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Environmental problems and policies in Kazakhstan: Air pollution, waste and water

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Environmental Problems and Policies in Kazakhstan: Air pollution, waste and water

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Abstract

We provide a comprehensive overview of the current state of environmental governance concerning air pollution, water problems and waste generation in Kazakhstan. The overview of the environmental and institutional framework in these fields reveals that major environmental problems exist in the country. Some steps have already been taken to ensure a proper management of air, waste and water. However, more coordinated cross-sectoral actions, both on the regional and the national level, need to be undertaken to ensure a productive cooperation between state institutions, business and the society.

JEL-Classification: O13, O44, Q53

Keywords: air pollution, waste generation, water usage, environmental policy, institutions, Kazakhstan

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1 Introduction

As shown in the working paper “Environmental Policy and Governance in Kazakhstan” (Nugumanova and Frey, 2017), high economic growth in Kazakhstan has come at a considerable cost to the environment. Even though, the country achieved improvements in social infrastructure, corruption is still widely prevalent. Empirical studies show that corruption can have a negative influence on environmental policies. It was also noted that there is a lack of qualified staff trained in environmental management and policy design. An appropriate legal and institutional framework was established in addition to the national framework strategy on green growth and sustainable development.

At the same time, almost every aspect of natural resource development resulted in enormous and often irreparable environmental damage. Major environmental problems in the country are either legacies of the Soviet times and/or a result of rapid economic development. Energy intensity in the country is high and the economy relies on fossil fuels which has a negative impact on the environment. Due to the geographical features, such as prevalence of semi-deserts, the country has a particularly fragile ecology. Moreover, water issues such as water shortages and pollution have negative effects on public health and the economy. In fact, all three problems (air pollution, waste generation and water shortages and pollution) have adverse effects on public health, the ecosystem, the environment and the economy (OECD, 2016, ADB, 2010). Addressing current environmental problems and the implications of climate change is paramount and thus a better understanding of these issues in Kazakhstan is necessary.

‘Hot’ environmental issues in the country are industrial, municipal and toxic waste disposal and processing, water access, quality and scarcity, urban air pollution, the Aral Sea situation, land degradation and desertification, the degradation of the Caspian Sea ecosystem, oil spills, biodiversity loss and low share of renewable energy sources (Ospanova, 2014). Kazakhstan inherited a number of environmental disasters from the Soviet times. Some of the most prominent are the Aral Sea ecological disaster and the Semipalatinsk nuclear testing site. In addition, there is a vast number of contaminated areas, including rivers, soil and settlements and a high level of radiation contamination.

Current environmental priorities of Kazakhstan are outlined in the “*Green Growth*” concept. The concept provides ambitious aims, which among others include the following:

- Energy sector: reach 50% share of renewable energy
- Increase of energy efficiency: 10% by 2015, 25% by 2025 in comparison to the base year 2008
- Water resources: solve all the problems with water supply to households by 2020 and to agriculture by 2040
- Waste management: by 2030 ensure a 100% household coverage of municipal waste service, 95% of sanitary storage of waste, and reach 40% share of recycled waste (50% by 2050)
- Air pollution reduction: by 2030 reach European level of air pollution (Green Bridge Partnership Program, 2013)

Against the background discussed above, the objective of this study is to synthesize available knowledge on current state of air pollution, waste generation and water issues in Kazakhstan. The analysis is based on available national and international statistical information and reports. Empirical studies on these three issues in Kazakhstan are scarce and mostly focus on the water sector.

The main part of this report consists of three sections, which cover the following topics: air pollution, waste generation and water issues in the country. Each section provides an overview of the current national framework conditions in each of the areas considered. Relying on available reports and data, some of the current critical points in each of the sectors are identified. The institutional structure of each of the sectors including relevant institutions, national policy and international commitments are described. Furthermore, economic aspects are considered. Section 5 discusses environmental implications of each of the topics and finally, section 6 concludes.

2 Air pollution

The OECD (2016c) predicts that increasing economic activity and energy demand will significantly raise global air pollutants by 2060 in the absence of more stringent policies. Emissions are projected to increase particularly in developing and energy-intensive countries which rely largely on coal-based energy. Outdoor pollution has a significant impact on public health, the environment, crop yields, biodiversity, land and water. The impact of outdoor air pollution on health and the environment is connected to a high concentration of fine and coarse shares of particulate matter (PM), ground level ozone (O₃) and other pollutants, such as nitrogen dioxide (NO₂) and sulphur dioxide (SO₂) (OECD, 2016).

The UNECE (2016) emphasizes that air pollution is the largest contributor to the environmental burden of disease¹. Air pollution causes numerous diseases, ranging from asthma to cancer and pulmonary illnesses. Air pollution also has a severe impact on the environment as sulphur and nitrogen emissions and ground level ozone effect ecosystems. Emissions of sulphur dioxide and nitrogen oxide (NO) increase acidity with negative effects on flora and fauna. Increased ground ozone level damages cell membranes on plants, which causes a loss of plant cover. Moreover, there is increasing evidence that air pollution threatens agriculture and food production. Some crops such as wheat and soybean are particularly sensitive to ozone.

The major share of primary emissions is generated during fuel combustion in the fossil fuel based power generation, the transportation and the industry sector. A significant amount of emissions also comes from agricultural waste, forest fires and the use of fertilizers (OECD, 2016c).

2.1 Present state and trends

While the impact of air pollution on the Kazakh economy and the environment have not been quantified yet, first attempts have been made to quantify health consequences. A recent study by the OECD (2016a) finds that air pollution causes 2,800 premature deaths and over 1.3 USD billion of health costs in Kazakhstan. Urban population affected by air pollution reached 1.4 million people in 2010 (ADB, 2012). The main sources of pollution are industrial, municipal,

¹ A concept developed by the World Health Organization. It "...assess the disease burden attributable to environmental risk factors, and are closely linked to assessments of the disease burden for individual diseases and injuries..." (Prüss-Üstün et.al., 2003, p. 7).

agricultural and transport emissions. Industrial and energy plants generate the major share of overall pollution by the use of fossil fuels (particularly coal) for energy production. Even though, emissions from stationary sources have been declining, low prices on energy and fossil fuels lead to increase in pollution, particularly from vehicles (OECD, 2016).

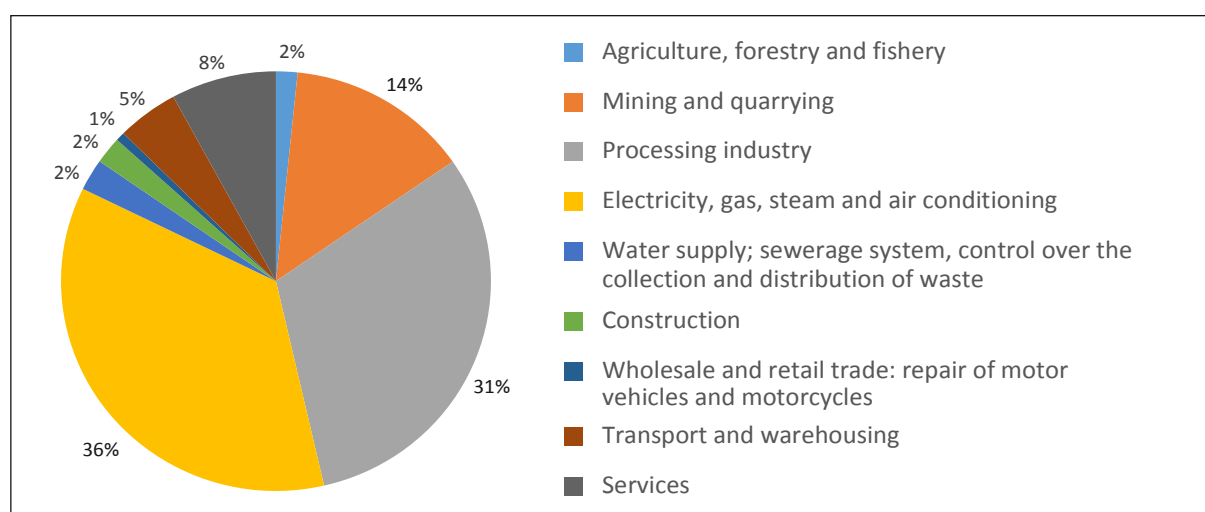
Principal air pollutants are sulfur dioxide, carbon monoxide, nitrogen oxides, hydrocarbons (volatile organic compound free) and volatile organic compounds (VOC) (Table 1).

Table 1: Atmospheric emissions in Kazakhstan

	2010	2011	2012	2013	2014
Total, thousand tons	2 226,5	2 346,2	2 384,3	2 282,7	2 256,7
Sulfur dioxide	723,6	774,2	769,6	729,2	729,1
Carbon monoxide	401,1	445,1	446,2	457,8	478,8
Nitrogen oxide	215,6	232,7	249,4	250,2	256,5
Hydrocarbons (VOC-free)	132,1	137,6	170,5	96,1	62
Volatile organic compounds	49,7	53,4	58,1	92	114,4

Source: Author's compilation based on the Ministry of Energy of RK, 2015

Figure 1 shows that the main sources of atmospheric emissions in Kazakhstan are the energy sector (36%), the processing industry (31%) and mining and quarrying (14%).



Source: Own illustration based on Committee on Statistics, 2016

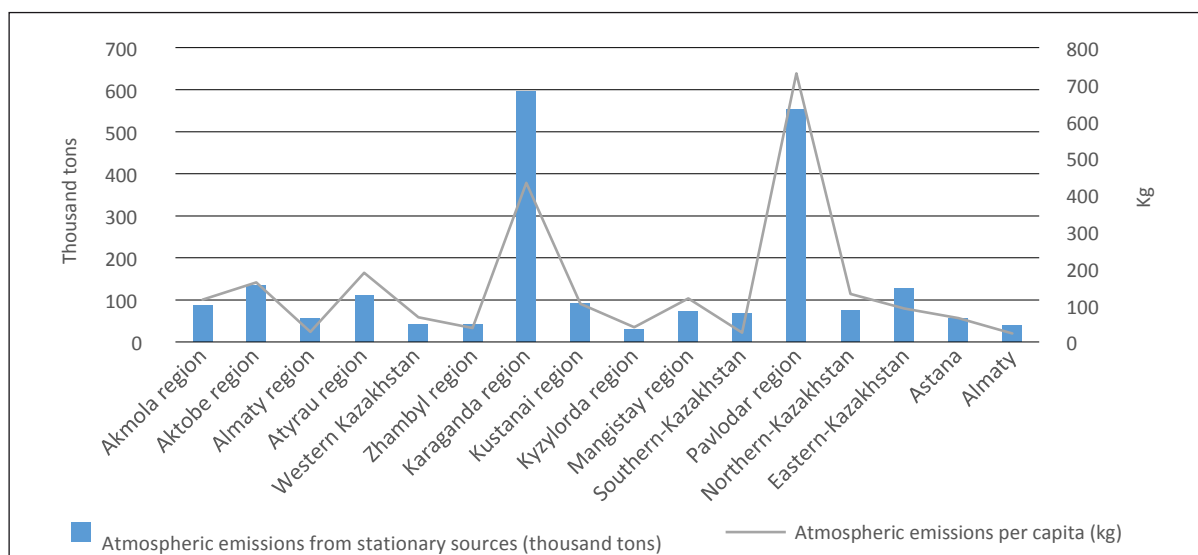
Figure 1: Atmospheric emissions by sector, % share 2015

Regional trends

Air pollution is one of the major environmental problems in Kazakhstan. However, air emissions vary strongly across regions. The amount of emissions in two regions accounts for 52 percent of overall emissions. As Figure 2 shows, the Karaganda region emits 27% and the Pavlodar region 25% of total air emissions in the country. Atmospheric emissions per capita in these two regions are significantly higher than in the other regions. This can be explained by the economic and industrial structure of these regions.

The Karaganda region is characterized by a large heavy industry, coal mines, steel complexes, metallurgy enterprises and major power stations. Accordingly, the 15 largest enterprises are responsible for most of the region's air pollution. Temirtau, located close to the regional administrative center Karaganda, is a center of heavy industry production with results in massive atmospheric pollutant emissions.

The Pavlodar region is a major industrial center. It is home to the following activities: bauxite mining, alumina and aluminium production, heat and power production, oil refining and mechanical engineering. The majority of emissions is originated from three cities: Ekibastuz (48%), Aksu (24%) and Pavlodar (26%) (World Bank, 2012, World Bank, 2013).



Source: Own illustration based on Committee on Statistics, 2016

Figure 2: Atmospheric emissions by region, 2015

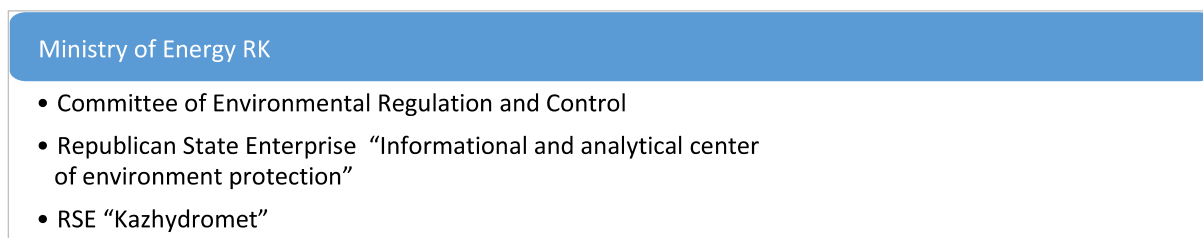
The series of studies conducted by the Czech NGO Arnika and funded by the EU in the framework of the project “Empowering civil society in Kazakhstan in improvement of chemical safety”. One of the case studies is on public monitoring of air pollution in the city of Temirtau (170,000 inhabitants), located in the Karaganda region. Temirtau is one of the most polluted areas in the country. For decades, this area was one of the centers of the heavy industry with large steelworks, coal-fired power stations, chemical production plants and foundries. One of the largest steelworks in the CIS region, owned by the corporation Arcelor Mittal, is located in Temirtau. The steel mill is based in the city, just 500 meters away from the nearest houses (Sir et.al., 2015). According to the state authorities, concentration of air pollution substances in the city and surrounding areas are always within the permitted limits. In reality, the average concentration of phenol exceeds four times the threshold value, 1.6 times in case of particulate matter and 1.4 times for ammonia. The health effects of pollution are alarming. Medical examination, conducted on adults not working in hazardous conditions and children living in the city of Temirtau and the village Chkalovo detected that the physical development of boys is behind age norms; the sexual development level of one-third of the surveyed girls is below the normal level; brain development of adolescents shows signs of stress; adults shown symptoms of chronic fatigue and depression (Arnika, n.d.).

2.2 Institutional structure and policy

The Ministry of Energy is the central executive body of the RK which oversees the formation and implementation of state policy and coordinates the regulation in the fields of oil and gas, petrochemicals, transportation of hydrocarbons, production of fuel products, gas and gas supply, electricity, coal industry, nuclear energy, environmental protection, control of rational use of natural resources, waste regulation and the development of renewable energy. It also controls the development of the “Green Economy” strategy (Ministry of Energy RK, 2016). Figure 3 lists the main institutional actors involved in the area of air pollution.

The RSE “Informational and analytical center of environment protection” provides the organization of the state fund of ecological information and the state cadastre of natural resources. In addition, it gathers and processes information from the state monitoring of environmental and natural resources, from projects and texts of legal acts and international

agreements, from the register of emissions and transfer of pollutants. It also supervises ecologically dangerous production activities and provides ecological expertise.



Source: Own illustration based on Ministry of Energy RK

Figure 3: Institutional structure: air pollution

Air quality monitoring in Kazakhstan is expandable. Given that the country is large and dominated by heavy industry, there is only a small number of monitoring sites. Moreover, the current list of monitored pollutants does not match with the current understanding of priority pollutants that have the most serious impact on human health. In addition, monitoring is slow and still partially based on laborious manual analysis and unrepresentative sampling (World Bank, 2013).

Monitoring is conducted in major cities and industrial centers of the country. At the moment, monitoring of atmospheric emissions is done via 104 monitoring stations in 34 urban or industrial areas. Of these, 56 are manual and 48 are automatic stations (Kazhydromet, 2017). The monitoring stations measure 17 compounds including total suspended particles, sulfur dioxide, sulfate, carbon monoxide, nitrogen dioxide, ammonia, hydrogen sulfide, phenol etc. Monthly, quarterly and annual reports are compiled on air quality monitoring (World Bank, 2013).

International agreements

Kazakhstan is a signatory to several international agreements related to greenhouse gas (GHG) and atmospheric emissions.

- The 1979 Geneva Convention on Long-range Transboundary Air Pollution-ratified on 11.01.2001. The convention deals with air pollution on a broad regional basis. It lays down the general principles of international cooperation for air pollution abatement and sets the institutional framework.

- The United Nations Framework Convention on Climate Change (UNFFCC) and the Kyoto Protocol
- The Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol

2.3 Economic aspects

Traditionally, the Kazakh companies focused on the cleaning-up of pollution rather than on mitigating pollution caused by industrial activities. The current mechanisms in the air pollution policy do not encourage investments in preventive measures. Accordingly, companies do not have any financial incentives to invest in green and ecologically friendly technologies or optimize production in order to reduce the impact on the environment.

In addition to traditional command and control instruments, Kazakhstan has implemented a market-based instrument, namely an emissions trading scheme (ETS). Kazakhstan was the first country in the CIS region to implement an ETS. Due to many shortcomings and complaints from the industry, the ETS was suspended in 2016. It is planned that the scheme will be revised, improved and relaunched again. It is important to consider country specific factors before relaunching an ETS and to also take into account potential alternative instruments like a carbon tax. In case of Kazakhstan, regulative, institutional, human capital and financial capacities should especially be considered. Other factors include the lack of local enterprises' experience with carbon markets, market imperfections such as an oligopolistic structure of certain large sectors and the level of corruption, which is still high in Kazakhstan (Nugumanova et.al., 2016).

State charges on air emissions from enterprises are determined in accordance with the current tax legislation. Companies obtain environmental permits for a period of three years. Environmental permits need to be approved by the relevant state authorities. Tariffs differ by region. If companies exceed the emission thresholds, indicated in their environmental permits, the following penalties are applied 1) tenfold tax payment for excessive emissions, 2) administrative code fine, 3) economic charge for environmental damage caused (World Bank, 2012).

2.4 Environmental aspects

Air pollution and climate change are interconnected, meaning that air pollution can be influenced by climate change and climate change can have an impact on air pollution. Different pollutants have different effects on climate change. Ozone in the atmosphere causes climate warming and different components of particulate matter can have either cooling or warming effects. Black carbon, which is a PM formed from incomplete combustion of solid fuels, warms up the climate and particulate sulfates cools down the climate (US Environmental Protection Agency n.d.).

Benduhn et.al. (2016) point out that though air quality and climate change are linked from their shared emissions sources and impact on climate, human health and ecosystems, the link is often not taken into account in global environmental policy. It is therefore important to explore the possibility of an integrated approach that includes both aspects of air pollution and climate change. The approach should take into account three factors 1) mix of emissions, 2) lifetime, and 3) benefits and trade-offs. First, the particulate mix of emissions determines the effects on air quality and climate change. Usually, air pollutants and GHG emissions are emitted from the same source. Reducing one pollutant emission will usually also have an effect on other pollutant emissions. Second, atmospheric lifetime of GHG and air pollutant determines the geographical scale the impact will have. CO₂, a long-lived GHG, remains in the atmosphere for centuries or even longer. Air pollutants usually have lifetime lasting from hours to month and thus local to regional impact scale is more prevalent. Finally, policy options that address both issues can have unintended benefits or trade-offs which need to be considered beforehand.

3 Waste

Potential effects of insufficient waste management on public health and the environment call for special attention from policy makers. Waste management is an essential utility service. It can be considered as a basic human need and as a ‘basic human right’. Inefficient waste management translates into environmental, health, social and economic consequences. For example, uncontrolled burning of waste causes particulate and persistent organic pollutant (POP) emissions and uncontrolled dumpsites and mixing of hazardous waste with other types of waste can contribute to the spread of diseases in the residential areas. Moreover, burning and dumping waste in uncontrolled dumpsites has negative effects on air, surface and groundwater, soil and the coastal environment (UNEP, 2015).

Whiteman et.al. (2001) suggest that waste management effectiveness can be an indicator of urban development and sustainability of a city. Therefore, waste management is one of the most visible municipal services. Different standards of waste management services exist across countries and different urban areas.

Key factors which affect the generation and composition of waste include:

- 1) Economic growth: higher income and thus higher consumption leads to an increase in waste production.
- 2) Population growth and the composition of the population: households with children and persons aged 25 to 64 produce more waste.
- 3) Growing urbanization: urban population usually has a higher income, which is associated with a greater consumption of goods and thus a higher level of waste generation. However, waste management is better in urban areas (OECD, 2004).

It is recognized that the level of industrial waste generation is linked to economic growth and GDP. Industrial waste usually varies depending on the country’s industrial structure. Industries that produce a lot of waste are the chemical, pulp, paper, iron and steel sectors. Since industrial waste is usually managed at the source by the industry itself, receiving detailed data on industrial waste is especially difficult (OECD, 2004).

3.1 Present state and trends

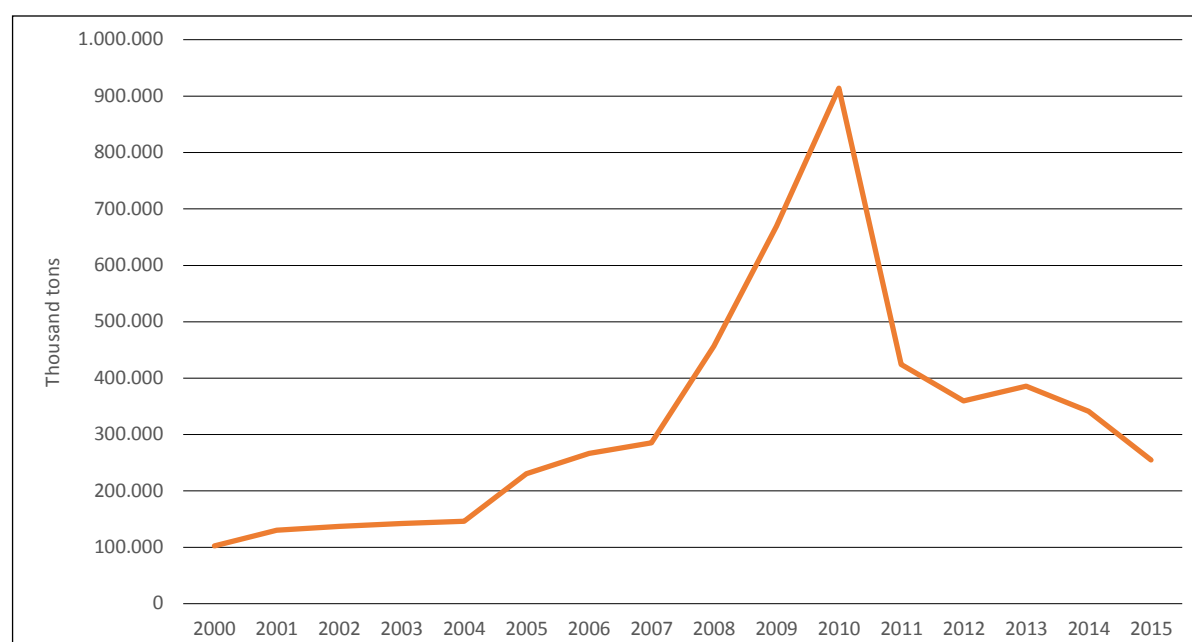
According to the official data available, Kazakhstan generates an immense quantity of waste and even more than France or the Netherlands. This is remarkable, given that the population in France is four times higher than in Kazakhstan and its GDP is even ten times higher (Table 2).

Table 2: Total waste, 2014 (thousand tons)

Kazakhstan	340,861
Germany	387,504
France	327,996
Netherlands	134,146

Source: Author's compilation based on Committee on Statistics RK, 2016 & Eurostat, 2016

Data on total waste generation in Kazakhstan can be obtained from national statistics. Figure 4 illustrates that total waste generation increased nine fold from 2000 to 2010. After 2010 total waste generation started to decrease.



Source: Own illustration based on Committee on Statistics RK, 2016

Figure 4: Total waste generation RK 2000–2015

Table 3 shows that almost 100% of total generated waste is hazardous waste². Kazakhstan is also one of the largest producers of hazardous waste in the world (World Bank et.al., 2014). Municipal waste constitutes a small share of total waste. Such a high share of hazardous waste can be explained by the classification and definition of hazardous waste in the country. The UNECE (n.d.) emphasizes that the share of hazardous waste in the CIS countries varies from 0% in Moldova to 100% in Kazakhstan. Besides Kazakhstan, Kyrgyzstan and Russia are also having a very high share of hazardous waste. Significant differences in classification and definition of hazardous waste among the CIS countries can be one of the explanations for such different levels of hazardous waste. Several countries mentioned that there is no non-hazardous waste and that practically all waste is toxic to some extent.

Table 3: Total waste RK (thousand tons)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Hazardous waste	228.243	263.971	281.769	453.373	227.555	910.351	420.668	355.953	382.214	337.415	251.566
Municipal waste	1.678	1.960	2.868	2.604	3.348	3.095	3.172	2.430	2.496	2.421	2.318
Total waste	230.335	266.373	285.121	456.785	669.278	914.135	424.587	359.541	385.762	340.861	254.801

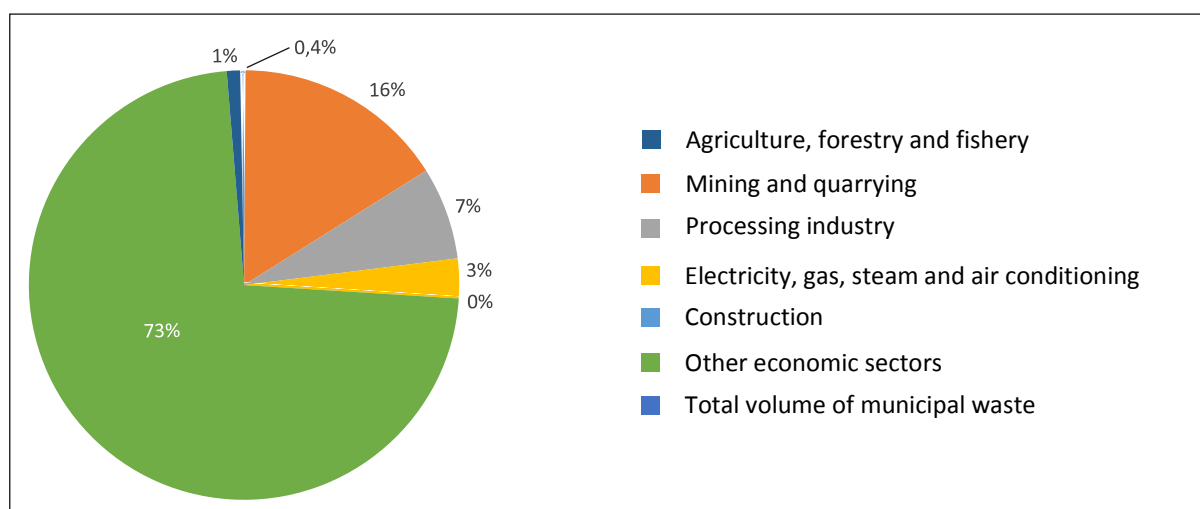
Source: Committee on Statistics RK, 2016

Regional trends

According to the official statistics, almost 86% of total industrial waste in 2014 was accumulated in the Kostanai region, 6.3% in the Karaganda region, 3.6% in the Pavlodar region and 3.6% in Eastern-Kazakhstan (Ministry of Energy of RK, 2015). This can be explained by the industrial structure of the regions. For example, the major waste problem in Eastern Kazakhstan stems from toxic waste generated in the mining and metallurgy sectors. Other examples include: waste from power plants and metal ore concentration plants in Almaty; coal mining, metallurgy and chemical industries in the Karaganda region; oil and gas industries waste in the Kyzylorda, Atyrau and West Kazakhstan regions; toxic and radioactive waste at the non-industrial and military zones of Baikonur and the Semipalatinsk nuclear test ing sites (UNEP, 2014).

² “waste that contain hazardous substances with hazardous properties (toxicity, explosion hazard, radioactive, fire risk, high reactivity) and may represent immediate or potential danger to the environment and human health, alone or upon coming into contact with other substances...” (Ecological Code, Article 1, 34).

In the Kostanai region, 91% of total industrial waste is generated by only three companies: АО “ССГПО”, АО “Варваринское” and АО “Алюминий Казахстана”. АО “ССГПО” is the country’s largest enterprise involved in the extraction and enrichment of iron ores and is a subsidiary of the Eurasian Natural Resource Company. This company is responsible for 59% of the total quantity of accumulated industrial waste in the region (Ministry of Energy RK, 2015).



Source: Own illustration based on Committee on Statistics RK, 2016

Figure 5: Waste generation by sector, 2015 RK

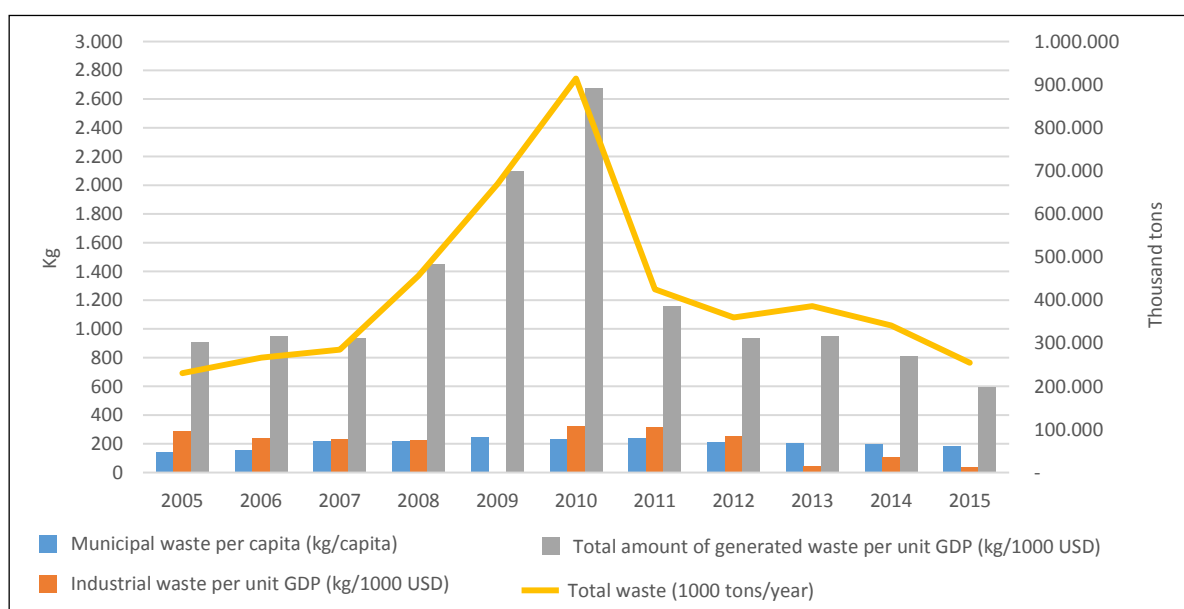
According to the Committee of Statistics of the RK “Other economic sectors” account for the largest share (73%) of waste in the country. Waste generation from mining and quarrying accounts for 16% of total waste generation (Figure 5).

The major share of industrial waste is disposed at discharges and different sites of waste dumps. This poses a threat to the environment. Only a small share of total industrial waste is processed. Outdated industrial facilities are not able to cope with large quantities of waste, which leads to a massive accumulation of waste. Industrial waste is accumulated and usually stored at the industrial sites. Hazardous waste storage sites are equipped with an outdated technology and equipment that does not provide sufficient soil, groundwater and air protection (World Bank et.al., 2014).

An ADB (2012) assessment concludes that all major cities in the RK have inefficient solid waste management (SWM), which is not capable of adjusting to increased urbanization and economic growth. The largest cities in the country, Astana and Almaty have invested in improvements of the

SWM, but illegal dumping is still present and widespread. ADB estimates that \$2–\$3 billion of investment is necessary to develop a SWM in the country. On average 0.4–0.9 kg/capita waste is generated per day. The collection rate is 40–60 percent. Waste is usually disposed at untreated landfill sites or city dumps with hardly any environmental or sanitary requirements.

Figure 6 shows that the share of processed and recycled waste is very low. In 2015, only 12% of the municipal waste, 4.1% of the hazardous waste and 4.4% of total waste was recycled. Interestingly, in 2009 the share of recycled hazardous and total waste rose significantly.



Source: Own illustration based on Committee on Statistics RK, 2016

Figure 6: Processing and recycling of waste in the RK

According to the UNEP (2014), Kazakhstan has practically no waste recycling enterprises. Rapid urbanization led to an increase in solid waste. However, public utility services are not able to provide sufficient services to the urban population. Municipal services lack means of transportation, fuel and staff. Currently three main issues are of major concern: waste is not separated, municipal waste is often mixed with hazardous waste and there are not enough waste processing plants.

In order to overcome these problems, ADB (2012) recommends the following actions

- (1) Handle, separate, collect, and process waste disposal safety and procedures

(2) Develop institutional and regulatory reforms to support the development of SWM

(3) Develop institutional investors and private sector involvement in SWM

The current municipal solid waste (MSW) management does not meet the necessary requirements and is characterized by the following aspects (Ministry of Environment and water resources of the Republic of Kazakhstan, 2013)

- The choice of waste storage landfills location is not chosen on any engineering and hydrological grounds
- Separate waste collection does not take place in Kazakhstan. There are no companies to utilize or dispose MSW components
- No environmental monitoring is carried out at landfill areas
- Sanitary and environmental requirements concerning the placement and equipment of the MSW temporary storages are not met
- No measures are introduced to reduce the amount of generated waste
- Illegal dump creation is prevalent and not all MSW reach permitted waste landfills

Another concern is persistent organic pollution (POP). POP is caused by an obsolete and unwanted pesticides in the agricultural sector, equipment containing POPs, industrial technologies that lead to unintentional dioxin and furan releases and by the formation of dioxins and furans during open combustion. Only 20% of the country is covered by an inventory of pesticides with POP characteristics. Pesticide waste in the country is stored in destroyed storage halls or at dump sites. Kazakhstan ranks second after Russia in the Eastern and Central European region in terms of stockpiles of POP waste. Kazakhstan signed and ratified the Stockholm Convention on POP on May 23, 2001. The structure of the implementation of the Stockholm Convention in Kazakhstan is outlined in the National Implementation Plan of the RK. The Plan includes short-term and long-term activities (National Implementation Plan of the RK on the Obligations under the Stockholm Convention on Persistent Organic Pollutants, 2009).

3.2 Institutional structure and policy

The key authority involved in the regulation of waste is the Ministry of Energy of the RK and particularly the Department of Waste Control and JSC “Zhasyl Damu” (Figure 7). JSC Zhasyl Damu’s main function is the development of the management system. It is particularly concerned with the following types of waste and the respective management issues

- Ownerless waste inventory and statement on the government’s balance sheet (including mercury wastes, PCBs, pesticides, etc.)
- Development of comprehensive measures and projects for the destruction and disposal of economically unattractive waste
- Creation of a network of branches in the regions of Kazakhstan to build up production facilities for centralized waste collection and its preparation for onward transmission to the disposal (destruction)

Ministry of Energy RK	<ul style="list-style-type: none"> • Department of Waste Control • JSC “Zhasyl Damu”
Ministry of Health RK	<ul style="list-style-type: none"> • development and monitoring of requirements concerning collection, storage and transportation of medical waste
Ministry of Transportation and Communication RK	<ul style="list-style-type: none"> • conducts monitoring of hazardous waste transportation
Ministry of Agriculture RK	<ul style="list-style-type: none"> • develops and monitors activities concerning pesticides and toxic chemical waste

Source: Own illustration based on Ministry of Energy RK

Figure 7: Institutional structure: waste

Industrial enterprises are obliged to provide a yearly report on the generation of hazardous waste to the authorized state authorities. In 2013, a total of 290 enterprises provided annual reports to the Ministry of Environment of the RK. Out of these 290 enterprises, 65 belong to the mining sector (World Bank et.al., 2014).

The major environmental legislation which regulates the management of hazardous substances and waste is the Ecological Code.

International agreements

Kazakhstan is a party to major multilateral agreements regulating the management of waste and the disposal of toxic and dangerous products and waste. These agreements include the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade and the Stockholm Convention on Persistent Organic Pollutants.

3.3 Economic aspects

Waste policies depend on who bears the costs and who receives the benefits. Various price instruments can be implemented. Waste levels can be influenced by traditional policy instruments, market-based instruments and by manufacturer take-back initiatives. The unit price system involves households by making them purchase stickers or special bags for every unit of garbage generated. Other options are a deposit-refund system and manufacturer take-back systems (OECD, 2004).

Governments turned to various methods to manage MSW. This includes quantity-based fees, unit charges for garbage collection services, recycling programs and so forth. When implementing a unit price system, the government needs to decide between a user level fee and a fee on the unit of garbage. Based on this decision, governments can either implement a weight-based or a volume-based pricing system. Other unit pricing systems would be frequency-based programs (Ferrara, 2008).

The waste management sector is usually highly regulated. Transportation costs in waste management are one of the most important factors. In the MSW, collection is the most costly phase and is subject to large economies of density. It is estimated that 40% to 80% of total costs is due to collection. Therefore, effective collection would have a large effect on the overall efficiency of waste handling. Usually, municipalities handle the collection of residential waste themselves or make contracts with private or public providers. Each stage of the MSW management has its specific market characteristic. Waste collection is usually a natural monopoly. A single provider of waste collection is considered to be more efficient. On the other hand, the markets for waste transfer stations, landfills and incinerations are characterized by scale economies and high entry barriers (OECD, 2013).

Households in Kazakhstan are charged flat rate fees per month and person for waste collection. Tariffs on solid municipal waste in the country are low and do not include the costs for the following things: sorting, handling, transshipment of waste, equipment of collection areas, renewing the vehicle fleet and containers. Tariffs differ by city and range from 107 tenge in Taraz to 341 tenge in Almaty per person and month as of December, 2016 (Committee on Statistics RK, 2016b). No other economic instruments are implemented in Kazakhstan to decrease the quantity of solid waste. However, the current tariff system should not be the only instrument to address waste problems. Policy makers should take into account the experience of developed countries and the results of scientific studies when addressing the waste problem.

Several modern waste processing facilities opened in Kazakhstan in the last decade. The first municipal waste processing facility in the country opened with the support of local authorities in 2007 in Almaty. The plant covered 90% of the city's utilization of municipal solid waste. Within the first five years, the company had to pay back \$28 million of investment. The plant was expected to reach cost recovery by producing secondary materials like PET flex, plastic pellets, paper and ferrous and non-ferrous metals. During the economic crisis in 2009, the price of recyclables decreased by 1.5–3 times and municipal subsidies were removed. Thus, the plant was not able to cover its costs and pay back the loan. Accordingly, the plant had to shut down. The management of the plant emphasized that operating such a plant is financially not viable without state assistance (Netherlands Water Partnership, 2013).

In 2012, the Agency for Construction, Housing and Utilities of the RK announced plans to build 41 waste processing plants within 10–15 years. The pilot projects will be launched in Aktobe, Atyrau, Karaganda, Abai, Saran, Shakhtinsk, Kostanay, Pavlodar, Taldykorgan, Taraz, Ust-Kamenogorsk and Kokshetau. The Astana Waste Processing Plant was opened in 2012. The plant utilized municipal solid waste in Astana. After few years of operation, the plant had to shut down as well (Netherlands Water Partnership, 2013).

Sources of hazardous waste or companies generating hazardous waste are allowed to utilize or process own waste themselves or use the services of external companies. Every producer of hazardous waste can decide itself and choose the most optimal solution. At the moment, there is no official list of licensed facilities that process hazardous waste. Companies face difficulties in choosing appropriate facilities to process their hazardous waste. Most of the time, companies choose waste process facilities based on recommendations or word-of-mouth advertising. There

is also no information on which type of hazardous waste can be processed by which specific facility. The World Bank recommends that the state authorities develop a list of specialized companies that offer transportation services and secondary treatment and processing and utilization of hazardous waste. The list should also include the type of hazardous waste which could be handled by the facilities (World Bank, 2014).

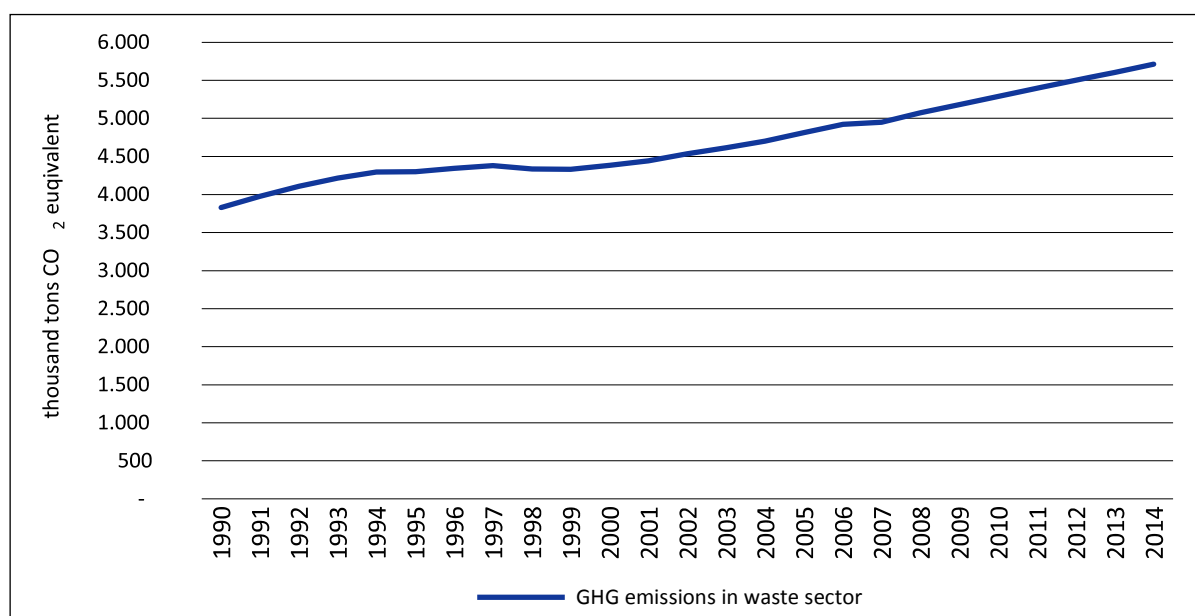
At the moment, the legal entities which generate hazardous waste follow the system of fees and taxes on air pollution. Rates are set depending on the type of waste utilized. Fees are set for utilization and storage of hazardous waste. Producers of hazardous waste calculate their fee rates depending on their waste permits. In case the level is higher than allowed, fee rates are multiplied by 10. If hazardous waste is transported from the source of waste generation to utilization at the landfill, the facility that utilizes the waste is responsible for the payment of the fee for environment pollution. This is contradictory to the strategy of reducing waste at the source considering that waste reduction is not a goal of the waste processing facility. Thus, waste processing facilities should not be charged such fees, but rather the producers of the hazardous waste.

Furthermore, revenues generated by environmental fees are assigned to local and city budgets. International practice shows that revenues are used best for financing environmental initiatives. In Kazakhstan, it is difficult to identify if the revenues are really used to compensate the damage caused to the environment or not (World Bank et.al., 2014).

3.4 Environmental aspects

Better waste management is limited not only to resource use efficiency and reduced burden on the environment, but also offers an opportunity to reduce GHG emissions. GHG emissions from waste constitute one percent of total GHG emissions in Kazakhstan (Figure 8) (UNFFCC, 2012).

Poor waste management can have a negative impact on the environment. In low and middle income countries, MSW is usually dumped in low-lying areas and land close to slums. Medical and hazardous waste often mixes with MSW, which has a negative impact on the environment and the local population. Moreover, contamination of groundwater and surface water and air pollution from burning waste is a threat to the environment.



*Sources of emissions from waste sector are solid waste management (managed and unmanaged landfills of solid waste), incineration of medical waste, treatment and disposal of wastewater).

Source: Own illustration based on Ministry of Energy RK, 2016

Figure 8: GHG emissions in waste* sector, RK 1990–2014

4 Water sector

Water is a necessary input for all economic sectors. The agriculture sector uses large quantities of water for irrigation. Water is also a necessary component in energy production and is used for the following activities: running powering turbines in hydroelectricity, cooling power plants and growing biofuels. Water shortage can hinder economic growth and stability. Water is essential for public health and for maintaining an intact ecosystem and environment (UNESCO, 2012).

Water management is a complex policy issue, which involves the determination of the economic value of the resource. Water as a commodity has unique features such as it is both a private and a public good, it is bulky and challenging to transport, it can be used sequentially and can be recycled and it is a heterogeneous commodity. Similar to fossil fuels, water resources are limited and distributed unevenly. Therefore, water should not be underpriced since it leads to an overuse and further undersupply. Increasing water scarcity and competition for water resources call for setting the right price for this commodity. This in turn can be an important policy instrument for managing water resources (Kochhar et.al., 2015).

4.1 Present state and trends

Water resources in Kazakhstan come mainly from surface water sources and include four major hydrological regions, which are categorized by the final destination of the water: 1) the Arctic Ocean through the river Ob, 2) the Caspian Sea, 3) the Aral Sea and 4) internal lakes, depressions or deserts. Water scarcity, water pollution and transboundary water issues with the neighboring countries are the major water-related problems in Kazakhstan (World Bank, 2013a).

There are about 39,000 rivers and streams. Groundwater resources are unevenly distributed within the country. Central Kazakhstan has only 2.6 % of the total water resources, whereas the eastern region has 34.5%, the northern region 4.2%, the southeast region 24.1%, the southern region 21.2% and the western region 13.4% (Ministry of Energy of RK, 2015).

There are eight river basins in the country (Figure 9):

1. The Aral-Syr Darya basin occupies 345 000 km² and includes South Kazakhstan and the Kyzylorda region. The main water source is the river Syr Darya.
2. The Balkash-Alakol basin occupies Southeast Kazakhstan, a part of China and a small part of Kyrgyzstan. Its area is 413 000 km².

3. The Chu-Talas-Assa basin has a total area 64 300 km² and is formed by the rivers Chu, Talas and Assa. The flow of the rivers Chu, Talas and Kukureu-su is formed in Kyrgyzstan.
4. The Irtysh river basin is located in East Kazakhstan and the Pavlodar region and occupies a total area of 316 500 km². The river originates in China. This basin constitutes the most secure water resources.
5. The Nura-Sarysu basin includes the basins of the rivers Nura and Sarysu, and the lakes Tengiz and Karasor.
6. The Ishim river basin is located in the areas Akmoal and North Kazakhstan and has a total area of 245 000 km². This basin has low security in regards to water resources, due to its low groundwater reserves.
7. The Tobol-Targai basin includes the rivers Tobol, Torgai and Irgiz. This basin has the lowest water resources in the country.
8. The Ural-Caspian basin is located in Russia, West Kazakhstan and Atyrau and has a total area of 415 000 km² (FAO, 2013)



Source: Ministry of Energy RK

Figure 9: River basins in Kazakhstan

There are 48,262 lakes, ponds and reservoirs that cover an area of 45 000 km² and have a water volume of 190 km³. The Caspian Sea is the largest lake in the world. However, its levels vary significantly. Additional large lakes include Lake Balkhash (18 000 km²), lake Zaisan (5500 km²) and lake Tengiz (1590 km²).

Overall freshwater resources are estimated to be 524 km³, out of which 80 km³ originates from glaciers, 190 km³ are concentrated in lakes and 100.58 km³ come from rivers. Underground water resources make up 15.6 km³ (Ministry of Energy RK, 2015).

Water usage

Total water withdrawal³ in 2010 was estimated to be equal to 21.12 km³, out of which 14 km³ was used for agriculture, 6.263 km³ for industrial usage and 0.878 km³ for municipal purposes. Water withdrawal per capita in Kazakhstan is the lowest in the Central Asian region, but comparing to other countries like Israel, consumption of water is still relatively high (Table 4).

Table 4: Water withdrawal

	Agricultural water withdrawal (10 ⁹ m ³ /year)	Industrial water withdrawal (10 ⁹ m ³ /year)	Municipal water withdrawal (10 ⁹ m ³ /year)	Total water withdrawal (10 ⁹ m ³ /year)	Total water withdrawal per capita (m ³ /inhab/year)	Freshwater withdrawal as % of total renewable water resources (%)
Kazakhstan	14 (2010)	6.263 (2010)	0.878 (2010)	21.14 (2010)	1 257K (2010)	18.43K (2010)
Kyrgyzstan	7.1 (2011)	0.336 (2006)	0.224 (2006)	8.007 (2006)	1 531K (2006)	32.63I (2006)
Tajikistan	10.44 (2006)	0.4078 (2006)	0.647 (2006)	11.49 (2006)	1 619K (2006)	51.07I (2006)
Turkmenistan	26.36 (2004)	0.839 (2004)	0.755 (2004)	27.95 (2004)	5 753K (2004)	112.5I (2004)
Uzbekistan	50.4 (2005)	1.5 (2005)	4.1 (2005)	56 (2005)	2 106K (2005)	100.6I (2005)
Israel	1.016 (2009)	0.113 (2004)	0.712 (2004)	1.954 (2004)	282.3K (2004)	79.72 I (2004)

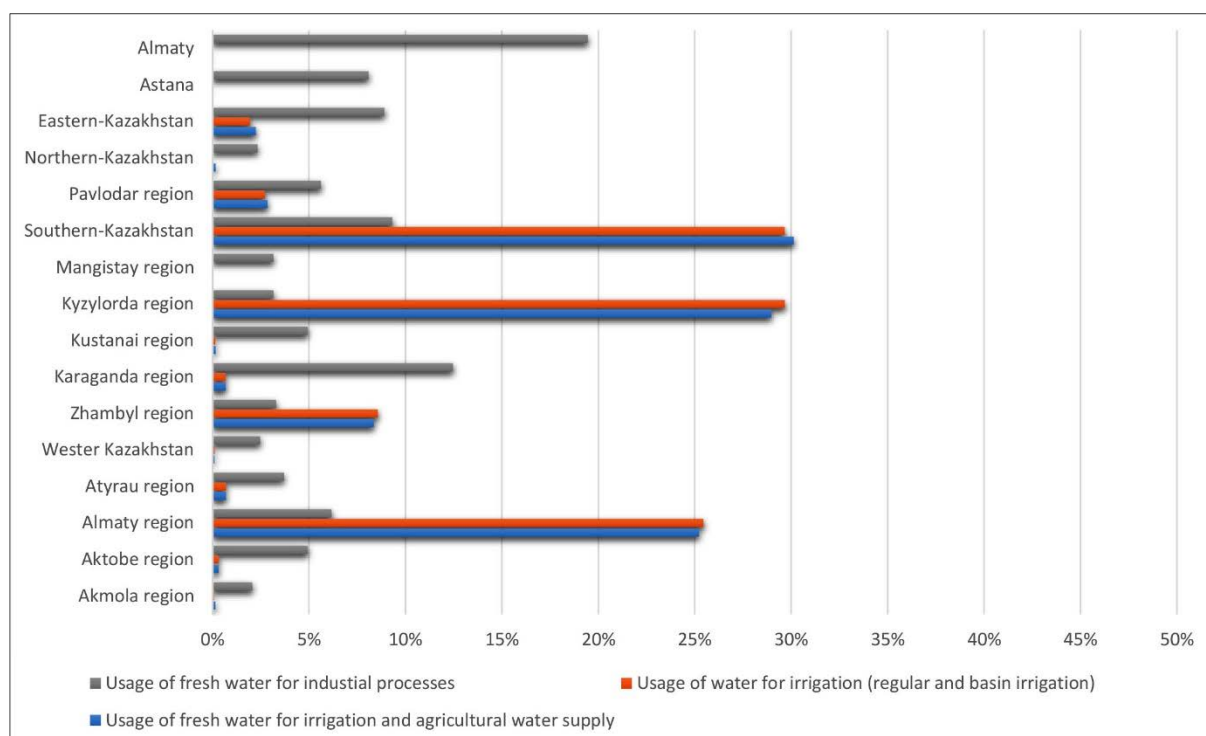
Source: Author's compilation based on FAO, 2016

Regional trends

Water from Syr Darya, Ili, Chu, Talas and the Irtysh rivers is mainly used for irrigation. Almost 85% of overall irrigation water is used in three regions (Kyzylorda, Southern-Kazakhstan and

³ Water withdrawal is the total water diverted for human use (including domestic, agricultural and industrial water use) (Kochhar et.al., 2015).

Almaty). Central heating energy enterprises, metallurgy and the oil industry account for the major share of industrial water withdrawal. The regions that exhibit the largest usage of water for industrial purposes are Almaty (19%), Karaganda (12.5%), Southern-Kazakhstan (9%) and Astana (8%) (Figure 10).



Source: Own illustration based on Committee on Statistics, 2016

Figure 10: Regional water usage: industry and agriculture (2015)

The agricultural sector is largest user of water not only in Kazakhstan but globally. Given the country's high temperatures in summer and the low rainfall, Kazakhstan and other Central Asian countries depend on irrigated agriculture for its food production. It is widely contended that the irrigation system in Kazakhstan is inefficient. In 2010, the area equipped with a full irrigation system was estimated to account for 1 199 600 ha, out of which 96.6% is surface

irrigation⁴, 2.5% sprinkler irrigation⁵ and 0.9% localized irrigation⁶. About 93% of the total area equipped for full controlled irrigation is located in four southern regions (South Kazakhstan, Almaty, Kyzylorda and Zhambyl). The most commonly irrigated crops are cereals (wheat, maize, rice and barley), cotton, oil crops, soybeans, fodder, potatoes, vegetables, grains and permanent grasses (FAO, 2013).

Wasteful water user practices and overuse of pesticide and fertilizers in the agriculture are of major concern. Problems with water quality and increasing mineralization of content are caused by evaporation of irrigation and drainage run-off. Especially in the Central Asian region, the upstream communities have better quality of water, while downstream settlements receive water with high mineralization and the minimum recommended flow is not reached (FLERMONECA et.al., 2015).

The Lake Balkash basin is the planet's largest lake ecosystem. Three major rivers drain into Balkash including Ili, which provides 80% of the river's flow. Balkash is rich in biodiversity and forage for animals, and is an important fishing ground and reservoir. More than 3 million people live in the river basin area. The area has an expanding industry and agricultural sector. Increasing agricultural practices and the irrigation and drainage systems used in Kazakhstan negatively affect the hydrology of the lake Balkash and decreases the Ili river flow. This is partly caused by an increased water use from the expanding areas in the parts of the basin in China. Degradation of the lake's coastal areas and aquatic and wetland ecosystems can already be observed. The diminishing lake size and its increasing salinization indicate the danger of Lake Balkash becoming a second Aral Sea (ADB, 2010).

Water pollution⁷ and water contamination⁸ are also important issues. For example, the river Nura is the main river in Central Kazakhstan flowing through the Karaganda and Akmola regions. Water from the Nura is used for residential water supply, irrigation, industrial use and

⁴ "Surface irrigation systems are based on the principle of moving water over the land by simple gravity to moisten the soil..." (FAO, 2013 p. 14)

⁵ "Sprinkler irrigation systems consists of a pipe network, through which water moves under pressure before being delivered to the crop through sprinkler nozzles." (FAO, 2013 p. 14)

⁶ "Localized irrigation is a system where the water is distributed under low pressure through a piped network, in a pre-determined pattern, and applied as a small discharge to each plant or next to it..." (FAO, 2013 p. 14)

⁷ "...introduction by man, directly or indirectly, of substances or energy into the marine environment (including estuaries) resulting in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities including fishing, impairment of quality for use of sea water and reduction of amenities..." (FAO n.d.)

⁸ "...the presence of elevated concentrations of substances in the environment above the natural background level for the area and for the organism..." (FAO n.d.)

for recreational and commercial fishing. It is also a source of drinking water for the capital city Astana. The river Nura received high inflows of mercury since the 1950s, originating from the chemical factory located in Temirtau. During 47 years of operation of the acetaldehyde factory, according to various estimations, around 150 to 3,000 tons of mercury was discharged in the river, poisoning water and soil. A major clean-up project of the river Nura was conducted between 2005–2013 with a loan of the World Bank and 64.9 million USD from the state budget. However, according to the Czech NGO Arnika, the project was conducted with many violations. For example, receiving information on mercury content in the river and soil in the river banks after the project completion was not possible. Thus, the current situation in the Nura River is unknown. Research conducted by the Arnika in 2013–2014 confirmed that the water and soil are still contaminated with mercury (Arnika n.d.).

4.2 Institutional structure and policy

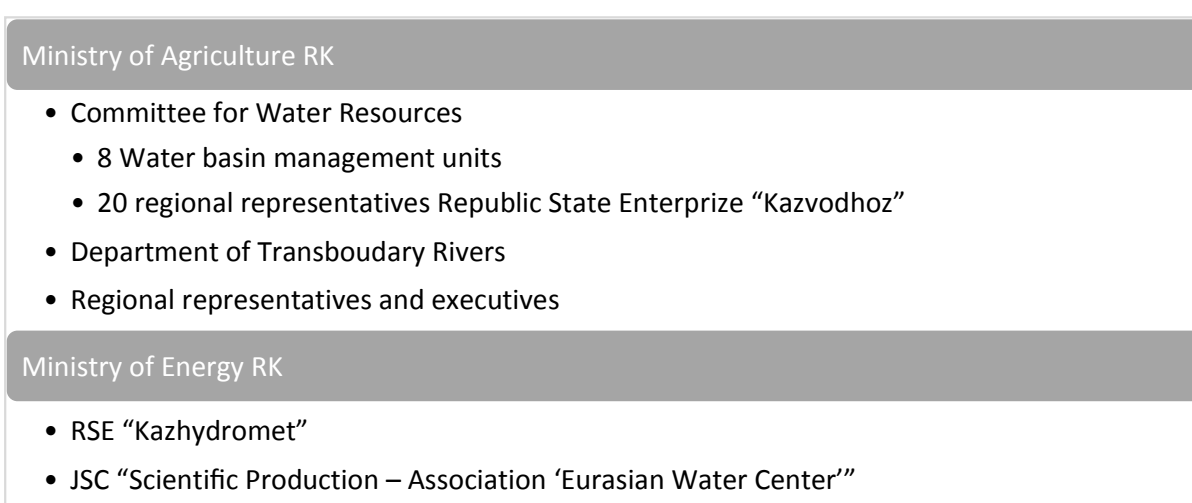
The Ministry of Agriculture of the RK is the main authorized body for managing water resources. The Committee for Water Resources under the Ministry of Agriculture manages water use and conservation (Figure 11). Its tasks include 1) management and cross-sectoral coordination of the implementation of the state policy for managing water resources, 2) improvement of legislation for managing water resources, 3) improving the system of state governance for managing water resources, 4) development of international cooperation for managing water resources, 5) to ensure state control in managing water resources (Ministry of Agriculture RK, 2015).

The eight water basin management units are territorial subdivisions of the Committee for Water Resources. “Kazvodhoz” which has 20 regional representatives is responsible among others for the operation, maintenance and safety of water facilities of national significance and the supply of irrigation and drinking water. Moreover, the Department of Transboundary Rivers works under the Ministry of Agriculture of the RK.

Local representatives (maslikhats) and executives (akimats) manage water issues at the regional level. Maslikhats set the rules for common water use, approve regional programs for the rational use and conservation of water bodies, control their implementation and regulate the leasing of water facilities. Akimats set up water organizations to manage and maintain water

facilities under communal administration, define water conservation areas and sanitary zones, organize regional programs on water conservation, etc. (FAO, 2013).

The Ministry of Energy RK includes the RSE “Kazhydromet” and the JSC “Scientific – Production Association – ‘Eurasian Water Center’”. “Kazhydromet” monitors and forecasts the weather, provides data on precipitation and water levels, monitors air quality, natural hazards and soil conditions for crop productions. The main aim of the “Eurasian Water Center” is to conduct research and to study questions of water resource protection.



Source: Own illustration based on the Ministry of Energy RK

Figure 11: Water governance: institutional structure

As it is also the case for other environment related issues, the Ecological Code provides the major legal framework. Furthermore, a Water Code was adopted in 1993, and amended and supplemented in 2003 and 2009.

International agreements

The five Central Asian states are closely inter-connected due to the joint use of the rivers Syr Darya and Amu Darya and other transboundary rivers. The water-rich countries, Tajikistan and Kyrgyzstan, which are located upstream, rely heavily on hydropower for an energy production. The water-poor countries, Kazakhstan, Uzbekistan and Turkmenistan, which are located downstream, use water for agricultural land irrigation. Most water in the region is generated in

the upstream mountainous areas. Water flows from smaller streams into bigger streams and finally into the Amu Darya and Syr Darya. The water is comprised of four components 1) rain water flowing overground directly into the streams, 2) rainfall seeping into the soil and flowing through the soil into the streams and groundwater, 3) precipitation falling as snow and flowing into the streams when it melts, 4) precipitation feeding glaciers which melts and flows into streams (ADB, 2014).

During the Soviet times, water use between the five Central Asian states was based on the master plans for development of water resources in the Amu Darya and Syr Darya river basins. After the collapse of the Soviet Union, the countries signed a number of agreements to regulate the cooperation for joint management and use of water resources. Some of the agreements are briefly described below.

In 1992, the Central Asian countries signed an interstate agreement on water sharing, use, conservation and financing. The agreement established an Interstate Commission for Water Resources (ICWR). The ICWR is responsible for policy formulation and water allocation among the five countries.

- In May 1992, an interstate agreement was reached with Kyrgyzstan concerning the Chu and Talas rivers coming from Kyrgyzstan.
- In 1996, the five Central Asian countries have signed the “Agreement on joint actions to address the problem of the Aral Sea and socio-economic development of the Aral Sea basin”.
- The 1998 agreement between Kazakhstan, Kyrgyzstan and Uzbekistan regarding the dams in the upper Syr Darya river basins.
- In 1997, the International Fund for Saving the Aral Sea was founded (FAO, 2013).

Kazakhstan and China signed a cooperation agreement on the usage and protection of cross-border rivers. Both countries agreed on a list of 23 cross-border rivers. Kazakhstan's transnational water issues with China concern major rivers such as Irtysh, Ili, Talas and Khorgos. The two largest rivers, Ili and Irtysh, are increasingly under pressure and are diminishing due to China's water withdrawal. The increasing demand is largely due to the state project aimed at developing China's Xinjiang region and increasing its population. Moreover, increasing agricultural production in China puts pressure on the Ili river (Baizakova, 2015).

Interstate water issues with Russia concern the rivers Ural, Irtysh, Ishim and Tobol. An interstate agreement between Kazakhstan and Russia on the joint use and safeguarding of cross-border water facilities was signed in 1992. Within the framework of this agreement, both countries meet twice a year to approve the work schedule for reservoirs of joint use, set limits for water extraction, etc. In 2010, an agreement between the two countries on the joint use and protection of transboundary water bodies was signed (FAO, 2013).

4.3 Economic aspects

Establishing an effective tariff policy and improving the tariff calculation system for natural monopolies in regulated markets are the state's priority. The main aim is to attract investment into the water supply and sanitation sector in order to upgrade the infrastructure and improve the quality of services. Accordingly, water tariffs were adjusted to better reflect actual costs of water supply and sanitation. For example, drinking water tariffs have been increased by 46.2% in 2013 and tariffs for sewage services by 43.6%. Thus, the government tries to motivate consumers to reduce water consumption. Customers with water meters installed receive lower tariffs. In 2010, 76% of urban and 40% of rural household had water meters installed (OECD, 2016b).

Table 5: Cold water household tariffs (KZT/m³) in RK cities, 2016

Republic of Kazakhstan	64.55		
Astana	49.9	Kyzylorda	60.84
Almaty	55.56	Uralsk	50
Aktau	234.08	Ust-Kamenogorsk	55.53
Aktobe	74.23	Pavlodar	29.47
Atyrau	113.49	Petropavlovsk	76.02
Zhezkazhgan	41.07	Semei	51.02
Kokshetau	70.93	Taldykorgan	68.68
Karaganda	110.26	Taraz	26.96
Kostanai	78.21	Shymkent	77.17

* As of December, 2016 for 1 cubic meter. Source: Own compilation based on Committee on Statistics, 2016

Cold water residential tariffs in Kazakhstan vary across cities. The lowest tariffs can be found in Taraz (26.96 KZT/m³) and the highest in Aktau (234.08 KZT/m³) (Table 5).

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Even though, water tariffs have been increased over the last years, they are still estimated to be within the range of affordability for urban areas. This means that water supply and sanitation constitute less than 4% of household disposal income. In rural areas, water tariffs are higher and the economic situation is worse. Therefore, affordability in rural areas is lower than in urban ones. The financial situation of rural households is worse. At the same time, the household size is larger and water tariffs are higher. Accordingly, rural households usually do not use centralized water supply (OECD, 2016b).

The financial performance of urban water utilities remains a major issue. Financial sustainability of operators is essential for sustainable operation services. Operational costs remain high. This is largely due to the inadequacy of oversized infrastructure and declining demand. As indicated above, tariffs have been increased, but still remain low. However, a positive aspect is that the payment discipline improved significantly since the 1990s (OECD, 2011).

Industrial water supply is to almost 100% covered by meters. Metering in the agricultural sector is practically absent and no modern water saving techniques are used for irrigation (Ministry of Energy RK et.al., 2013).

The agricultural sector is the main consumer of water resources. In regard to water supply and sanitation, large farms or agricultural enterprises usually maintain their own water supply and sanitation (WSS) systems and have their own operation and maintenance staff. Farms provide drinking water for their own needs and those of their employees. In case if they sell water to other consumers, farms can charge water tariff fees set by the Agency of Regulating National Monopolies. There is no data available on how many people are supplied through these scheme, but it seems that in rural areas this is the most widespread model. Local state authorities usually do not have to allocate local budgets to support this scheme, therefore this model is especially supported by the authorities. Often authorities ask farms to maintain existing public WSS infrastructure. Due to a lack of expertise in proper maintenance of WSS of farmers, the services provided are insufficient. Inadequate maintenance leads to supply shortages, poor sanitation and technical failures (OECD 2016b).

Though WSS is a public service utility, increasingly more countries involve the private sector in water system management. Especially in developing countries appropriate WSS requires

substantial investment. Private sector agents involved in water services ranges from international operators, local and regional actors to joint ventures between public and private companies.

An input-output (I-O) table, published by the Committee on Statistics of the RK, shows transactions in an economy during a certain accounting period. In the I-O table “Usage of products and services at basic prices” of Kazakhstan for the year 2014, “Water supply; sewerage; waste management and remediation activities” is aggregated to one sector.

Analyzing the I-O table shows that the sectors with the highest input shares into the *Water supply; sewerage; waste management and remediation activities* sector are mining of coal and lignite, mining of non-ferrous metal ores, other mining and quarrying; manufacture of wearing apparel, manufacture of refined petroleum products, manufacture of tubes, pipes, hollow profiles and related fittings, of steel, manufacture of basic precious and other non-ferrous metals, electric power generation, transmission and distribution, construction; wholesale on a fee or contract basis, land transport and transport via pipelines, water transport and administrative and support service activities.

Regarding the use of *Water supply; sewerage; waste management and remediation activities* as an intermediate input into other sectors, the latter is of minor importance. For most of the production sectors the share of the water sector is below 1%. The exceptions are presented in the Table 6 below.

Table 6: Share of water supply; sewerage; waste management and remediation activities in the production input

Sector	Share input*
Coal and lignite	2.6%
Mining support service activities	2.3%
Manufacture of food products and beverages	3.1%
Manufacture of pulp, paper and paperboard	67%
Manufacture of rubber and plastic products	4.8%
Electric power generation, transmission and distribution	2.2%
Steam and air conditioning supply	3.9%
Water transport	1.5%
Education	1.2%
Creative, arts and entertainment activities	2.2%

* As % of total used in basic consumer prices. Source: Own calculations based on Committee on Statistics RK, 2015

4.4 Environmental aspects

Recent evidence suggests that climate change will aggravate water scarcity in Kazakhstan and in the Central Asian region as a whole. Increasing water shortages and water demand will tighten competition on national and regional levels between different sectors of the economy. One of the major issues in Central Asia is the increasing shortage of water due to desertification and rapid melting of glaciers in the mountains. The region's glaciers are expected to completely disappear by the end of the century, which will significantly impact water availability in the region. Long-term projections forecast a significant decrease in water availability (Sorg et.al., 2014, Ibatullin et.al., 2009).

Temperature increases by 1.6C to 2.6C are expected in Eastern Europe and Central Asia by 2050, even if considerable global effort to reduce GHG emissions is undertaken. Without global efforts, temperatures will increase by 5C by 2100. Such changes pose considerable stress on ecological and human systems. A significant increasing trend in temperature is already observed in Eastern European and Central Asian. Moreover, increasing weather-related natural disasters negatively affect the region's economy (Fay et.al., 2010).

Climate change can cause or intensify water stress in various ways. Increased temperature reduces water availability through increasing evaporation which in turn leads to increased demand for irrigation or other purposes. This can also affect water quality through increasing aquatic pollution. Warmer temperatures will also decrease the share of precipitation that falls as snow which serves as a mechanism for storing water and releasing it in spring and summer. Climate change will raise the sea levels which can lead to salinization of coastal areas. Moreover, non-climatic factors such as population growth, urbanization, changing land use and unsustainable water use threaten the sustainability of water resources (Fay et.al., 2010).

According to the World Resources Institute ranking⁹ of the world's most water-stressed countries in 2040, Kazakhstan ranks 20th out of 167 countries and will face extremely high water stress in 2040 (Table 7).

⁹ Based on business-as-usual climate scenario

Table 7: Top 20 Water stressed¹⁰ countries in 2040 (business-as-usual climate scenario¹¹)

Rank	Country	All sectors	Industrial	Domestic	Agricultural
1	Bahrain	5	5	5	5
1	Kuwait	5	5	5	5
1	Qatar	5	5	5	5
1	San Marino	5	5	5	5
1	Singapore	5	5	5	No data
1	United Arab Emirates	5	5	5	5
1	Palestine	5	5	5	5
8	Israel	5,00	5,00	5,00	5,00
9	Saudi Arabia	4,99	5,00	5,00	4,99
10	Oman	4,97	4,97	4,97	4,97
11	Lebanon	4,97	4,97	4,97	4,97
12	Kyrgyzstan	4,93	4,93	4,92	4,93
13	Iran	4,91	4,97	4,97	4,90
14	Jordan	4,86	4,87	4,86	4,86
15	Libya	4,77	4,60	4,60	4,80
16	Yemen	4,74	4,66	4,63	4,75
17	Macedonia	4,70	4,69	4,59	4,79
18	Azerbaijan	4,69	4,59	4,58	4,74
19	Morocco	4,68	4,65	4,63	4,69
20	Kazakhstan	4,66	4,50	4,51	4,76

2015 Scores: [0–1) Low (<10%), [1–2) Low to medium (10–20%), [2–3) Medium to high (20–40%), [3–4) High (40–80%), [4–5] Extremely high (>80%). Source: Author's compilation based on Luo, Young, Peig.

¹⁰ Water stress measures total annual water withdrawals (municipal, industrial, and agricultural) expressed as a percentage of the total annual available blue water. Higher values indicate more competition among users.

¹¹ Based on the IPCC 5th assessment report

Given that the agricultural sector is the main consumer of water and taking into account increasing global food demand and climate change impact, necessary measures need to be implemented. These include

- Strengthening institutions and water rights
- Setting appropriate water tariffs in the agricultural sector which take into account the cost of supply, scarcity, social values and environmental costs and benefits.
- Improving the adaption of agriculture production activities to the impact of climate change (OECD, 2012).

5 Concluding remarks

The discussed environmental trends confront Kazakhstan with multiple challenges. The following analysis depicts that the environmental issues are region specific and are characterized by the industrial features of the region. All three issues already have an impact on public health and the environment and a lack of actions to tackle the problems will drastically worsen the situation.

Despite significant progress in Kazakhstan's environmental policy, so far, the actions on the reduction of air pollution and waste and the increase of efficiency of water usage have been insufficient. Kazakhstan has been reluctant to introduce stringent environmental policies in these fields. This can be explained by the expectations of negative impact on economic growth. Without stricter actions, air pollution and waste will continue to rise and the pressure on water resources will intensify.

A particularly drastic situation can be observed in the waste sector. Immense quantity of waste, including large amount of toxic waste is produced yearly and accumulated over many years, but hardly any part of the waste is processed or recycled. Currently, consumers face no incentives to reduce waste. The lack of proper infrastructure is a significant barrier to sound waste management.

The literature has identified two main ways to reduce total waste disposal. One would be source reduction through decreased consumption and increased recycling (Acuff et.al., 2013). A survey on empirical studies conducted by Ferrara (2008) emphasizes positive effects of user fees for waste disposal on the reduction of waste and the increase of recycling. Potential effects of illegal disposing due to the unit pricing system should not be ignored. Other measures such as educational programs can also have a positive influence on public environmental awareness and waste management (Ferrara, 2008). Moreover, more and more countries move from traditional approaches to waste management to an approach of viewing waste as a resource, where the design of a circular economy is one of the tools towards resource efficiency.

Low water tariffs and the overuse of water resources show that there is a market failure in Kazakhstan. It is extremely important that water resources are priced appropriately. In the economic literature, particularly two incentive-based mechanisms – water markets and irrigation subsidies – have been analyzed as a tool to address climate change impacts on agriculture. Water markets implementation aims to improve the allocation of water resources

between different users and to reduce the effects of water scarcity. The main idea behind the creation of water markets is that market institutions enable better water allocation efficiency than can be achieved by public management. Water markets already exist, both formally and informally, in countries like Australia, Chile and Mexico. Providing subsidies for investment in efficient irrigation systems can contribute to the adaption of the agricultural sector to climate change and water scarcity. The two approaches have limitations and advantages. (Gomez-Limon et.al, 2006; Kochhar et.al.,2015). Given that the agricultural sector is the main consumer of water resources in Kazakhstan, it would be valuable to study the measures to encourage efficient water use and tools for adaption to climate change.

Bithas (2008) studied sustainable residential water use in European countries. He emphasizes that water pricing, particularly full-cost pricing, can be an essential tool to achieve an efficient use of water. Studying the experience of European countries, he finds that full-cost pricing does not prevail because of inappropriate perceptions, institutional settings, historical conditions and misinterpretations of equity objectives. This leads to underpricing and overuse of the water resources. Therefore, full-cost pricing is a necessary instrument for the sustainable use of water.

Abbreviations

GHG	greenhouse gas emissions
CA	Central Asia
CIS	Commonwealth of Independent States
CO ₂	carbon dioxide
ETS	Emissions Trading Scheme
ICWR	Interstate Commission for Water Resources
I-O	Input-output
KZT	Kazakh tenge
MSW	municipal solid waste
NO	nitrogen oxide
NO ₂	nitrogen dioxide
O ₃	ground level ozone
OECD	Organisation for Economic Co-operation and Development
PM	Particulate matter
RK	Republic of Kazakhstan
RSE	Republican State Enterprise
SO ₂	sulphur dioxide
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
VOC	volatile organic compound
WSS	water supply and sanitation

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