INSTITUTIONAL ANALYSIS OF INTERNATIONAL PRACTICES OF WATER REUSE

Institutional analysis involves taking into account the impact of institutions, both formal and informal, on the processes occurring in the economic system – in our case, the reuse of treated wastewater in the urban economy. Among the formal institutions of interest to us there are legislative acts and rules for regulating the water management complex, which are designed to ensure the effective provision of water to both organizations and enterprises at the municipal level, as well as the population, occupy a special place. The article gives a comparative analysis of relay-based regulatory institutions in the field of water supply in many countries, especially of modern Europe. Relevance is determined by the ability of institutions to ensure the sustainable development of water resources and prevent or mitigate the water crisis. It is additionally shown that the international, with emphasis on Europe, practices of reusing treated wastewater are an important element for solving environmental problems, compensating the negative impact of global climate change on urban ecosystems. Some features of regulation of water reuse as one of the possible alternative water sources in regions where they are limited are also discussed.

Keywords: formal and informal institutions, water reuse, sustainable development, urban management, international practices in the use and regulation of water resources.

JEL Classification: L31, O52, Q25, R58.

1. PRINCIPLES OF FORMING INSTITUTIONS FOR PROVIDING WATER REUSE

Forming institutions, especially for water resources problem solution, is a task of great importance which must attract attention of state or municipal bodies and should be based on the certain principles designed to ensure the effective provision of water to both organizations and enterprises, as well as the population. As to treated wastewater reuse the main principle formulated by UN Economic and Social Council in 1958 is as follows: the water of high quality shall not, unless it has in abundance, to be used for the purposes that allow use of water of lower quality.

The idea of this principle's emergence is clear enough: over the past 100 years the consumption of fresh water in the world has grown in 2 times – this growth has overtaken population growth. Many scholars believe that increased consumption of fresh water will continue to occur mainly due to: population growth; changes in the diet of the population and the increase in water consumption per person (in the world today, one person consumes an average of 2 times more than in 1900); the development of tourism (e.g., tourists in Grenada (Spain) use on average 7 times more water than locals; in Israel, water use by hotels along the river Jordan, believed to have caused the drying up of the Dead sea, where the water level since 1977, fell by 16.4 m); growth of water consumption from the industry (annually in the world for domestic, industrial and agricultural water supply consumes about 4,000 km³/year); growth of energy consumption.

Experts suggest that if the existing approach to the use and reuse of water resources, by 2030 the gap between the need for fresh water and its range can reach 40% (2030 WRG). Therefore, there is every reason to believe that water reuse in the near future will expand.

Wastewater must be seen not as a waste, from which you want to get rid of, but as a resource, which may be an important element in the sustainable management of water resources and become an important lever in solving freshwater shortages, mitigate the effects of climate change, have beneficial effects on the environment (Fontana, Fontana, 2016).

We will add also, that from the technical point of view the water reuse is a part of decision of the circular economy's problems, related to the water-supply and water control (Yerznkyan, Fontana, 2018). However technically feasible projects will not be realized from institutional, legal, economic and organizational barriers, bad perception of public, exhaustive quality and quantitative null data. These non-technical barriers are limitation for expansion of planning and adjusting of the water reuse, and they need in regulative documents.

2. SOME DEFINITIONS CONCERNING THE WATER REUSE

In this paper, speaking on the water reuse we have in mind above all its use in the city limits after cleaning of the households, and possibly, businesses and organizations. For clarity, we will give some definitions of this kind of water.

Water reuse is the use of water based on purified wastewater, especially in the urban area. Wastewater is cleaned before reaching a certain quality that is appropriate for its further use in limited applications, taking account of the legislation and the potential risks to human health and the environment.

Urban (municipal) wastewater is domestic waste water or the mixture of domestic waste water with industrial, located within the city limits and having common stock. Urban and industrial wastewater has different characteristics (e.g., on the content of organic matter, pathogens, heavy metals, etc.) that affect the way they clean for reuse.

Direct reuse refers to the supply of treated wastewater to the consumer using an appropriate infrastructure, in particular a dedicated pipeline. Indirect reuse refers to the collection of water from natural sources for subsequent use, where the discharge of (partially) treated effluents was previously carried out. Planned reuse refers to systems organized for the supply and use of treated wastewater that has been treated in accordance with its further use. Unplanned reuse means the out-of-control repeated use of effluents after their hit in natural reservoirs. For example, consumers «below down stream» use water from the river in that an up-cast comes true higher down stream (Yerznkyan, Fontana, 2019b, p. 17).

3. WATER REUSE IN RUSSIA AND ABROAD

In Soviet-period Russia, water treatment was made by the methods that included capital investments in sewage treatment plants and their subsequent exploitation, and also positive influence on chemical composition and agro-melioration properties of irrigable soils, productivity of rural economy cultures. The similar systems and practices were recommend-

ed to wide introduction in practice of agriculture's production, but however in future wide distribution of treated wastewater reuse did not get.

In contemporary Russia, in spite of the fact that in «Water strategy of Russian Federation on a period till 2020» is indicated, that the increase of rationality of water consumption is arrived at by the decline of losses of water at transporting, reduction of specific consumption of water in technological processes, on service-utility needs, and the last is arrived at by «expansion of the use of the circulating and repeatedly-successive water systems», wastewater is used mainly in industry or thrown down in natural reservoirs.

In practice, however, water is counted not as the main resource of life-support of population, but as the expensive material. Water reuse of effluents is not examined in a number priority at the decision of ecological and socio-economic tasks, and also as an important element of steady development of water resources neither in Water strategy of Russian Federation on a period till 2020, nor in Strategy of ecological safety of Russian Federation on a period till 2025, nor in other legislative acts.

In abroad, there are more than thirty legislative acts concerning water reuse in whose development participate a lot of organizations, such as the UNO, OECD, World Bank, etc. From the point of the view of institutional analysis it is remarkable that many of mentioned acts and documents do not have analogues in the Russian formal, i.e. legal, field. A situation is complicated by that «in the conditions of realization in regard to RF of politics of inhibition, the threat of access to foreign environmentally clean innovations, technologies, materials and equipment restriction is formed» (Strategy..., 2025, point 23).

According to the rules and norms accepted in RF, all effluents (before their up-cast in reservoirs) must be cleared to the level of *maximum to the possible concentration and approximately safe levels of influence* corresponding to the up-cast in the reservoirs and currents, intended for the economic-drinkable, cultural and welfare or fishing industry setting.

Afterwards, for providing of population by drinking-water and satisfaction of urban and rural economies' needs, water is perched from natural water sources, including reservoirs, where earlier an up-cast came true. Thus, for consumers «below down stream» we look after «unplanned indirect water reuse», that officially does not confess authorities, and the population is not informed of it (Yerznkyan, Fontana, 2019b, p. 18).

4. FORMAL INSTITUTIONS IN EUROPEAN UNION

There are a variety of formal institutions on water reuse in European Union (EU), namely the directives of the European Parliament and of the Council. Here are the main of them (Yerznkyan, Fontana, 2019b, p. 20-21):

1. Directive 91/271/EEC of 21 May 1991 on the urban wastewater treatment. Official Journal. L 135/40, 30 May 1991.

2. Directive 91/676/EEC of 12 December 1991 on the protection of waters against pollution caused by nitrates from agricultural sources. Official Journal. L 375/1, 31 December 1991.

3. Directive 98/83/EC of 12 December 2006 on the quality of water intended for human consumption. Official Journal. L 330/32, 5 December 1998.

4. Directive 2000/60/EC of 23 October 2000 establishing a framework for community action in the field of water policy. Official Journal. L 327, 22 December 2000.

5. Directive 2006/7/EC of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC. Official Journal. L 64/37, 4 March 2006.

6. Directive 2006/118/EC of 12 December 2006 on the protection of groundwater against pollution and deterioration. Official Journal. L 372/19, 27 December 2006.

7. Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and the wild fauna and flora. Official Journal. L 206, 22 July 1992.

8. Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds. Official Journal. L 20/7, 26 January 2010.

9. Directive 2006/44/EC of 6 September 2006 on the quality of fresh waters needing protection or improvement in order to support fish life. Official Journal. L 264/20, 25 September 2006.

10. Directive 2006/113/EC of 12 December 2006 on the quality required of shellfish waters. Official Journal. L 376/14, 27 December 2006.

It should be, however, mentioned that all these directives are used partially.

5. COMPARATIVE INSTITUTIONAL ANALYSIS

The results of the analysis are summarized in table.

Table

European Water Reuse Regulative Institutions

Country	Modern state of consumption of water, including the water reuse	Rules of application and stimulation of financing of the water reuse
Austria	The deficit of water is observed in some east and south districts. About 98% of drinking-water perches from subsoil waters and practically does not require cleaning	There are not acts / leading principles of water reuse regulation. A primary purpose of water politics is the rational water reuse which is recommended in the cases when it results in economic and/or ecological advantages. Thus, for the some industrial sectors there are limitations of the use of natural water and repeated its use is recommended

Country	Modern state of consumption of water, including the water reuse	Rules of application and stimulation of financing of the water reuse
Belgium	High index of water stress. Cleaning is passed by 70% of effluents for their subsequent RU (10 back this number made 38%). Hasty growth of modern sewage treatment plants improved the prospects of the repeated use. Reduction of upcast of effluents in the natural sources of water is other reason of RU of water	In 2003 Flemish regional Department on water resources offered to Government on the basis of Australian leading principles of EPA to work out the criteria of RU of water. Belgian Government would like to shorten the volumes of fence of subsoil waters and stimulate RU of water. Interest in RU is growing in the country, especially in water cooling systems at power plants, food and textile enterprises, in agriculture (although the share of treated wastewater is still limited), in coastal areas during the tourist season. Reducing discharges in ecologically sensitive areas is also the reason for the development and implementation of RU TWW projects
Bulgaria	In spite of the fact that Bulgaria is the second country in EC with the most index of water stress, no certain data, touching TWWRU, does not exist	Presently Government examines leading principles on introduction of water reuse
Czech Republic	It is on the watershed of three seas, and the most Czech currents nepetekajot in nearby countries. Priority questions are quality of water and level of contamination SR. Politics of Government is sent to reduction of volume of water intake in a public sector and in industry. However, any certain data about realization of projects TWWRU are not found out	No provisions or guidelines have been adopted
Cyprus	A shortage of water and worsening of the state of water on beaches are the retentive factors of development of tourism that is the important type of economic activity. TWWRU is an important contribution to the decision of problem of deficit of water not only in the field of tourism but also agriculture, maintenances of green plantations, fields for golf. TWW is an irreplaceable source and it is necessary to expect the increase of volumes of its use, that still will be in the future	From 1990 to 2005 temporal standards operated for TWWRU with mark criteria of quality for irrigation. These standards more hard, than Leading principles take into account the certain terms of Cyprus. With 2005 these standards went across from status «temporal» to «permanent» (Decree of N296/03.06.05)
Denmark	The index of water stress is appraised between 15 and 20%. A water-supply almost fully depends on the state of subsoil waters. Therefore management a primary value has quality and amount of subsoil waters for a steady water-supply and water consumption. As well as in other Scandinavian countries, a question about TWWRU is not examined seriously	In 1990th Ministry of environment rendered sponsorship to a few initiatives on introduction in the private sector (hoesholds) of practices of utilization of «grey» water for domestic aims. Some positions or leading principles are not accepted
Estonia	The index of water stress makes about 10%. Large attention is spared to cleaning of effluents before an upcast. Last years in a number of cities modern new sewage treatment plants are opened. Utilization of effluents is not used, except for a limit amount on some industrial enterprises	No provisions or guidelines have been adopted

Country	Modern state of consumption of water, including the water reuse	Rules of application and stimulation of financing of the water reuse
Finland	With water reserves of more than 20,000 m ³ / year per capita, the country does not need to consider the issues of TWWRU for irrigation	No provisions or guidelines have been adopted
France	From the beginning of 1990th French Government is concentrated on the question of TWWRU in connection with development of irrigable agriculture with the use of plenty of fertilizers and water. Growing demand on water in agriculture is accompanied by the becoming more frequent cases of drought. Running into such situation, authorities forced to impose restriction on the use of water. About 15 French departments are located in zones with the Mediterranean climate that befits for gardening and tourism. All of it, as a rule, increases a requirement in water in the conditions of limit nature WR. However practices of TWWRU will be realized mainly on island part of France, mainly from the high cost of tertiary treatment. Nevertheless, the realized projects overcame territory more than 3000 ha, and have a wide enough spectrum of application : gardening, including orchards, grain-crops, plantations of trees	In 1991 were published Recommendations on a health care at TWWRU for watering of agriculture and green plantations (Health Guidelines for reuse, after treatment, of waste water for crop and green spaces irrigation), that shows that projects waters RU must get approval of health (that corresponds to Leading principles of World Health Organization) authorities. In February 1996 Association of specialists for a water-supply and sewage system (Association of Water Supply and Sewerage Practitioners) published technical recommendations on cleaning of effluents. The most renewed rules touch TWWRU in agriculture. Since 1996, Guidelines D94-463.3.1994 DGS-SD1.D.9
Germany	The accessible volumes of water arrive at 182 billion m ³ /year, from that 25,8% is used only. Thus, stimuli are absent for TWWRU. Nevertheless, direct RU is practiced in agriculture, and on some territories (valleys of the river Rhine) – for artificial addition to the underwaters. During the last 120 there is practice of mixing of the cleared (to the certain level) flows with surfaces waters in Berlin	Federal Law on Water (Federal Water Act) from one side, provides the high level of defence of WR, and with other, gives the best possibilities for the repeated use of effluents, taking into account the guard of environment. In spite of absence of stimuli on introduction of practices TWWRU, developments and researches proceed in this sphere
Greece	Over the past 50 years, water demand has increased dramatically. In spite of sufficient amount of annual fallouts, the shortage of water arises up from the seasonal and territorial vibrations of fallouts, and also growing demand on water in summer months, complications of transporting of water from mountain locality. Therefore integration of purified-sewages in the plans of management of WR is an important for a country question. As more than 83% of TWW is produced in water-deficit regions, reuse of such waters could partially satisfy the demand for water in these regions. More than 88% of the treated wastewater is located at a distance of about 5 km from the existing agricultural land. Thus, the additional cost of irrigation with waste water disposal will be low	The directives of JMD 145116/11 (GGB' 354/2011) and JMD 5673/400/1997 (GGB' 192/1997) regulate ПИ of effluents, including for drinkable aims (as a rule, by mixing of the cleared water with subsoil waters) and agriculture of irrigation

Country	Modern state of consumption of water, including the water reuse	Rules of application and stimulation of financing of the water reuse
Hungary	96% of surface-water acts from nearby countries. In this connection, quality and amount of water largely depend on politics of nearby countries at a management WR. Nevertheless, Hungarian industry and agriculture bring in the contribution to contamination of water. More than 90% of drinking-water acts from subsoil waters, her defence is a strategic task in Hungary	There are numerous separate rules and norms, touching water RU. Single legislative acts, touching the repeated use of water, are absent. However Program on an environment (Decision 96/2009 XII.9) and management Plan assist river pools to the steady use of WR and water RU for defence and maintenance of quality and amount of accessible water. These programs envisage TWWRU on territories suffering from the shortage of water
Ireland	About 75% of drinking-water acts from surface-water, other – from mining holes. From a mild and moist climate requirement in agriculture irrigation is practically absent. To present tense no practices of TWWRU were marked	No provisions or guidelines have been adopted
Italy	The Italian sewage treatment plants can produce to 2.400 mm ³ /year of useful water. Presently TWW is used mainly for irrigation of agricultural lands. In Turin there are practices of ПИ of water in industry	The use of effluents in irrigation in Italy is regulated with 1977 (Water Protection Act, Annex 5, CITAI, 1977). This Law regulates the process of cleaning of effluents and was strict enough, but here he does not set some standards on a possible level toxic or biostory substances in soil. Some regional government (for example, in Apulia and Sicily) bodies, using the plenary powers (according to Law on protecting of water from 1976), worked out local regional standards on water RU. In accordance with Decree of Ministry, N185/03 from 12.06.2003 (Ministry Decree, D.M. no 185/03) and by Law-decree of N152 (Law – Decreen. 152, 2006) a vault was worked out governed in relation to water RU for agriculture and undrinkable municipal and industrial needs. The negative aspect of the Italian legislation is an excessive abundance of parameters (more than 50) that must be taken into account at monitoring of the cleared flows with high-frequency of realization of monitoring. Thus Rules are not set distinctions as water for watering of the different agriculture, not paid attention to influence of different types of irrigation (superficial irrigation tiny) for the decline of sanitary risks

Country	Modern state of consumption of water, including the water reuse	Rules of application and stimulation of financing of the water reuse
Latvia	Quality of fresh waters and their defence are one of basic priorities of ecological politics of Latvia. For providing of the rational use and their long-term defence WR was certain as important national property. At the same time water RU is not a priority task	In accordance with the decisions of Cabinet of Ministers and Water legislation of EC, the row of fundamental laws (with 2000) was accepted for providing of steady development of water ecosystem. As a result, control system by SR was reorganized and certain measures are pre-arranged on the guard of environment for the catchment basins of the rivers. Management plans are also worked out by river pools. All Latvia marked as highly sensitive territory for that the special requirements are used on cleaning of municipal sewer
Lithuania	TWWRU does not exist. Greater part of the cleared flows is thrown down in superficial reservoirs	Some positions or leading principles are not accepted
Luxembourg	Does not test problems with providing fresh water population and economy of country on the whole. TWWRU does not stand on an order-paper. Nevertheless, in order that to protect it to SR some positions were accepted recommending TWWRU in industry, including in the systems of cooling	Some positions or leading principles are not accepted
Mallta	It is on the sharp shortage of water. As agriculture is the basic source of acuests, TWWRU for irrigation is practiced with 1884 (to save fresh water for the domestic use). In 1986 possibility of TWWRU was considered in industry. Realization of similar projects depends in this case, mainly, from economic terms, in particular, comparisons of general charges on TWWRU with other sources of water (for example, by a desaltation)	Leading principles are in development
The Netherlands	Some regions on a south-west, east and north-east of country are on the shortage of water during droughts. TWWRU is possible at irrigation of agriculture under reaching certain quality of water, and also in industry (for example, in the systems of cooling). In rare cases, such water is used to maintain the level of the aquifer, as well as for fire fighting and other urban purposes. To date the general volume of cleaning and TWWRU is small. In the nearest future ПИ will be, probably, to increase, if it will be	Introduction of taxes and limits on the fence of water from aquiferous horizon (for renewal of primary water-table), TWWRU becomes more attractive. In a number of regions projects are realized renewals of wetlands with the use of the cleared flows, demonstrating ecological advantages of such approach

Country	Modern state of consumption of water, including the water reuse	Rules of application and stimulation of financing of the water reuse
Poland	Politics in area of water-supply and sewage system is sent both to the decline of consumption of SR and on the decline of influence of effluents on an environment. First of all, the decline of influence is arrived at due to reduction of amount of upcast of effluents, and also moving away ecologically of hazardous substances from effluents, application of the reserved chains and TWWRU	Local authorities, under the Law on local self-government (The Local Government Act on March, 8 1990) must provide utilization and cleaning of communal effluents. A law on Water obligates Ministry on the guard of environment to present a report in Council of Ministers on realization of the national program on cleaning of municipal effluents (National Program of Municipal Waste water Treatment), that was accepted by Council of Ministers in 16.12.2003. The program provides for the phased equipment of all municipalities with combined sewer systems and modern treatment facilities
Portugal	57.5% of mainland part of country suffers from the deficit of water. South areas especially suffer from periodic droughts. The volume of treated wastewater exceeds 480 mm ³ / year, which satisfies about 10% of the water demand during irrigation during the dry period. In Portugal purified-sewages are a valuable resource in irrigation	National legislation of DL 236/87, 1987, XVI and XVII (in relation to the standards of quality of water for irrigational applications in agriculture) determines the possible norms of maintenance of metals, to microbiology and salinity in water for her subsequent use. In 2005 the national standard of RU of the cleared municipal effluents was accepted for irrigation in rural and forest economies, lawns (including придомовой territory), in nurseries (NP4434), which sets water quality standards, appropriate treatment regimens, criteria for choosing the most appropriate type of irrigation and equipment, monitoring programs. In 2007 Leading principles of national regulator are accepted on the water-supply (ERSAR, former IRAR) of relatively effluents and wastes (Rec.IRARnr 2/2007). This document sets leading principles for a production and distribution of purified-sewages for irrigation, control of quality, base for the calculation of price on water and, who must pay. In 2010 Technical Guidance of national regulator is accepted on a water-supply, sewage system and wastes of services (ERSAR Technical Guidenr 14 N14), that regulates the use cleared municipal and industrial sewer
Romania	TWWRU is reality in a few Spanish regions in 4th application domains: irrigation of golf-fields, irrigation of agriculture earth, addition to subsoil waters and increase of flow of the rivers	TWWRU is regulated by the Royal decree 1620/2007 from 07.12.2007 (Royal Decree 1620/2007), that sets the legal mode for TWWRU
Slovakia	Purified-sewages repeatedly not used for lack of the effective sewage systems and modern secondary sewage treatment plants	No provisions or guidelines have been adopted

Country	Modern state of consumption of water, including the water reuse	Rules of application and stimulation of financing of the water reuse
Slovenia	Cleaning and water RU is one of priorities for maintenance of wetlands. However, these practices are used only on territory of small communities and consequently have a limit application. It is expected that in the near future these practices will be widely used in tourist districts	No provisions or guidelines have been adopted
Spain	TWWRU is reality in a few Spanish regions in 4th application domains: irrigation of golf-fields, irrigation of agriculture earth, addition to subsoil waters and increase of flow of the rivers. Private water companies, in collaboration with universities, are investing in research and development on this topic. Future TWWRU is promising	TWWRU is regulated by the Royal decree 1620/2007 from 07.12.2007 (Royal Decree 1620/2007), that sets the legal mode for TWWRU. The primary purpose of RD consists in maintenance of equilibrium between a health and environment care, providing water of high quality. A decree determines TWWRU as additional appendix of WR after realization of the corresponding cleaning and achievement of quality of water, according to the set requirements. Government, regional and local authorities, for stimulation of the repeated use of water
Sweden	In spite of high availability of WR and low level of abstraction renewable WR (in all 2%), in south-east part of country there is interest in the use of tertiary treat effluents for irrigation. Principal reason of such interest is maintenance natural to WR. There are more than 40 practices of TWWRU to date. Purified-sewages are about 9 months defended in enormous reservoirs, before used for irrigation. On occasion effluents interfuse with surface-water. The nutritives contained in effluents are processed and afterwards used on agriculture lands, and farmers get cheap water for irrigation. This practice is advantageous for authorities and water complex (as such water is for sale and not spent money on building and exploitation of expensive sewage treatment plants), and for farmers (because they buy more cheap water, increase the harvests). In addition, environmental problems are being addressed – discharge to natural sources of water is reduced	No provisions or guidelines have been adopted

Country	Modern state of consumption of water, including the water reuse	Rules of application and stimulation of financing of the water reuse
UK	Effluents are used for maintenance of river streams and ecosystems. This practice is especially developed on a south and east of country on the large rivers. Effluents use also for irrigation, including fields for golf, parks, roads, washing of machines, in the systems of cooling, fishing. Presently on experimental basis projects TWWU will be realized in laundries, washing off of rest rooms, etc., there is one third of RU of domestic effluents (sometimes the rain-water collected from the roofs of houses interfuses with effluents) on tha	Realization of projects is complicated by absence of clear reference-points in regard to the use of effluents and level of their cleaning. Leading principles on setting of sewage treatment plants for cleaning of flows with the purpose of their subsequent use, reorganization of the water systems, to their technical service, modernisations of the pipeline system were published as early as 1999 within the framework of Consultative System Adjusting Water Resources (WRAS – Water Regulations Advisory Scheme). In 2005 there is a research group UKWIR, together with AWWA and Fund repeated used

Source: authors based on (Alcalde-Sanz, Gawlik, 2014; Yerznkian, Fontana, 2019b).

As we can see from the table, EU countries, from the point of view of presence of formal institutions and regulation practices on the treated wastewater reuse, can be divided into four groups, mamely countires:

- with the leading principles (Cyprus, Germany, Greece, France, Italy, Portugal, Spain, UK);
- where these principles are used fragmentary (Belgium, Hungary, Latvia, Netherlands);
- where these principles are in the stage of development or consideration (Bulgaria, Malta, Poland);
- where the leading principles are absent (Austria, Denmark, Ireland, Lithuania, Luxemburg, Romania, Slovakia, Slovenia, Finland, Czech Republic, Sweden, Estonia) (Yerznkian, Fontana, 2019b, p. 21).

In countries (and not only European), where formal institutions (regulative directives) are absent or present partly, efficiency of the water reuse is arrived at due to the presence of informal practices, e.g. such as processes of collection and processing of data in cities. A good example is the platform of Boston City Score – online-instrument that accumulates data and municipal information reflecting efficiency of Boston as a city and its management system. Corresponding reports for the past day, week, month and quarter, so that everybody could to become familiar with actual information on management efficiency, are published on the city's web-site. Similar platforms are realized also in Los Angeles, New York and Houston. Their success demonstrates growing tendency to introduction of «management methods on basis of data», implying maximal use of data to increase the municipal economy's management efficiency and inform the habitants of results of realization of one or another decisions (Yerznkian, Fontana, 2019a, p. 861).

7. CONCLUDING REMARKS

Treated waste-water reuse in particular and a circular economy for water in general is treated as one of the most fruitful instruments for providing population, organizations, businesses, state bodies, etc. with water resources. It should be added, that it is also one of the key factors for providing the sustainable development of a socio-economic system, in particular urban economy. Their use supposes support on innovations, digital technologies and effective management on the basis of possibilities, given by a circular economy. The last term serves for denotation a special type of economy being based on the use of renewable resources and contrasted in this sense to the traditional, linear economy, based on creation, use, and order by them.

Of particular importance for the implementation of TWWRU are institutions, both formal and informal. Among formal institutions, we note the directives, acts, and regulations adopted in many countries that can provide, after D. North (1990), the «game» with relevant «rules». Their success is largely determined by the support of formal institutions by informal ones. In general, as comparative institutional analysis has shown, TWWRU is a process both important and at the same time incomplete. However, no alternative is expected to ensure effective regulation of this process.

Summarizing, we emphasize that in addition to adopting effective «rules of the game» to achieve positive results in the rational and efficient use of water resources, the uninterrupted supply of clean water to the population, it is necessary to provide for a set of interrelated measures carried out jointly by state authorities, local self-government, private business, financial sector, and scientific organizations.

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ИНСТИТУЦИОНАЛЬНЫЙ АНАЛИЗ МЕЖДУНАРОДНЫХ ПРАКТИК ПОВТОРНОГО ИСПОЛЬЗОВАНИЯ ВОДЫ

Институциональный анализ предполагает учет воздействия институтов, как формальных, так и неформальных, на происходящие в экономической системе процессы – в нашем случае повторное использование очищенных сточных вод в городском хозяйстве. Среди интересующих нас формальных институтов особое место занимают законодательные акты и правила регулирования водохозяйственного комплекса, призванные обеспечить эффективное обеспечение водой как организаций и предприятий муниципального уровня, так и населения. В статье дается сравнительный анализ релевантных институтов регулирования в сфере водообеспечения в странах мира, в том числе и современной Европы. Релевантность определяется способностью институтов обеспечить устойчивое развитие водных ресурсов и предотвращения или смягчения водного кризиса. Дополнительно показано, что европейская практика повторного использования очищенных сточных вод является важным элементом для решения экологических проблем, компенсируя негативное влияние глобального изменения климата на городские экосистемы. Обсуждаются также некоторые особенности регулирования повторного использования воды как одного из возможных альтернативных источников воды в регионах, где они ограничены.

Ключевые слова: формальные и неформальные институты, повторное использование воды, устойчивое развитие, городское хозяйство, международные практики использования и регулирования водных ресурсов.

JEL классификация: L31, O52, Q25, R58.