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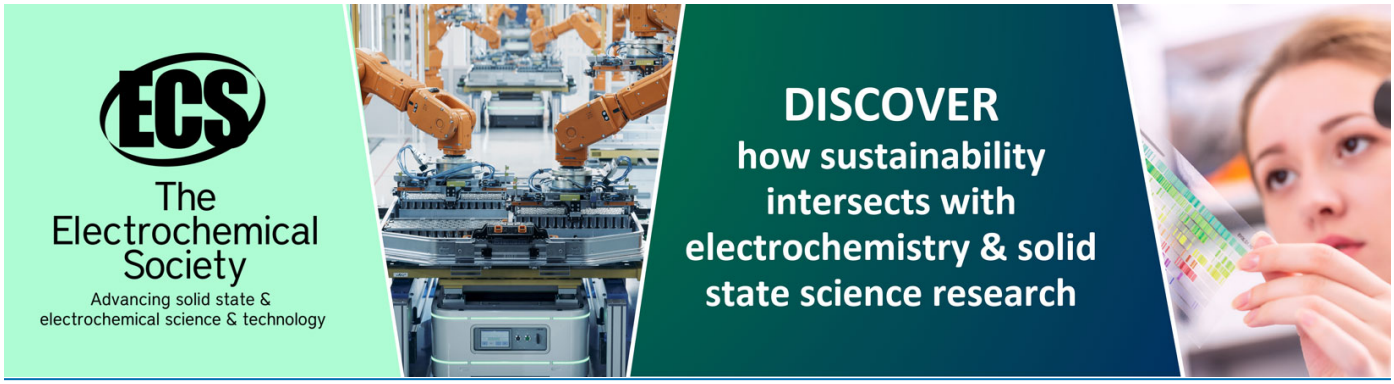

IOP Conf. Series: Materials Science and Engineering **262** (2017) 012153 doi:10.1088/1757-899X/262/1/012153

Analysis of Kerch by Local Indicators of Sustainable Development

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Abstract. This article presents an analysis of the city of Kerch (Crimea Republic, Kerch Peninsula) in accordance with the local sustainable development indicators. The authors carried out the assessment of the existing environmental problems in the city which was necessary for the further development of the environmentally oriented infrastructure under various development scenarios. Due to the natural and economic factors, Kerch can develop both as an industrial and recreational centre of the peninsula. The analysis of the atmospheric air condition, use of water and energy resources and the waste management system was conducted. The presented results showed the presence of major environmental problems in almost all spheres.

1. Introduction

More than half of humanity lives in cities, and the proportion of urban population continue to grow. However, urban areas occupy only 3% of terrestrial land, but account for 60-80% of all electricity consumption and 75% of carbon emissions [1]. In accordance with "Sustainable Development Agenda for 2015-2030", the Key Goal No. 11 is "... to make cities inclusive, safe, resilient and sustainable"[2].

In the Russian Federation, the share of the urban population reached 74% by 2015. But the system of settling people has not yet overcome the consequences of the Soviet stage of development and the crisis of the 1990s. This led to the fact that the population of Moscow (12.4 million people) and St. Petersburg (7.5 million people) is very different from the following Novosibirsk (1.5 million people). It means that there are not enough cities with a population of 1.5 to 4 million people in Russia [3]. It is necessary to create growth points throughout the country for uniform and sustainable development.

The city of Kerch can become a point of growth in the Crimea. Kerch is a regional industrial center of the Kerch Peninsula. There are an industrial and passenger ports, ship-repair enterprise "ZALIV" and companies for mining iron ore, limestone, clay, sand and table salt [4]. Also Kerch is an important link in the engineering and transport structure of the entire Crimean peninsula. The under construction Kerch bridge will provide a reliable link between the continental part of Russia and the Crimean peninsula. Also, the unique climatic and geographical characteristics and the natural potential of the Kerch Peninsula make it possible to develop resort and sustainable tourism and agriculture in this. In this case Kerch has various development scenarios. Kerch can be recreational or industrial center. But in any case it is obvious that the importance of the city for the Republic of Crimea will increase more and more.

Currently, Kerch is not a densely populated city (the population is 149,566 people, the population density is 1,384.87 people/km^2) [5,6], so it is possible to create an environmentally oriented and economically effective infrastructure of the city. This is a unique case of the possibility of planned introduction of the principles of sustainable development in the management of city management. Successful experience in the planning and introduction of this type of infrastructure in Kerch, can lead to the effective implementation of the principles of sustainable development in other cities of Russia. The need to change the urban environment is obvious, since in 123 cities of Russia (57% of cities) the degree of air pollution is estimated as high and very high and only in 22% of cities as low. At the same time, according to statistics, 54.2 million people live in cities with a high and very high level of atmospheric air pollution [4].

2. Methodology

For the successful transformation of the urban environment, taking into account the principles of sustainable development, a comprehensive socio-ecological and economic analysis of the existing situation in Kerch was conducted. The following local indicators were selected for this purpose:

- Atmospheric air condition:
  - Gross emissions of pollutants from stationary industrial sources per capita (kg/person)
  - Gross emissions of pollutants from mobile sources per capita (kg/person)
- Rational use of urban water resources:
  - Water consumption per capita (m^3/day)
  - Proportion of population provided by central water supply (%)
  - Proportion of population provided with hot water supply (%)
  - Share of water supply and sewerage networks with the status of dilapidated and emergency (%)
  - Number of accidents at water supply system and sewerage networks (units/year)
- Rational use of energy resources:
  - Main producers of electric energy
  - Share of electricity consumed by enterprises and population (%)
  - Share of population provided with electricity (%)
- Rational waste management:
  - Generation of consumption wastes per capita (m^3/year)
  - Share of consumption wastes sent for disposal (%)
  - Share of consumption waste sent for recycling (%)
  - Number of unauthorized dumps (units)

3. Results

3.1. Atmospheric air condition

The main stationary sources of atmospheric air pollution in Kerch are: Kamysh-Burunskaya TPP, “Krymteplokommunenergo”, “Shipbuilding Plant Zaliv” OJSC, “Southern Manufactory” LLC and transport enterprises (see table 1). The specific emissions of pollutants from stationary sources in Kerch are 6.7% of all emissions of the Crimea Republic [7-9].

However, the main source of atmospheric air pollution in Kerch is the motor transport which includes transportation of the population and cargo (see figure 1). According to the data for 2008, among the total emissions to the air 19.22% of emissions are generated by stationary sources, and 80.8% by mobile ones (3.08 tons/year). At the same time, emissions from mobile sources by 74.2% (2.28 thousand tons/year) consist of carbon dioxide [7-9].

Given that the constant population of Kerch is 148,299 people, emissions from stationary sources per capita are 5 kg/person, and emissions from mobile sources of pollution per capita - 20 kg/person.

Table 1. Emissions from stationary sources of pollution into the atmosphere per year [7-9].

Indicators	Unit of measurement	2014	2015
Number of objects with stationary sources of pollution	units	24	29
Emissions of air pollutants from stationary sources	thousand tons	0.793	0.701
Solids	thousand tons	-	0.096
Gaseous and liquid substances	thousand tons	-	0.605
Sulphur dioxide	thousand tons	-	0.066
Carbon monoxide	thousand tons	-	0.121
Nitrogen oxides (in terms of NO_2)	thousand tons	-	0.244
Hydrocarbons	thousand tons	-	0.015
Other gaseous and liquid substances	thousand tons	-	0.127
Captured and neutralized air pollutants from the total volume received for cleaning	thousand tons	0.276	0.031

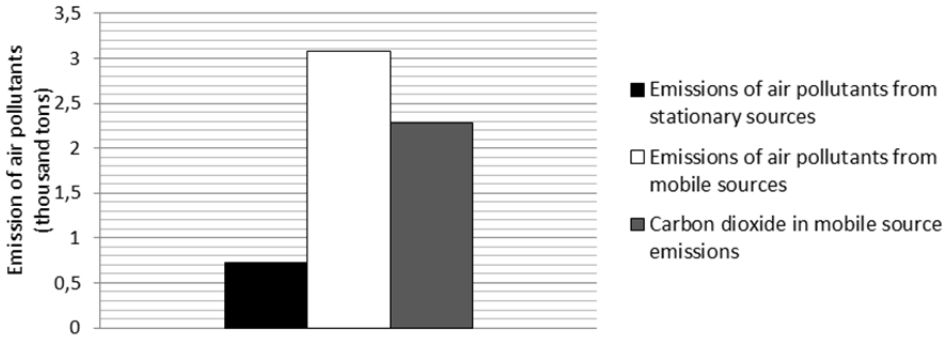

Figure 1. Emissions from stationary and mobile sources.

3.2. Rational use of urban water resources

The enterprise providing Kerch with water is the Kerch branch of the State Unitary Enterprise of the Republic of Crimea "Water of the Crimea". Its powers include: providing the population and organizations with water, drainage and wastewater treatment. 88.5% of Kerch residents have access to central water supply. At the same time, there is no central hot water supply in the city completely [10,11].

Since 1974, Kerch has been feeding water from the Dnieper, which through the North-Crimean Canal fills the Kerch reservoir (capacity 29 million m3, useful capacity 24 million m3[10,11]) in the Novo-Nikolaevka. Before that, Kerch took water exclusively from artesian wells, but groundwater resources gradually began to fail with growing water consumption. Also, water from artesian wells was unsuitable for drinking purposes it was only suitable for technical use.

At the same time the condition of the reservoir is not satisfactory - there is no concrete bed and forest protection, clogging is increased, the process of water intake is technically not perfect. Novo-Nikolaevsky reservoir is not able to constantly satisfy the city of Kerch with enough water. So in the summer of 2016 there was water for the Kerch only for 20 days. In this connection, the process of chlorination of the water pipe was postponed, and an emergency water injection into the reservoir was required. Also, during the period of low water level in the reservoir (flood period), when additional water injection is required, the water enters the wastewater treatment plant with turbidity up to 140 mg/l (at a norm of 3.5 mg/l)[12].

The city water treatment plant in Kerch was put into operation in 1976 according to a temporary scheme, in which such important stages of post-treatment as liming, carbonation and flocculation were not envisaged. Until now, the station operates in the same mode, so the water supplied to the water pipe system does not meet modern quality requirements.

An important point is that, in addition to inadequate quality, the city does not receive enough drinking water. The normative water consumption of the city is 140,000 m3 per day, and the station with a design capacity of 100,000 m3 per day gives only 67,000 m3 per day[12].

At the same time, the technical condition of many water supply facilities is extremely unsatisfactory. So the service life of contact clarifiers at the water treatment plant is exceeded more than 3 times (normative - 10 years). 67.2% of water supply and 66% of sewer networks have the status of dilapidated and emergency (total length of water supply networks - 559 km, total length of sewerage networks - 214.1 km)[13].

Urban wastewater treatment is carried out by two functioning treatment facilities: Bondarenkov (capacity is 43 thousand m3/day) and Ordzhonikidzevsky sewage treatment plants (capacity is 20 thousand m3/day). It should be noted that overhaul at the treatment facilities has not been carried out for more than 30 years. In this regard, significant deterioration of buildings and equipment was identified. Operation of water supply networks in an emergency condition leads to frequent accidents of different scale. So, the following accidents at sewerage networks have occurred in 2013: clogging - 8,170 pcs, breakthroughs - 108 pcs, failures due to thinning of the pipe due to corrosion - 5 pcs. Further use of the sewage network and facilities without major repairs, even with the current load, can lead to a local environmental disaster[13].

3.3. Rational use of energy resources

Kamysh-Burunskaya TPP is the main producer of electric power in Kerch. The main fuel is natural gas, the supplier of which is SUE Crimea Republic "Chernomorneftegaz". The main characteristics of the natural gas used are:

- Composition:
  - Methane - 94.0593%
  - Oxygen - 0.0046%
  - Dioxide carbon - 0.8233%
  - Nitrogen - 0.5652%
  - Ethane - 2.4715%
  - Propane - 0.9855%
- Density - 0,7308 kg/m^3
- Combustion heat (lower) - 8,403 kcal/m^3 [14,15]

Electricity consumption in the city of Kerch is distributed more to enterprises than to the population (see table 2). The share of electricity consumed by enterprises is approximately 60%, and the share of the population use is 40% [14,15].

Table 2. Characteristics of energy consumption in Kerch [13-15].

Indicators	Unit of measurement	2014	2015
Produced electricity by Kamysh-Burunskaya TPP (Fuel - natural gas)	kilowatt-hour	77 426 335 *	80 500 000
Specific value of electricity consumption in apartment buildings per resident	kilowatt-hour per year	1960,8	1848,02
Specific value of electricity consumption by municipal budget institutions per person in the population	kilowatt-hour per year	17,74	16,8
Average annual population	units		148 299
The amount of electricity consumed by municipal budget institutions	kilowatt-hour per year	2 630 824,26	2 491 423,2
Number of people living in apartment buildings provided with electricity	units	38 145,4	42 211,9
Share of population provided with electricity	percent	25,7	28,5

The amount of generated electricity in Kamysh-Burunskaya TPP is not sufficient even to cover the needs of the population. And the share of electricity consumption by the population in Kerch is only 40%.

3.4. Rational waste management

A particular danger for the ecological situation in the city is the problem of waste disposal. More than 200,000 m^3 (44,500 tons) of solid domestic waste are generated per year [16]. The situation on waste management system id represent in table 3. Only one landfill operates for disposal of municipal solid waste, which has already been overcrowded for several years (projected capacity is 7 million m^3, waste disposal is more than 9 million m^3 [17,18]. The waste disposal process also took place with violations of technological standards - the range is located in 800 m from the drinking borehole of the Leninsky district, the landfill was not clamped and filled with clean soil followed by compaction of layers, there are no monitoring objects for the level of environmental impact, there are no monitoring wells, power lines pass through the landfill [17].

Insufficient quality and quantity of landfills in Kerch leads to the fact that there are unauthorized dumps. Eleven unauthorized dumps with a total area of 2,966.45 m^2 were officially identified [18].

Table 3. Characteristics of waste management in Kerch [17,18].

Indicators	Unit of measurement	2014	2015
Number of enterprises for disposal of municipal and industrial waste	units	1	1
Number of municipal enterprises for disposal of municipal and industrial waste	units	1	1
Number of municipal solid waste removed to the enterprises for disposal	thousand cubic meters	340	524.5
Number of municipal solid waste removed to the enterprises for recycling	thousand cubic meters	0	0

4. Discussion and conclusions

1. The assessment of the condition of atmospheric air showed satisfactory results, but emission increasing is forecasted based on the industrial and/or recreational development scenario of the city. At the moment, mobile sources of emission are responsible for major amount of pollutant. So sustainable public transport network should be created, especially if the city develops as a tourist and health resort.

a) Gross emissions of pollutants from stationary industrial sources per capita– 5 kg/person

b) Gross emissions of pollutants from mobile sources per capita – 20 kg/person

2. The water supply system in Kerch requires immediate reconstruction. The further use of water and sewerage networks in an emergency condition can lead to both an ecological catastrophe and the epidemics of diseases associated with contaminated water such as dysentery, typhoid fever, cholera, etc. It is also necessary to provide citizens with central hot water and increase the amount of water consumed by the citizens at least to the normative indexes.

a) Water consumption per capita – 67,000 m3/day (normative water consumption – 140,000 m3/day

b) Proportion of population provided by central water supply – 88.5%

c) Proportion of population provided with hot water supply – 0%

d) Share of water supply and sewerage networks with the status of dilapidated and emergency – 67.2% and 66%

e) Number of accidents at water supply system and sewerage networks – 8,283 pcs/year

3. The energy sector of the Crimea and Kerch in particular, needs reconstruction. At the moment less than 30% of the Kerch population is provided with electricity. Electricity is supplied in the city on a special schedule, the population does not have 24-hour access to electricity. It is necessary to put

into operation new enterprises for the production of electricity, especially those operating on renewable energy sources.

a) Main producers of electric energy - Kamysh-Burunskaya TPP (Fuel - natural gas)
b) Share of electricity consumed by enterprises – 60% and population – 40%
c) Share of population provided with electricity -28,5%

4. The waste management system in Kerch also requires immediate changes. At the moment, there is 1 landfill for disposal of municipal waste, and the term of its operation has expired. It requires the introduction of an enterprise for processing and utilization of municipal solid waste. Also, it is necessary to eliminate numerous unauthorized landfills in the city.

a) Generation of consumption wastes per capita – 200,000 m3/year
b) Share of consumption wastes sent for disposal – 100%
c) Share of consumption waste sent for recycling – 0%
d) Number of unauthorized dumps – 11 pcs

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