desalination plants are dangerous for the environmental situation in the country, because remaining after desalination mineral substances are dumped back into the sea and cause salinity of the coastal zone, which negatively affects creatures living in it and marine life.

There were also projects of procurement of fresh water in Turkey and the transportation of icebergs, but these projects have remained on paper primarily due to the high cost of such enterprises. Another project is transportation of the water of the Egyptian Nile deserves more attention. According to the calculations made by Fishelson (Kimenyi, 2015), this project could become environmentally safe and attractive for both sides for several reasons:

1. Large volumes of Nile water just evaporate and stagnate in swamps, located along its riverbed.

2. Irrigation technology, existing in Egypt, gives a very low marginal product of Nile water at less than us $0.05 per cubic meter.

3. The volume of water that would be required for deployment to Israel does not exceed 1% of the annual Nile flow.

As L. Fishelson states, Egypt could intensify agricultural production and reduce its "water intensity", if it introduced used in Israel water-saving technologies. Today, the annual consumption of water in Egypt per acre cultivated agricultural land is 6000 cubic meters. This amount could be reduced by at least 30% through the use of sprinklers, and 40% after the introduction of drip irrigation.

Today, the annual consumption of water in Egypt per acre for cultivated agricultural land is 6000 cubic meters. This amount could be reduced by at least 30% through the use of sprinklers, and 40% after the introduction of drip irrigation (Zygmunt, 2007).

At the moment, neither the Egyptians nor their government are willing to invest in the modernization of agricultural technology. Moreover, the Egyptian farmers have no incentives that might encourage them to reduce water use. For a typical Egyptian peasant, processing 4 acres of land, spending $4400 on the sprinklers is too expensive, taking into consideration the fact that its annual income does not exceed $1500. For the Egyptian government introduction of water saving technologies in the territory of one million acres of land would cost $1.4 billion, and such expenses are not included in its immediate plans. So Fishelson offers, in fact, exchanging water and technology: Israel supplies Egypt appropriate equipment at preferential prices, and Egypt directs to Israel half the volume of water that it saves using this equipment.

This new technology will allow Egyptian farmers to reduce the amount of fertilizer (if fertilizer is fed through the sprinklers, they are more evenly distributed) and to increase the productivity of land, which, in turn, will positively affect their income. According to researchers, the marginal cost of supply of the Nile water will be even lower than the desalination of seawater, however, mutual economic benefits can not overcome political ambitions, and the project is not yet implemented (Kimenyi, 2015).

A successful example of water cooperation of the conflicting parties in Israel can be considered a "Union of cities around Karmiel for recycling". This example of regional cooperation is not the only one, but it is especially significant, because it includes both Jewish and Arab cities. The total population of the region is about 120 thousand people, of which 70 thousand are Arabs.

The Union was established in 90-ies of the last century with the aim of unification of the system of sewage and the construction of a general processing and cleaning plant. It is very expensive to build a plant of this type in each city, so municipalities have decided to join forces and build the total plant, so that the recycling of water should be distributed among the farmers of the same region.

Several municipalities entered the Alliance under the pressure from the authorities of the Arab settlements, only after the allocation of subsidies, but then the plant started working and they created a special inter-municipal authority with its own Treasury. Today there are a few unions of this type in Israel, however, this Union is remarkable, because most of the

cities in it are Arabic and, however, municipalities manage to find understanding on the distribution of the recycled water.

5.4. Substitution of scarce natural resource of water by innovative potential of people

Shrinking fresh water resources could become an impediment to the development of the Israeli economy, if it were not possible to introduce a residual factor of development. However, the problem consists in the fact that perfect substitutes have no fresh water. Not only the man himself needs water daily, but in many industries, fresh water is indispensable. However, the reduction of its resources and its consumption per capita is a reality in the State of Israel.

The question is: what can substitute such a necessary resource as water in industrial function so as to enhance production opportunities? To make it possible, people need another resource, which usage will affect the economy favorably. The state of Israel seems to have found such a resource. This resource, from our point of view, turned out to be the most effective substitute of fresh water due to its special qualities.

Let us, firstly, consider the way fresh water is used in agriculture in Israel today. From our point of view, agriculture in Israel can be called "economical", in terms of water consumption sector. A perfectly adjustable water distribution system was created, where the water supply depends on the specific properties of the land, and on what culture is grown there.

For best results, with the support of the government, training of farmers is carried out. They are given advise of more efficient water use. The government also supports development of irrigation systems, enhancing agricultural productivity, a large part of production is grown in greenhouses. Israel became the first country to use dripping irrigation that minimize water consumption.

It is forbidden to grow cotton in the country, because this culture requires abundant watering. As it was mentioned above, 17% of fresh water used in the country is the so-called "secondary" water obtained by purification of wastewater. And all this recycled water is used exclusively in agriculture for irrigation (data from the website "Makrot" mekorot.co.il).

Close collaboration with geneticists and biotechnologists helped to create cultures that require salt water for their irrigation (for example, tomatoes "Desert Sweet") (mekorot.co.il).

From the 1950s until the middle 1990-ies the agricultural sector in Israel has achieved impressive results. The amount of water needed to produce 1 kg of dry material, was reduced by approximately 50% over this period (Shilova, 2011: 85).

This result became possible, in our opinion, due to the fact that Israel from the very beginning of its existence set two important tasks:

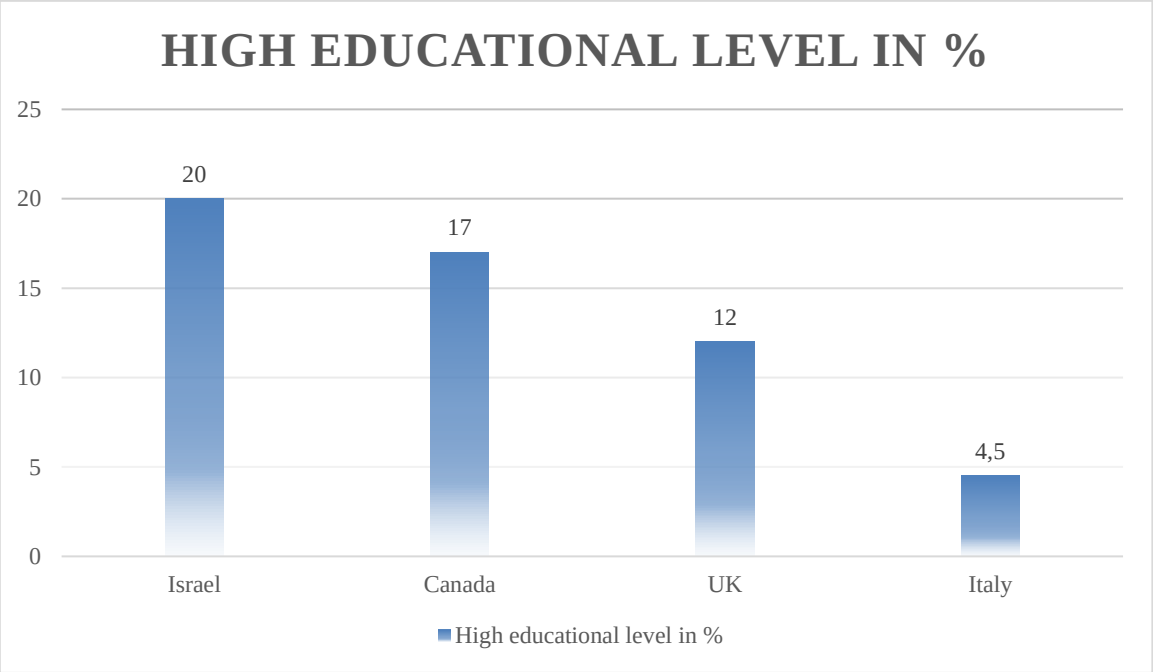
1. to ensure the security of the country with a small army

2. to solve the problem of shortage of water as a resource.

In fact, it is the scarcity of water that boosted agricultural producers to implement new technologies to save water and contributed to the development (and borrowing) of innovations in this area.

It should be noted that since the state's foundation of transition to innovation, including in agriculture, the sphere of consumption of water was not exclusively a public task. On the contrary, in the first three decades the main goal was recognition of the expansion of cultivated areas and expansion of rural settlements (Menahem, 1998). However, the state managed to create such economic mechanisms which allowed the structure of the economy to change decentralized and this has led to the fact that a scarce resource was replaced by new technologies.

An important part of the state policy of Israel is to support high educational level of the population. Twenty percent (20 %) of all the employees have higher education. Israel concedes on this indicator only the USA (in Canada it is 17%, UK 12%, Italy 8%). Israel ranks first in the world in number of engineers; the country has 28 thousand doctors per capita: it is the highest world level.



At the state level and at the level of institutions it is encouraged and paid for so-called "Shabbaton" - sabbatical, which the scientist can take once in seven years, as well as participation in international conferences and workshops, postdoctoral studies abroad, exchanges with foreign partner institutions, and more.

However, it is necessary to note that theoretical work itself could hardly become a real engine for economic development, but for the ability to implement them. Doing large-scale research activities, universities make a great contribution to the real development of high-tech sector in Israel.

Institute named after Weizmann was one of the first institutions in the world, which created a special organization for the commercial implementation of its development (1958), and today these structures exist in all Israeli universities. For the first time in the world high-tech industrial projects began to attach to the University programs in Israel. In addition, universities often create subsidiaries of industrial firms, often in collaboration with local or foreign companies, which engage in commercial sales of products created on the basis of technical development of these universities.

Israeli universities work in close cooperation with neighboring industrial enterprises. Here are a few examples of such cooperation: Industrial Park "Kiryat Weizmann" and the Institute named after Weizmann in Rehovot; Jerusalem technological parks "Har Hotzvim" and

"Malchus" and the Hebrew University; the high-tech Park, MATAM in Haifa and the Haifa Technion; high technology Park "Atidim" and Tel Aviv University.

Now universities establish interdisciplinary research centres and expert institutions, whose role in such industries as construction, transport and education is truly invaluable. Research institutes also offer huge consulting work in the areas of Technology, Finance and Management. The share of Israeli industry in the funding of scientific research under contracts with universities is more than 9% (Compare: in US and Canada this figure is 6-7%).

Government subsidies to innovation and reduction of water consumption, not directly related to innovation, play an important role. Private entrepreneurs involved in the creation of enterprises for the return of water in turn, receives investment subsidies in the amount of 50% of the investments in the company. Projects aimed at the creation of downstream water use in agriculture are strongly supported with the purpose of reaching the volume of this water by 600 million cubic meters per year by 2020. This project was highly supported financially: the government had allocated an amount of 915 million shekels for the years 2008-2013 (Principles of budget, 2009). Water Council financially supports the creation of enterprises for the purification of saline and contaminated wells (including freeing from the tax on extraction of fresh water).

Thus, development of high technology in Israel was not and could not be a spontaneous process. The state was actively involved in the relevant projects, and developed the subsidy program for the development and production of high-tech products. Private investors are mainly interested in developments that have already passed all testing and check of the market for which a new invention was aimed. Therefore, the support of major research centers and small start-up companies is the work for either very large investors or the state.

Support of science and education as such is rather the prerogative of the state, awaiting not only the concrete result in the form of a highly profitable product, but also the overall innovative capacity of the population and competitiveness of produced goods in the global market. The positive externalities associated with the development of high-tech industry do not have principal meaning for a certain individual firms, but they are important for the social planner, watching the total increase in the share of expensive high-tech products in production.

CONCLUSION

It is a paradox, but abundance of the resource may be a curse for the country and the lack of it may become a stimulus for economic development, contributing to the development of technology replacing this resource. The most effective in this sense can be the replacement of scarce resource by the intellectual one, as the latter perpetuates itself and its quality only grows as you use it. Additionally, intellectual resource has a wonderful quality: being sufficiently developed, it can be used in any field. Moreover, technologies developed for one industry with the help of this resource, can be successfully applied in the other. Overflow of technology encourages the overall development of the economy. Israel can be considered an example of such successful use of the intellectual resource to replace the deficit natural resources, in particular, water.

Instead of building large plants, consuming fresh water, Israel has relied on high-tech sector, where the main consumer of fresh water is the researcher himself, consuming it for drinking, not in industrial scale. Even agriculture – the main consumer of fresh water — has moved into high technology. Watering is controlled by computers that regulate drip irrigation of plantings.

Water-loving plants have long been replaced by less hygrophilous ones, plants that need less watering have been brought. These are the only ways possible to save existing water resources and use new ways to get water without disrupting the ecological situation in the region at the current pace of growth of the population (mostly Arab).

The productivity of the scarce resource of water increases, various schemes of water saving technologies develop, which allows to produce the maximum number of products with minimal amount of losses (drip irrigation here is the clearest example). Water losses due to imperfections in the means of delivery are being minimized. If the difference between the volume of water that entered to the "city gates" and one that households consumed amounts to 10% or more, urgent measures are taken to reduce these losses.

Technology is evolving in the direction of increasing productivity of a limited resource of water. As the relative price of water is high, and the marginal product of high-tech sector is

also relatively large, Israel uses the replacement of the water resource, which is used in hi-tech: it is the people, their intellectual abilities. Technology, according to D. Acemoglu has become "skill-developing" and "water-replacing" (Acemoglu, 2002).

For Israel, such a development is crucial, because water supplies tend to be weakening not only due to the unauthorized siphoning off of groundwater by Palestinians and the construction of dams in the North by neighbouring states, but also due to the fact that the climate in the middle East is gradually becoming more and more arid.

In our thesis, on the example of Israel, we show that the practical implementation of theoretical models of reimbursement of scarce resources is really possible, even if the conditions are tough, though full substitution of water does not exist.

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