

**CLIMATE CHANGE IN KYIV:  
WAYS TO CONTERACT AND MINIMIZE NEGATIVE EFFECTS**

*Vital issues of climate change in Kyiv are studied with elucidation of the need for developing a comprehensive research technique to analyse and assess a cumulative impact of the process. The study exposes anthropogenic and natural factors responsible for climate formation in Kyiv and the climatic changes. With an account for recent international experience the proposals are formulated how to make use of contemporary administrative, economic, legal and regulatory levers to forestall climatic changes in the capital and cope with the negative environmental aftermath.*

**Keywords:** environment; emissions; climate change; climate protection; climate management.

**Presenting the problem in its general outline and relation to important scientific and practical challenges.** Formation and implementation of effective environmental policy under climate change gain especial importance with the transition to sustainable development, which Ukraine declared by signing *Agenda 21*, the Rio Declaration on Environment and Development at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, 3 to 14 June 1992, and the adoption in 2010 of the Law of Ukraine: 'On the Fundamentals (strategy) of the National Environmental Policy of Ukraine by 2020'.

Despite the debate about the issue of climate change and its effects that is taking place over the past three decades, it is evident that any citizen of Ukraine on the base of his/her own observation realizes that climate changes do occur, notwithstanding opinion of the doubters who speculate whether to accept or reject the idea. The scope of climate change increases from year to year with the increase of its impact on the economy, welfare and people health. Of great concern is the research outcome showing that 90 per cent of the climate change are of anthropogenic origin and just the remaining ten per cent are due to natural causes [1, p.4.]

Climate change is considered to be the greatest threat to nature and humanity in the 21st century. By the end of this century the average temperature of the Earth can increase by 1.4–6.4 °C, which threatens the entire existence of over quarter of all animals and plants. In addition, the annual loss from warming can reach almost five per cent of GDP [2].

**Review of recent studies and publications on the issue in question.** Climate change is in the focus of many studies conducted by many well-known foreign and domestic researchers, such as S.N. Bobyleva, O.O. Veklych, S.M. Voloshyn, L.V. Zharova, I.G. Hrytsevych, A.O. Kokorin, S.N. Kuraev, V.G. Potapenko, S.I. Snizhko, Nicholas Stern, O.G. Shevchenko, M.A. Yulkin and others [1, 3–6]. Most researchers reveal the geographical, ecological, climatic aspects at the global, national, regional levels.

**Unsolved parts of the general problem that the paper deals with.** For the time being there has not been developed any exclusive clear technique for analysis and assessment of climate change as well as whichever quantitative measurement has been suggested to estimate an impact on this process exerted by the whole of various factors, primarily the anthropogenic ones related to vital (industrial, technological, power generating, cultural and household etc.) activities of the humans. There are no evidence-based approaches to estimative appraisal of losses and damages due to climate change. In general, the studies are limited with estimates of the changes occurring in atmospheric air, water, land or amounts of the carbon dioxide emissions and waste produced. According to another method, evaluation of the impact of climate change is made by taking into account losses due to emergency

situations, which some researchers believe were caused by climatic factors [4, p. 239]. There are no studies of still imperfect mechanism to control climate change in urban areas with their growing in size and role urban settlements, population, concentration of production and territorial expansion. The approaches available are incomplete as they take into account only a limited number of factors that can be expressed quantitatively and directly measured. This is mainly because of the indirect nature of many of the factors, the lack of a coherent system of perfect monitoring, appropriate and reliable information base and imperfect scientific and methodological support. Thus, the economic aspect of climate change requires deeper and systematic studies involving a wide range of researchers and practitioners of various knowledge and expertise domains.

**Statement of the paper goals.** The aim of the article is in identifying main economic and legal levers to manage climate change in urban areas. To achieve the goal, the following objectives were set:

- to identify main factors that affect climate,
- to highlight the impact of factors on urban climate change,
- to work out proposals for use of the economic and regulatory management tools to prevent and eliminate the negative effects of climate change in Kyiv. The object of the study are climate changes in Kyiv.

**Main material of the study with evaluation of the research results.** The city of Kyiv is one of Europe's largest natural landscape, business, financial, commercial and industrial centers that has the following key characteristics of its economic and social development: the total area is 83.6 hectares that equals to 0.14 per cent of Ukraine's territory; the area covered with forests and woods is 35, 500 hectares with over five hectares as the area of public green space; water mirror covers 6.6 hectares [7, p.18.] In 2010 Kyiv's production of the gross regional product exceeded UAH 196.6 bln, or UAH 70,400 per person. The city's permanent population was 2,757,900 or just 6.2 per cent of the total population in Ukraine though it produced 18.2% of the national GDP.

Climate change in Kyiv is one of the most pressing problems in the chain of general natural and climatic transformations and requires establishment of an effective management system to anticipate, eliminate or reduce its negative effects. Climate changes in urban areas, including Kyiv, are due to a number of factors, which can be divided into two groups: the man-made and natural ones. Anthropogenic factors are related to human activity and, as already mentioned, have the greatest impact on climate change. The action of natural factors is much weaker. Climate change is manifested in deviations temperature readings caused primarily by changing the state of the air due to emissions, accumulation of unprocessed waste. This paper focuses just on these very factors and consequences of their impact on climate change in Kyiv (Fig. 1.)

State of atmospheric air has the greatest impact on the urban climate. Air quality in Kyiv depends on various types of economic activities that result in emissions of diverse substances from stationary (enterprises, shops, production units, installations, etc.) and mobile sources of emissions (automobile, air, rail, water transport and production equipment.) According to information of the State Statistics Service of Ukraine, the stationary and mobile sources of emissions released 254500 tons of pollutants into the atmosphere of Kyiv in 2011, i.e. 90.9 kg of waste per capita or 39.8 kg per square kilometer. In 2011 air emissions increased as compared to 2007 both in overall evaluation (from 265,300 to 230,500 tons or 10.4%) and the per capita assessment (from 84,500 to 107,600 tons or 7.6%.) The density of emissions per square kilometer in the city has grown each year and reached 304,400 t in 2011. It is 27 times as much as the average parameter for Ukraine. In recent years there has been a positive trend towards reduction of emissions. In 2011, the above figures dropped as compared to 2010 from 265300 to 254500 t or by 4.1%, as well as from 95,100 to 90,000 kg per capita, or by 4.4%. Fewer air emissions were observed in Obolonskiy,

Desnyanskiy, Darnitskiy and Solomyanskiy districts of the city with the greatest pollution recorded in Shevchenkivskiy, Pecherskiy and Dniprovskiy districts.

Mobile sources of pollution, i.e. vehicles produce the largest part of emissions in Kyiv. In 2011, the share of emissions from vehicles was 221200 t or 86.9 % of emissions with 33,300 t or 13.1% of emissions from stationary sources. Road transport has the greatest impact on the atmosphere, releasing 212,700 tons of pollutants of which 166,600 t account for carbon monoxide. The results of the analysis of the structure of the carbon monoxide emissions from mobile sources in Kyiv in 2011 showed that the largest share of emissions came from motor vehicles (97.8 %), in particular from the vehicles of the population (80.8 %) and business entities (17 %). Such emissions from other types of transport are negligible: from air transport it accounted for 1.3% and rail transport – 0.4 %, industrial machinery and -0.4 % -0.1 % water transport. Over the past years, emissions are rising, especially from road transport. Thus, in 2011 as compared to 2007, emissions of carbon dioxide increased by 11.5 %, nitrogen dioxide – 22.4 %, sulfur dioxide – 28.6 %, and soot – 37.5% (see: Table 1.)

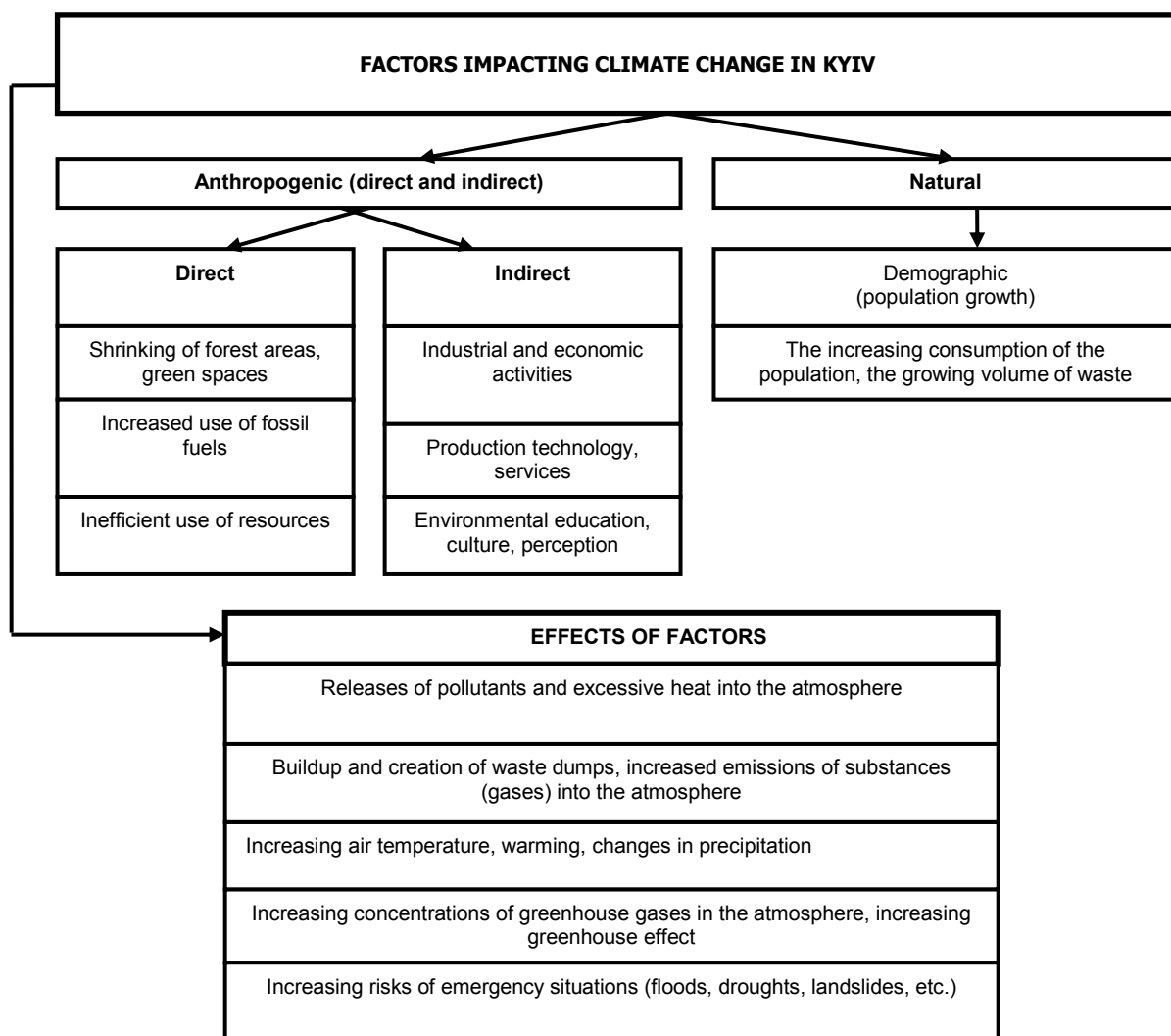


Fig. 1. Key factors and consequences due to their impact on climate change in Kyiv

Source: Developed by the authors

The grounds for such a negative impact of transport on environment are the wear of vehicles, their and fuel in compliance with the current international environmental standards, the poor state of roads, their failure to accept

a rapidly increasing number of vehicles. According to the State Statistics Service of Ukraine at the end of 2011 there were 743,200 cars, 60,400 trucks and 17,200 buses

in Kyiv, which, respectively by 15.5%, 24.5 and 65.4% greater, as to the data of 2007.

Another source of emissions into the atmosphere is the manufacture and business activities of Kyiv enterprises and organizations. Generation and distribution of electricity, gas and water are principal sorts of industrial technologies that affect climate of Kyiv due to great volume of harmful emissions into atmosphere from stationary sources. In 2011 the stationary sources of twelve companies of this branch released 27,772,300 tons of harmful materials (an average of 2,314,400 t per enterprise) into atmosphere, which accounted for 83.4% of the total emissions. Such a high share in the amount of emissions is due to the fact that the economy of the city, like of Ukraine as a whole, is charac-

terized by a high level of energy consumption when compared with other advanced economies. There are three powerful fuel-burning power plants in the city that meet the city's power needs: CHP-5 (Goloseevskij district, 700 MW), CHP-6 (Desnyanskiy district, 500 MW) and ZAT DARteplotsentral (160 MW). Their cleaning and waste treatment equipment does not comply in full with modern environmental requirements. Thermal power plants emit the largest share of those compounds which fall as acid rain.

Processing industry was second after utilities that generate and distribute electricity, supply gas and water. Emissions from 178 enterprises reached 4,225.6 t (23.7 tons per enterprise), or 12.7%. The dirtiest of processing plants is the production of rubber and plastic products (Table 2.)

**Table 1. The volume and structure of emissions into the atmosphere of Kyiv in 2007 and 2011 by the source of emission\***

Source of emission	Total emission	of which:							
		sulfur dioxide	nitrogen dioxide	nitrogen oxide	carbon monoxide	methane	non-methane organic compounds	soot	other
<b>2007</b>									
All sources (thousand ton)	230.5	7.2	30.4	0.2	155.9	0.9	28.7	2.1	5.1
including:									
stationary	26.5	5.4	9.1	0.0	3.4	0.2	3.3	0.0	5.1
mobile	204.0	1.8	21.3	0.2	152.5	0.7	25.4	2.1	0.0
Mobile sources by kinds of vehicles, thousand ton:									
automobile	190.8	1.4	15.2	0.1	148.1	0.7	23.7	1.6	0.0
air, rail, water, industrial machinery	13.2	0.4	6.1	0.1	4.4	0.0	1.7	0.5	0.0
All sources, %	100.0	3.1	13.1	0.1	67.7	0.4	12.4	0.9	2.3
including:									
stationary	11.5	2.3	3.9	0.0	1.5	0.1	1.4	0.0	2.3
mobile	88.5	0.8	9.2	0.1	66.2	0.3	11.0	0.9	0.0
<b>2011</b>									
Всі джерела, тис. т	254.5	11.9	31.9	0.2	169.3	1.4	31.5	2.4	5.9
including:									
stationary	33.3	9.9	10.7	0.0	2.7	0.7	3.4	0.0	5.9
mobile	221.2	2.0	21.2	0.2	166.6	0.7	28.1	2.4	0.0
Mobile sources by kinds of vehicles, thousand ton:									
automobile	212.7	1.8	18.6	0.1	162.9	0.7	26.4	2.2	0.0
air, rail, water, industrial machinery	8.5	0.2	2.7	0.0	3.7	0.0	1.7	0.2	0.0
All sources, %	100.0	4.7	12.5	0.1	66.5	0.6	12.4	0.9	2.3
including:									
stationary	13.1	3.9	4.2	0.0	1.1	0.3	1.3	0.0	2.3
mobile	86.9	0.8	8.3	0.1	65.4	0.3	11.1	0.9	0.0
<b>2011 compared to 2007 (% , +/- percent points)</b>									
All sources, %	110.4	165.3	104.9	100.0	108.6	155.6	109.8	114.3	115.7
including:									
stationary	125.7	183.3	117.6	-	79.4	350.0	103.0	-	115.7
mobile	108.4	111.1	99.5	100.0	109.2	100.0	110.6	114.3	-
Mobile sources by kinds of vehicles, thousand ton:									
automobile	111.5	128.6	122.4	100.0	110.0	100.0	111.4	137.5	-
air, rail, water, industrial machinery	64.4	50.0	44.3	0.0	84.1	-	100.0	40.0	-
All sources, +, %	0.0	1.6	-0.6	0.0	-1.2	0.2	0.0	0.0	0.0
including:									
stationary	1.6	1.6	0.3	0.0	-0.4	0.2	-0.1	0.0	0.0
mobile	-1.6	0.0	-0.9	0.0	-0.8	0.0	0.1	0.0	0.0

\* Source: Compiled by the authors with data of the State Statistics Service of Ukraine [7, p. 381].

Activities of the housing and communal services and accumulation of household waste cause changes in the urban environment as well. In 2011 Kyiv companies produced over 7,087,700 tons of waste, of which 7,076,500 tons, or 99.8% were of the fourth class of hazard. Almost all of the waste products (91.7%) were hazardous. The most dangerous among them were the products of the dust and gas-trapping units (6.4%), and the waste containing heavy metals or their compounds (1.9%). The greatest amounts of waste of the I-IV hazard classes were produced in Pecherskyi district (89.1% of the total city waste), and

almost 95.2% of extremely hazardous waste of the first class of hazards were in Svyatoshytskyi district [8, p.73.]

At the beginning of 2012, nearly 10.2 million tons of the I-IV class hazardous waste, of which 95.7% were from the treatment of industrial waste and sewage, piled up on territories of the manufacturing facilities or in specially allocated areas [8, p.73]. Because of the lack of separate collection and sorting of waste, it is impossible to provide proper utilization and that involves superfluous energy consumption at the waste incineration. Only a small portion (5998.2 t, i.e. less than 1%) of the above-mentioned hazardous waste

was recycled, processed or refined in 2011. A part of the waste (154,962.7 tons – 2.2%) was burned at the "Energy" incinerator, but the dominant volume of waste (6,585,033 t,

i.e. 92.9%) was transported into the specially designated areas. At the beginning of 2012, the volume of waste reached 12,137.8 tons per square kilometer [7, p. 387.]

**Table 2. Amount and structure of 2011 atmospheric emissions from Kyiv stationary sources by sorts of economic activities\***

Economic activity	Number of business units	Amount of emission (tonnes)		A share in %
		Total	Per 1 enterprise	
All sorts of economic activities	355	33289.9	93.8	100.0
of which:				
agriculture, hunting and forestry	4	46.6	11.7	0.1
manufacture	178	4225.6	23.7	12.7
including:				
food, beverages and tobacco products	23	582.9	25.3	1.8
wood, manufacture of wood products, except furniture	6	231.4	38.6	0.7
pulp and paper production, publishing	19	316.3	16.6	1.0
chemical manufacture	16	75.7	4.7	0.2
rubber and plastic products	11	1905.0	173.2	5.7
other non-metallic mineral products	23	470.3	20.4	1.4
machinery and equipment	20	123.3	6.2	0.4
electrical, electronic and optical equipment	18	60.5	3.4	0.2
vehicles and transport equipment	14	380.4	27.2	1.1
Other industries	28	79.8	2.9	0.2
power generation and distribution, gas and water supply	12	27772.3	2314.4	83.4
construction	21	82.6	3.9	0.2
trade, repair of vehicles and household goods	23	548.5	23.8	1.6
Transport and communications, in total	62	313.2	5.1	0.9
including land transportation	39	128.5	3.3	0.4
communal, social and individual services; cultural and sport activities	14	86.6	6.2	0.3
Other	41	214.5	5.2	0.6

\* Source: Compiled by the authors with data of the State Statistics Service of Ukraine [6, c. 35].

Unprocessed waste dumped at the sites is an additional source of gas generation and emissions in the atmosphere of the capital and its adjacent areas. The situation is particularly critical regarding processing electronic devices, as only 3% of them are recycled. This is not only because of a technological backwardness, but imperfection of the system of state regulation and legislation. In particular, the Law of Ukraine of 05.03.1998 No 187/98-BP *On Waste* has an indirect mode of action, especially in the aspect of processing electronic waste (screens, mobile phones, etc.). In addition, some Kyiv enterprises have accumulated significant amounts of toxic substances, including metal constructions and buildings, land contaminated by mercury waste at the territory of former *Radical* plant.

The negative effect of the above and other factors leads to changes in temperature of Ukraine and that of in Kyiv. Thus, between 1980–2011, compared to 1950–1980, the temperature in Ukraine increased by 0.5–0.6 °C [9, p.16]. Over the past 100–120 years temperature in Kyiv has increased by an average of 1.5 °C [10]. By the data of the Ukrainian Research Hydrometeorological Institute of the State Service of Ukraine of Emergencies and according to reports of NAS of Ukraine, the ultraviolet radiation in the geographical area of Kyiv is becoming more intense every year, for example, in 2012 it exceeded the norm by 3 or 4 times [11.]

The negative impact of these factors leads to extreme weather events, natural disasters, which in recent years have become more frequent and evident. The climatic changes in Kyiv manifest themselves in not previously so characteristic extremely high and low temperatures, increased number of hot days, heavy rains, floods, landslides and so on. Thus, according to the State Service of Ukraine on Emergencies as of 8 April 2013 there occurred 18 landslides (at Vydubitsky monastery Askold's Tomb, Naddniprovske Shose, Vulytsya Frunze, Pecherskyi district, etc.) due to snow melt, rise of groundwater and water levels in rivers all over the city. In addition, another 12 sites were

identified as potentially hazardous landslide areas. Among them, a major threat is the destruction of the Dnieper slopes, causing soil slips onto Parkova Doroga. It should be noted that this negative process has been enhanced by the unreasonable and uncoordinated, often chaotic city development policy that impedes or blocks the airflows.

To prevent climate change in Kyiv and make adaptation to those alterations that have already occurred, it is necessary to implement a set of effective measures of legal, economic and organizational sort. It is necessary to follow example of the advanced economies and in the beginning develop the Kyiv city strategy and after that the city's programme of preventing climatic changes and adaptation to some of them.

The study of the German experience has shown that the Senate of Berlin develops a climate program of the city, which is formed by two components: climate protection and adaptation to climate change. Berlin district offices develop their district programmes for climate protection and adaptation to changes in their detailed reference to the area and taking into account peculiarities of the territorial development. The main sections of climate programme are: green zoning, transport, logistics, energy saving, waste recycling, buildings and constructions, housing and communal services.

Based on the study and evaluation of the main factors that influence climate change in Kyiv, which are listed in the Kyiv Municipal Strategies for Preventing and Adapting to Climate Change, it is necessary to highlight the following key trends in developing the economic, organizational and legal mechanism to prevent climate changes and adapt to climate alterations:

- upgrading (rehabilitation) of existing buildings, urban infrastructure facilities,
- formation of climate-friendly architectural environment,
- developing an efficient transport and logistic systems, stimulating transition to ecological vehicles,
- planting areas and buildings, creating green areas,

- providing effective resource-saving technologies and equipment; use of renewable energy sources,
- improvement of processing the industrial and household waste, creating an effective system of waste management,
- modernization of housing and utilities,
- fostering green culture and improving environmental knowledge of the citizens.

The above scope of tasks should be considered in more detail.

*Modernization (sanitation) of the buildings and objects of the available infrastructure.* This primarily concerns old residential buildings, the social and manufacture sectors and involves a number of engineering efforts to improve thermal characteristics of the building, reduce the loss of energy and water. These measures include: insulation of walls, windows, door, installation of solar collectors on the roofs, updating the water, sewer, electrical, ventilation networks, and so on. Only the exterior walls insulation can save a third of the heat energy for heating the buildings. These processes must be preceded by an energy audit of buildings, especially by a thermal survey. Implementation of an energy management system, development of the building energy efficiency passports will also improve energy efficiency of the housing stock. A number of measures to improve energy efficiency in Ukraine are foreseen by the "State Special-Purpose Economic Program of Energy Efficiency for 2010-2015", which was approved by the Cabinet of Ministers by the Decree No 243 of 1 March 2010.

European countries are increasingly introducing new compact design of buildings with windows oriented to the south side and reduced glass-covered areas of the walls. The buildings are erected with an account for wind rose and their walls are painted in light colors.

*Formation of climate-friendly architectural environment* is a new for Ukraine strategy for architecture and construction development that entails implementation of a set of effective actions as to taking into account an effect of environmental factors at design, construction and operation of buildings and structures of production and non-production areas in order to ensure favorable environmental and climatic conditions for people's life there. One of these actions is planning of the street planning with an account for the prevailing wind direction that allows creation of optimal wind conditions, cooling of buildings, structures, industrial and residential areas. Disorganized, often chaotic land development that ignores the prevailing direction of air masses results in thermal imbalance in the urban area. The imbalance is aggravated with reduction of the natural active surface due to asphalt, concrete streets and squares and construction of multi-storey buildings with metal or asphalt roofs.

*Creation of an efficient transport and logistics system, augmented with a transition to environmentally-friendly vehicle,* is a prerequisite for better management of climate change. Ukraine has made some progress in the development of eco-friendly cars. Thus, the first eco-friendly car in Ukraine – HADI-34 AIS was presented at SIA-2013, the 21st International Motor Show, which took place in Kyiv in the spring of 2013. Using 1 liter of gasoline, the car drove 575 km. The vehicle weight is 43 kg, fuel tank capacity is 100 g of gasoline, the top speed is 60 km/h. At low-consumption contest of the European Shell Eco-marathon in Rotterdam 2013 the HADI-34 AIS was twenty second among eco-cars of 200 teams. The developers of this car is a team of "LSA Hadi AIS" (High-speed car laboratory at Kharkiv National Automobile and Highway University under support of a group of companies AIS.)

The first electro-taxi fleet company is being created now in Kyiv owing to a private investor. The pilot project is being im-

plemented with the active support of the Kyiv City State Administration, which assists in the allocation of land for the taxis and organization of charging units. By reducing harmful emissions from transport Kyiv will improve its environmental conditions and lessen the motor vehicles' impact on air quality.

Of special attention is solving the problem of improving quality of roads and increasing of the state control over their use. Currently, the load on the axle of trucks is on average 80% higher than that of the standards. This results in destruction of the road beds and intense emission of pollutants, especially of carbon monoxide. Therefore, Ukraine should equip its motorways with the automatic load weight verification systems for trucks/trailers (like in Chop) and legitimize the road fund payments for exceeding permissible weight of vehicles. The country should also encourage development of cycling with allocation of sites with special harness for bike parking and foresee such parking sites in the new construction plans.

The Kyiv transport scheme requires improvement. Prior to allocating land for supermarkets and other retailers it is vital to make an assessment of trade and transport flows, in order to identify existing or potential environmental problems and develop an effective logistics strategy.

*Landscape gardening, arrangement of green spaces* is essential for the formation of the urban environment, optimizing climatic conditions. Greenery is a biological filter for harmful substances emitted into the atmosphere. Vegetation lowers temperature in summer, maintains humidity and air mobility. Unfortunately, there is no single record of greenery in Kyiv. Bookkeeping of trees is scattered throughout business entities, and thus there is no complete picture, which complicates analysis, management, planning and control. In addition, there is an imperfect system of financing and public procurement of seedlings of trees, shrubs (too late held tenders for purchase of seedlings, seedling.) There has not been conducted any audit of Kyiv green zones, and therefore the estimations and planning of green spaces are based on outdated data.

Advanced economies pay great attention to gardening, arrangement of green spaces and control over preservation of plants and vegetation, especially at the construction sites. Germany, for example, has established a precise record of trees, each of which is furnished with an inventory number tag. An electronic record system of trees is presently implemented with a support of a special satellite program. Construction plans have to foresee planting of trees. There is a law on protection of trees in Berlin. Actions are held to restore the number of trees and new plantings. The height of buildings and structures (up to four storeys) is under strict control for not to interfere with the growth of trees. Ukraine and Kyiv need implementation of similar actions. Unfortunately, in recent years, the city allocated areas for construction sites among many green spaces, including parks, urban forests, and protected areas (Zhukov island, for example.)

Thus, well formed and well-developed network of urban green space will optimize wind conditions, reduce the temperature contrast of the city and suburbs, increasing relative humidity.

*Implementation of effective environmentally friendly and resource-saving technologies and machinery, with the use of renewable energy sources* will contribute to saving energy, reducing greenhouse gas emissions, protecting climate in the city. All the above-mentioned constitute objectives of the Energy Strategy of Ukraine up to 2030 and the State Environmental Policy Strategy of Ukraine up to 2020. Both documents stipulate a technical re-equipment of manufacture through accomplishment of innovative projects, implementation of energy-efficient and resource-saving technolo-

gies, low-waste, waste-free and environmentally friendly processes; introduction by 2015 a system of economic and administrative mechanisms to motivate manufacturers use sustainable and renewable natural resources, provide environmental protection, care about new cleaner technologies, innovations in nature management [14.]

The current regulatory framework also needs to be improved in terms of its harmonization with the legal framework of the European Union, the application of environmental norms, standards, rules and requirements in the aspect of resource conservation, environmental protection, use of mineral wealth, implementation of the environmental management systems and environmental criteria to goods and services. The Strategy of State Environmental Policy of Ukraine for the period up to 2020 indicated the need to improve the taxes on emissions and releases into environment, increase the fee for the discharge of a mass unit of substances in the atmosphere to the European level, taking into account the toxicity [14.]

The system of carbon labeling for consumer goods adopted in some advanced economies (the UK, Sweden, France), is noteworthy. Since 2007 British Tesco, for example, has introduced carbon labeling system for 70 thousand kinds of products all over its supermarket chains [15, p. 12]. The purpose of this marking is, on the one hand, to encourage consumers to buy local products due to reduction of distances of the goods carriage and, consequently, a reduction of harmful emissions into the atmosphere. On the other hand, such a labeling is a causative factor for manufacturers to implement environmentally cleaner, more efficient resource-and energy-saving, though more expensive technologies.

*To improve processing of industrial and domestic waste with a creation of an effective system of waste management is a high priority for Kyiv.* In order to solve this problem, firstly it is necessary to improve the acting laws. The Law of Ukraine of 05.03.1998 No 187/98-BP *On Waste* has an indirect mode of action, especially in the aspect of processing electronic waste (screens, mobile phones, etc.) It is necessary to decide on implementation of European standards of waste management, requirements and regulations on responsibility of importers, and a guarantee as to joint responsibility of local authorities, business structures (HCS) and enterprises. An assistance (soft loans, etc.) should be foreseen in purchasing expensive equipment for recycling electronic waste. However, with the low volume processing (3%), it is not profitable. It is also necessary to introduce non-waste technology. For example, Berlin botanical garden is an effective model of zero waste nowadays.

*Modernization of housing and communal services* implies renovation of the water-supply, drainage and sewage systems, extension of the open space parking areas that are not covered with concrete or asphalt. In addition, the housing and construction branch requires further improvement of the existing regulatory framework to ensure its compliance with environmental requirements, particularly in terms of saving energy and resources, industrial and residential design, construction, renovation and dismantling of buildings and structures, as well as in improving energy and resource conservation in dwelling houses.

*Improving environmental education, culture and awareness* will enhance competence of the employees in implementing the modern and efficient environmental policy, caring in taking low-cost economic and energy-saving decisions to preserve environment and natural resources. Berlin municipal realizes importance of awareness of residents of the ideas and goals of environmental conserva-

tion, climate protection, for example, in the Lichtenberg district office manager at a special climate, which deals with, among other types of work, awareness and education and information among the population of the district. Such experience must also be included in Kyiv.

*Improving environmental knowledge, culture and awareness* will enhance competence of the Kyiv employees who implement modern and efficient environmental policy, care about low-cost economic and energy-saving decisions, protection of nature and resources. Berlin Senate recognizes importance that its residents be aware of ideas and objectives as to preservation of environment, protection of climate, and for example, the Lichtenberg District Office employs a special climate manager, who besides other types of work is responsible for promoting environmental knowledge and awareness among population of the district. Such a practice must also be introduced in Kyiv.

**Findings of the study and prospects for further research into the field.** Outcomes of the study into the main factors affecting climate change in Kyiv, as well as the expertise of the advanced economies show feasibility of the system of actions of economic, organizational and legal sort in order to prevent these changes or adapt to them. The most important of the actions comprise modernization of buildings and structures; organization of an efficient transport and logistic systems; changing for green transport vehicles; creation of green spaces; implementation of clean and resource-saving technologies; use of renewable energy sources; organizing an effective system of management; modernization of housing and utilities; spreading environmental knowledge, culture and awareness. It is these measures should form the basis of the Kyiv city strategy to prevent climate changes or adapt to climate alterations.

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### ЗМІНА КЛІМАТУ МІСТА КИЄВА: ШЛЯХИ ПОПЕРЕДЖЕННЯ ТА УСУНЕННЯ НЕГАТИВНИХ НАСЛІДКІВ

*Досліджені актуальні питання зміни клімату, обґрунтована необхідність розробки наукової методики комплексного аналізу та оцінки впливу сукупності різноманітних факторів на цей процес. Висвітлені антропогенні та природні чинники, які впливають на формування та зміну клімату м. Києва. З урахуванням досвіду розвинених зарубіжних країн сформульовані пропозиції щодо упередження та усунення негативних наслідків зміни клімату столиці за допомогою сучасних організаційно-економічних та нормативно-правових інструментів управління.*

*Ключові слова: довкілля; викиди; зміна клімату; захист клімату; управління кліматом.*

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### ИЗМЕНЕНИЕ КЛИМАТА ГОРОДА КИЕВА: ПУТИ ПРЕДУПРЕЖДЕНИЯ И УСТРАНЕНИЯ НЕГАТИВНЫХ ПОСЛЕДСТВИЙ

*Исследованы актуальные вопросы изменения климата и обоснована необходимость разработки научной методики комплексного анализа и оценки влияния совокупности различных факторов на этот процесс. Освещены антропогенные и природные факторы, влияющие на формирование и изменение климата г. Киева. С учетом опыта развитых зарубежных стран сформированы предложения по предупреждению и устранению негативных последствий изменения климата столицы с помощью современных организационно-экономических и нормативно-правовых инструментов управления.*

*Ключевые слова: окружающая среда; выбросы; изменение климата; защита климата; управление климатом.*

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### DEVELOPMENT OF THE CUSTOMS STATISTICS IN UKRAINE: HISTORICAL ASPECTS

*This article examines the history of the origin and development of customs statistics in Ukraine. Stages of its formation are characterized and singled out. The role and place of customs statistics in the state regulation of the Ukrainian economy and making of managerial decisions are determined.*

*Keywords: statistics; customs statistics; customs; statistics history; duties; taxes; fees.*

**Statement of the problem.** Effective social and economic development of any country, its state management and regulation are impossible without the timely receipt of complete, accurate, scientifically grounded official statistical information on economic, social, demographic, environmental and other public events taking place in Ukraine. Customs statistics takes an important role in this process.

**Analysis of the recent researches and publications.** Nowadays customs statistics and the history of its development are paid almost no attention, caused, as we see it, by the lack of fundamental, comprehensive, coherent theoretical development of this customs authorities activity in Ukraine, although some aspects of this subject were dealt with in the researches by S. Kivalov, A. Pavlov, V. Chentsov, N. Kovtun, E. Chekotovskyy, E. Dodin, P. Pashko, B. Kormych, O. Morozov, P. Kravchenko and some other Ukrainian scientists, where customs statistics is examined to some extent, but, in our opinion, not as thoroughly and extensively as it deserves. Some questions of the historical aspect of the customs statistics development were covered mainly in the writings of economists that in bear only the observational nature the context of genesis. Consequently, the issue of customs statistics and the history of its origin are not developed enough in the Ukrainian science and require further comprehensive study. **The purpose of this paper** is to study the formation and to separate the stages of the customs statistics of Ukraine development.

**The main material of the study.** With the formation of the first states the need for the statistical practice appeared, i.e. in the accumulation of information on the availability of land, the amount of projected and actual harvest, population, its property situation – the system of public and administrative records has developed. Several thousand years ago such accounting existed in ancient China, Rome, Greece, Egypt and Israel [1]. In particular, this is evidenced

in Bible, where in the Fourth Book of Moses – "Numbers" – the accounting of the male population capable of bearing arms is described.

The study of historical sources revealed that customs statistics as a separate branch of statistics was being studied only from the late XIX – early XX centuries, but its formation begins since ancient times, with the formation of the first powerful states, the development of their external trade, tax system and customs.

Thus, we can highlight the following stages of the customs statistics development:

Stage I (early IX – the end of XI century) – the era of Kiev Rus. According to the chronicles, various information was already gathered in IX-XI centuries gathered about the origin and development of urban settlements located on the waterways, the presence of temples, churches, monasteries, residential buildings in them, as well as information related to taxation. One of the organizers of customs in Ukraine was Prince Oleg, who gave great importance to the creation of customs outposts around the perimeter of the Princely state, collection of duties and other fees from the international merchants. In 911, after the victorious campaign against Constantinople, Oleg signed a treaty with the Byzantine Empire, under which the city's inhabitants had to not only pay a large indemnity, but also gave the Rus merchants the right to the duty-free trade. Collecting a trading duty ('tslo', 'myt') in Kyiv Rus was a state matter. It was personally conducted by the Prince and leaders of his retinue, the crown trustees appointed by the ruler. Financial management was in direct charge of the Prince. For collecting taxes and tribute, he appointed special officials – customs officers, 'danschyks', 'p'yatenschyks' that did not depend on the crown trustees – governors and 'volostelis'. The money they collected was passed to the Prince or whomever he ordered. Historic accounts sometimes mention governors and 'volostelis' as