

Reconstructive Activity in the Context of Urban Life Cycle Phases. The Case of Ukrainian Cities

Alla Pleshkanovska ¹ | Viktor Yatsenko ² | Polina Berova ³ | Natalia Filvarova ⁴

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Abstract

Based on the classical concept of the “Urban Life Cycle”, this study formulated the main stages of the city existence process – from its inception, through functioning (formation, three possible options for further existence – development, stabilization or stagnation) and possible death of the city. A new stage has been introduced – the revival (reconstruction) of the city – as the basis of its long cyclic existence. The study formulated the external and internal factors and prerequisites that entail the transition of the city from one phase of existence to another, as well as the forms and content of reconstructive activities at each stage of the city's life cycle. The practical part of the study was based on the analysis of the features of the life cycle and urbanization processes of Ukrainian cities with a population of more than 50 thousand people during the 19th-21st centuries. Particular attention is paid to the stage of “death” of cities. Groups of factors are formulated that can lead to the destruction and possible death of the city, namely: socio-political, natural, man-made environmental and economic. It has been established that among the factors that led to the destruction and death of hundreds of cities and towns, the most important for Ukraine are socio-political and man-made. The threats to the existence of Ukrainian cities at the present stage are analyzed in detail. The main directions of reconstructive activities and the criteria for choosing options for design solutions for the comprehensive restoration of cities in Ukraine are formulated.

Keywords: uricide; death of city; city revival; complex city reconstruction

Citación

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Actividad reconstructiva en el contexto de las fases del ciclo de vida urbano. El caso de las ciudades ucranianas

Resumen

Basado en el concepto clásico del “Ciclo de Vida Urbano”, este estudio formuló las principales etapas del proceso de existencia de la ciudad, desde su inicio, pasando por el funcionamiento (formación, tres posibles opciones para una mayor existencia: desarrollo, estabilización o estancamiento) y la posible muerte de la ciudad. Se ha introducido una nueva etapa: el renacimiento de la ciudad. El estudio formuló los factores externos e internos y los requisitos previos que implican la transición de la ciudad de una fase de existencia a otra. La parte práctica del estudio se basó en el análisis de las características del ciclo de vida y los procesos de urbanización de las ciudades ucranianas. Se presta especial atención a la etapa de “muerte” de las ciudades. Se formulan grupos de factores que pueden llevar a la destrucción y posible muerte de la ciudad, a saber: sociopolíticos, naturales, ambientales y económicos provocados por el hombre. Se ha establecido que entre los factores que llevaron a la destrucción y muerte de cientos de ciudades y pueblos, los más importantes para Ucrania son los sociopolíticos y los provocados por el hombre. Las amenazas a la existencia de las ciudades ucranianas en la etapa actual se analizan en detalle. Se formulan las direcciones principales de las actividades de reconstrucción y los criterios para elegir opciones de soluciones de diseño para la restauración integral de las ciudades en Ucrania.

Palabras clave: uricidio; muerte de la ciudad; renacimiento de la ciudad; reconstrucción compleja de la ciudad

¹ Doctor of Technical Sciences, Professor, Kyiv National University of Construction and Architecture (ORCID: [0000-0001-9370-3570](https://orcid.org/0000-0001-9370-3570), Scopus Author ID: [57218095248](https://orcid.org/57218095248), WoS ResearcherID: [AAD-7119-2019](https://orcid.org/AAD-7119-2019)),

² Doctor of Architecture, Professor, Kyiv National University of Construction and Architecture (ORCID: [0000-0002-6054-729X](https://orcid.org/0000-0002-6054-729X)), ³ Assistant, Kyiv National University of Construction and Architecture (ORCID: [0000-0002-2142-4377](https://orcid.org/0000-0002-2142-4377), WoS ResearcherID: [AAC-8812-2019](https://orcid.org/AAC-8812-2019)), ⁴ Researcher, Institute of Urban Planning (ORCID: [0000-0002-1824-667X](https://orcid.org/0000-0002-1824-667X)). Contact e-mails: pleshkanovska.am@knuba.edu.ua

1. Introduction

The concept of the "Urban Life Cycle" (ULC) was formed in the 70s of the last centuries and gained significant popularity in various areas related to the problems of the existence and development of urban systems (Forrester, 1969; Roberts, 1991; Alfield, 1995; Czamanski & Broitman, 2018). First, it addressed the cyclicity of urbanization processes at the macro level. The five stages of urbanization formulated by Gibbs (Gibbs, 1963) determined the relationship between the size of the urban and rural populations at different stages of the economic development of society, from preindustrial to postindustrial. The cyclical dynamics of the city's population (urbanization, suburbanization, deurbanization and re-urbanization (Klaassen & Scimemi, 1981)) had a direct impact on the spatial dimensions of the city itself and its zone of influence – the agglomeration or suburbia zone – determining the nature of horizontal economic, social and transport links (Kolosta, 2011; Morelli, et al., 2014; Keil, 2018; Jansen, 2020).

A critical approach to the general theoretical regularities of the cyclical development of urban systems (Cividino, et al., 2020; Carlucci, et al., 2020; Morelli, et al., 2014) prompted researchers to look for specific features of the life cycle of cities in different regions of the world (Kunzmann & Wegener, 1991; Salvati & Carlucci, 2016; Benassi & Salvati, 2020; Salvati, 2020). Thus, analyzing the evolution of the development of cities in Ukraine, researchers (Havryluk, et al., 2021; Krisjane & Berzins, 2012; Pleshkanovska, 2019) drew attention to the imperfection of the standard model of urban development and its inability to adequately describe the evolution of cities in the postsocialist world in specific economic, social, and political conditions.

The evolutionary nature of the urbanization processes of the pre- and post-industrial periods, inherent in most cities of the world, in Ukraine has experienced a significant impact of destructive factors – from the revolutionary events of the beginning of the 20th century (revolutions of 1905, 1917), military conflicts of the world scale (I and II World War) and local scale (civil war of 1917-1921, war between Russia and Ukraine in 2022-2023), to man-made and natural disasters (the world's largest man-made disaster – the accident at the Chernobyl nuclear power plant in 1986).

All these events that took place on the territory of Ukraine significantly impacted the dynamics of urban development and the life cycle of Ukrainian cities. The prolonged periods of destructive events, combined with the difficulties in maintaining proper technical condition of many outdated buildings (Biriuk & Pleshkanovska, 2021), as well as the importance of maintaining the level of quality of life of the urban population (Rappaport, 2009), emphasized the great importance of reconstructive activity in maintaining and developing of Ukrainian cities at different stages of their lifecycle.

Theoretical and practical experience in solving the problem of city reconstruction that have undergone significant destruction due to military conflicts is widely presented in the scientific literature. Classical examples were the reconstruction of Coventry, London, Berlin, Dresden, Warsaw, and others. The implemented solutions for the reconstruction of cities have significantly affected not only the restoration of the planning structure and destroyed buildings, but also the improvement of the quality of life of residents, the provision of service facilities, and the reduction of overcrowding in residential areas (Diefendorf, 1989; Larkham & Adams, 2023; Jankowski, 2022).

Special attention was paid to the revival of the cultural, architectural, and historical heritage of these cities as a basis for preserving the city's identity, the unity of a person with the urban environment and its heritage at a new stage of the city's life cycle (Nasser, 2003; Tweed & Sutherland, 2007; Veldpaus, 2013). Among the factors contributing to the restoration of the population and the further growth of the quality of urban life, the following can be distinguished:

- change in the institutional guidelines of society (Haase & Rink, 2015; Nuisl & Rink, 2003);
- external, state and local investments (Rink, et al., 2012);
- introduction of innovative technologies (Leydesdorf & Deakin, 2011; Pleshkanovska, 2021; Martyniuk-Pęczek, et al., 2022);

- improvement of the planning organization of urban space (March, et al., 2017);
- ecologization of urban development (Hale & Sadler, 2012; Semeraro, et al., 2017; Bulakh, 2022; Hidalgo & Arco, 2022);
- involvement of society in the management of urban development (Kim, et al., 2020; Pleshkanovska, 2020), etc.

Considering the events associated with the Russian invasion of Ukraine in 2022-2023, and the catastrophic destruction of Ukrainian cities, their buildings and infrastructure, massive processes of internal and external migration, restoration of Ukrainian cities become of key importance. Determining the place of reconstruction activities at different stages of the life cycle of Ukrainian cities, as a driving force for their restoration based on modern principles of creating a comfortable urban environment and ensuring further sustainable development, was the goal of this study.

2. Materials and Methods

Identification and study of the place of reconstructive activity in the context of different phases of the life cycle of cities was carried out using the methods of complex, systemic, historical, graph-analytical, and statistical analysis.

The present study was carried out on the examples of Ukrainian cities with a population of more than 50,000 people. To analyze the dynamics of the population of the cities under consideration, open statistical data from population censuses conducted within the territory of modern Ukraine were used, namely:

- the first general population census of the Russian Empire, 1897,
- partial census of 1920,
- census of the urban population in 1923,
- All-Union population censuses of 1926, 1939, 1959, 1970, 1979 and 1989,
- All-Ukrainian population census, 2001,
- data from Statistical Yearbooks of Ukraine.

Information about the settlements of Ukraine, which were granted the Magdeburg Law (as confirmation of the status of a “city”), was obtained from diversified open sources (Settlements of Ukraine Granted Magdeburg Law, 2021) and official sites of cities (Appendix A).

The identification of aggregated territorial zones that require special attention when solving the complex reconstruction and restoration of cities was carried out using a graph-analytical method based on the data of available sources of information.

3. Results

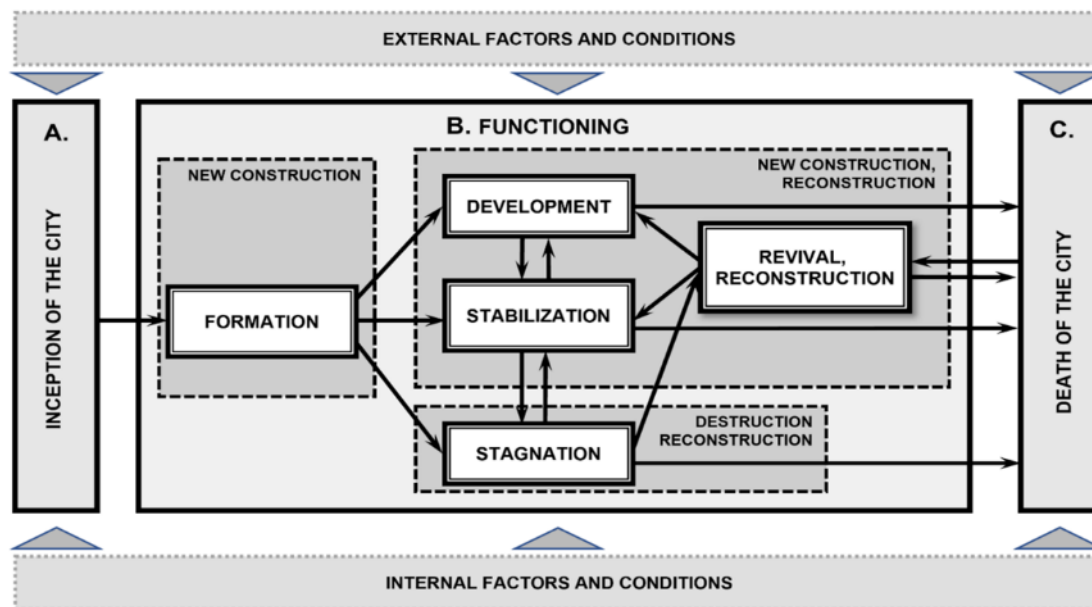
The urgent need for the revival of Ukrainian cities destroyed during the 2022 Russian invasion requires rethinking and combining the worldwide scientific and practical experience of reconstructive activities at different stages of the city's life cycle and the specifics of the development of Ukrainian cities.

3.1 *The form and content of reconstruction activities at different stages of urban development*

A settlement, arising in a certain period and at a certain point in space, over time during its historical existence gradually turns from a small group of buildings into a large city. The formation of living conditions in the settlement, as a kind of reflection and consequence of the gradual development of the urban material infrastructure, does not always occur at a uniform pace, experiencing either rapid growth or a long-term slowdown.

It is possible to single out several characteristic periods of the city's existence, forming its "life cycle" from its *inception* (period A), through a long period of *functioning* (period B) and up to the possible in some cases final stage of its existence – disappearance or *death* (period C) in the existing system of settlements (Figure 1).

Figure 1. Urban Life Cycle. Reconstructive activity in the context of urban life cycle phases



Source Elaborated by the authors.

The entire life cycle of the city occurs under the influence of external and internal factors and conditions and is enabled by urban planning activities, which have two main components – *new construction* and *reconstruction*. It is the reconstructive activity that ensures the renewal of the previously created fixed assets of the city – buildings and structures, the network of streets, roads, and engineering communication and, accordingly, all functional subsystems of the material and social infrastructure that ensure the proper level of life of the population. We are talking about the adaptation of the city as a complex socio-technical system to the historically changing conditions of its existence, its self-organization.

A. *The inception* of a settlement can be due to various reasons, from spontaneous to declarative, at the will of a particular ruler or government with a clearly defined goal. In ancient times, settlements most often arose as outposts to consolidate the military presence in the process of consistent development of space or as "places of trade" on trade routes.

B. *The functioning* of a city is the longest and most active period of a city's life cycle. It includes multiple phases.

1) *Formation* – the growth of the primary structural elements of the urban environment. This phase is characterized by the development of the area with the establishment of primary households and land holdings; the formation of the primary planning structure of the settlement and the construction of the first buildings and structures for residential and public purposes. New construction dominates at this stage. There is a formation of a permanent population as a community with a certain number of administrative features (functions) in the system of settlements of the state. The population is growing rather slowly.

The next stage of the city's existence can occur according to three principal scenarios.

2) *Development*. This stage is characterized by the strengthening and expansion of activity under the influence of external and internal factors and conditions that stimulate the rapid increase in the volume and quality of material objects, the level of comfort of the urban environment, and

dynamic population growth. Active influence on the adjacent territory in the administrative, commercial, and cultural sense is forming, and the city gains status. The importance of the city, its social and investment attractiveness is growing.

Urban planning activities to create fixed assets with the development of new territories are characterized by an active phase. In its composition, reconstructive activity occupies a limited role.

- 3) The phase of *stabilization* (or slow development), as a rule, follows the phase of active development. The formation of a structured socio-economic complex of the city is being completed, its stable functioning in the system of the region and the state, stable moderate population growth, strengthening of activities in the field of education, science, culture, and sports are also happening.

New construction continues and the role of reconstructive activities in the renewal and replacement of fixed assets, the redevelopment of urban areas, the increase in the economic and functional efficiency of their use, the development of engineering and transport infrastructure, and the improvement of the city is increasing.

- 4) The pessimistic scenario for the functioning of the city is the *stagnation* phase. It occurs in the event of the termination of positive external factors and the exhaustion of internal resources to maintain the viability of the city, for example, Detroit in the USA (drop in population by almost three times because of the curtailment of the automotive industry), Vorkuta in Russia (population decline by 67% in thirty years because of the collapse of the coal industry).

The stagnation of the city is characterized by a gradual loss of demographic potential – depopulation, for example, Dnipro in Ukraine (population decline by 18.8% over thirty years; the first place in the anti-rating of Europe at the current stage (UN-Habitat, 2013), curtailment of economic activity, including new construction and reconstruction, a drop in living standards, etc.

New construction is practically slowing down, and reconstruction measures are of a limited nature, aimed mainly at preventing and eliminating the consequences of emergency situations. Stagnation reduces the city in its general parameters to a level at which internal resources and external factors cannot ensure its existence as such. In some cases, the city practically ceases to exist, for example Hasima in Japan, Aghdam in Azerbaijan, Pripyat in Ukraine (UN-Habitat, 2020; UN-Habitat, 2022).

The stagnation phase is not irreversibly fatal for the city. For example, after entering this phase, the city, having lost some of its functions and worsened the rest, can stop and stabilize at a certain level of “fall”, moving from one status (qualitatively and quantitatively) administrative, economic or cultural level to a lower one.

- 5) Another option involves the *revival* of this city as a result of the restoration of the entire complex of prerequisites and development factors or the emergence of new, primarily resource-economic, prerequisites (for example, the discovery of mineral deposits in past centuries or the creation of the latest technological facilities in our time), or emergence of economic and geographical (for example, laying a significant transport route through the city, locating airports), political or military-political (creation of new administrative and political centres) conditions. As a result, the city passes (or returns) to the *development* phase and is included in a new urban development cycle.

C. And finally, in some cases because of military operations or of extraordinary natural, man-made situations and catastrophes, almost complete destruction of the city, its *death*, is possible. This option is the most pessimistic, however, even in the event of the complete destruction of the material infrastructure of the city, history knows many examples when the city is reborn in the same place in a fundamentally different capacity. These are Jerusalem (Israel), Lisbon (Portugal) or Coventry (Great Britain).

The forms and content of reconstructive activities, as one of the types of urban planning activities, at different phases of the city's life cycle are presented in more detail in the Table. 1.

Table 1. The content of urban planning and reconstructive activities in accordance with the phases of the city's development

city life cycle period	city life cycle phase	external and internal factors and prerequisites	content of the urban planning process	forms and content of the reconstructive activities
A. Inception of the city	Inception of the city	Availability of resources for functional activities and life support. Military political tasks of territory development. Economic and geographical position. Trade and economic expansion. Ideological (religious) influence on ethnic groups.	Primary construction development of space with a predominance of temporary buildings, structures, and communications.	There are none.
B. Functioning of the city	Formation	The need for the implementation of the basic functions of the city, the formation of social and infrastructural support for the life of the population.	Creation of a construction base; city engineering systems. Increasing spatial accessibility (formation of the road network), construction of a system of public buildings and service centres.	Replacement of temporary buildings with permanent ones with the development of the road network, reconstruction, and expansion of the network of administrative buildings, public and service facilities.
	Development	Expansion of types of multifunctional activities. demographic growth. Positive production and economic dynamics. Investment attractiveness.	Activation of construction activity (increased constructive activity); enrichment of the architectural image of the city, development of a system of representative (government, administrative, public, etc.) objects. Growth of the production and economic potential of the city. Development of the transport system.	Reconstruction of industrial facilities and territories. Expansion of urban supply facilities and engineering infrastructure, external transport facilities; architectural and planning reconstruction of the city.
	Stabilization	Resource constraints for further growth. Social and investment stabilization. Intensification of economic activity. Deepening cultural processes; public enrichment.	Selective construction of public and residential objects of a representative class. Expanded improvement of open urban spaces, enrichment of the urban environment with small architectural forms, creation of monumental art objects.	Reconstruction of the central part of the city, landscape reconstruction, improvement of the system of places of labour activity and ensuring social dynamics, ecological reconstruction.
	Stagnation	Exhaustion of internal and external resources of the city's existence, loss of a favourable economic and geographical position, social and political degradation	Dramatic reduction in new construction. Degradation of capital assets.	Situational reconstruction (mainly as a result of emergency situations).
	Revival, reconstruction	The emergence of new, primarily resource-economic, economic-geographical, or political factors	Activation of construction activity, growth of production and economic potential. Transformation of the road network and transport system.	Reconstruction of urban subsystems of various types to meet the increasing load.
C. Death of the city	Death of city	The occurrence of natural or man-made emergencies, hostilities leading to the death of the city	There are none.	There are none.

Source: elaborated by the authors.

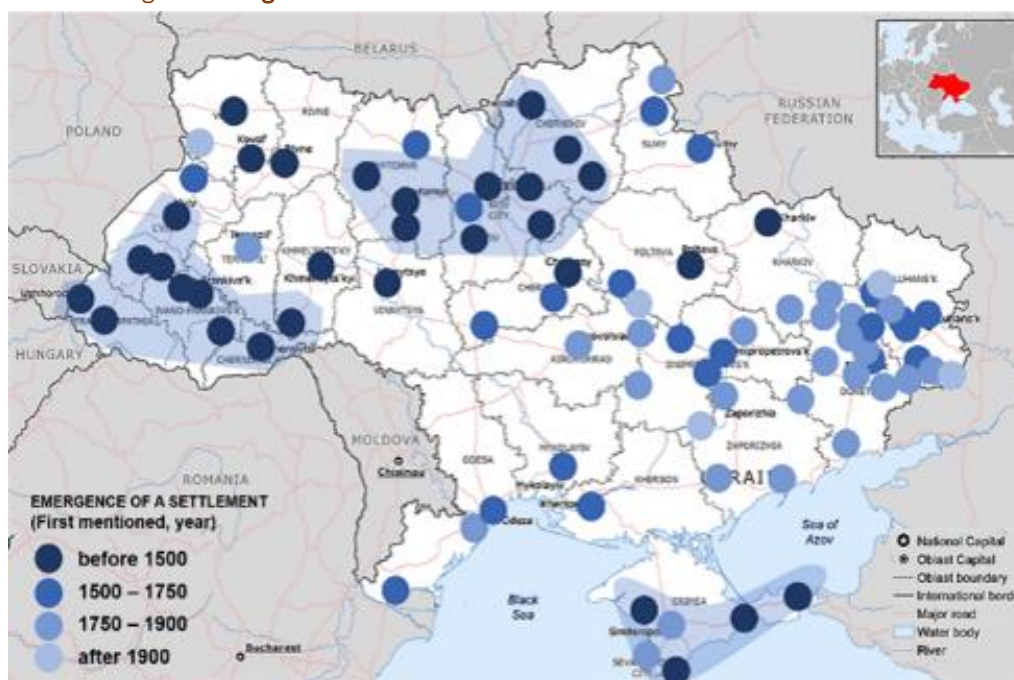
3.2 Features of urbanization processes in Ukraine

3.2.1 Formation of a modern network of settlements in Ukraine (Inception and Formation of cities).

The territory of Ukraine within its modern borders was formed over a long time, undergoing significant political, socio-economic, and administrative-territorial changes, undergoing wars, famines, repressions, and deportation of peoples in different historical periods. According to the “Statistical Yearbook of Ukraine” (State Statistics Service of Ukraine, 2021), the territory of Ukraine is 603.5 thousand sq. km, the population is 41.6 million inhabitants. The network of settlements in Ukraine includes 461 cities, 882 townships and 28,372 villages (State Statistics Service of Ukraine, 2020, 2021). In this study, cities with a population of more than 50 thousand people are considered in detail. As of January 1, 2021, their number is 87; 8,129.4 thousand people live in them, or 19.5% of the total population of the country.

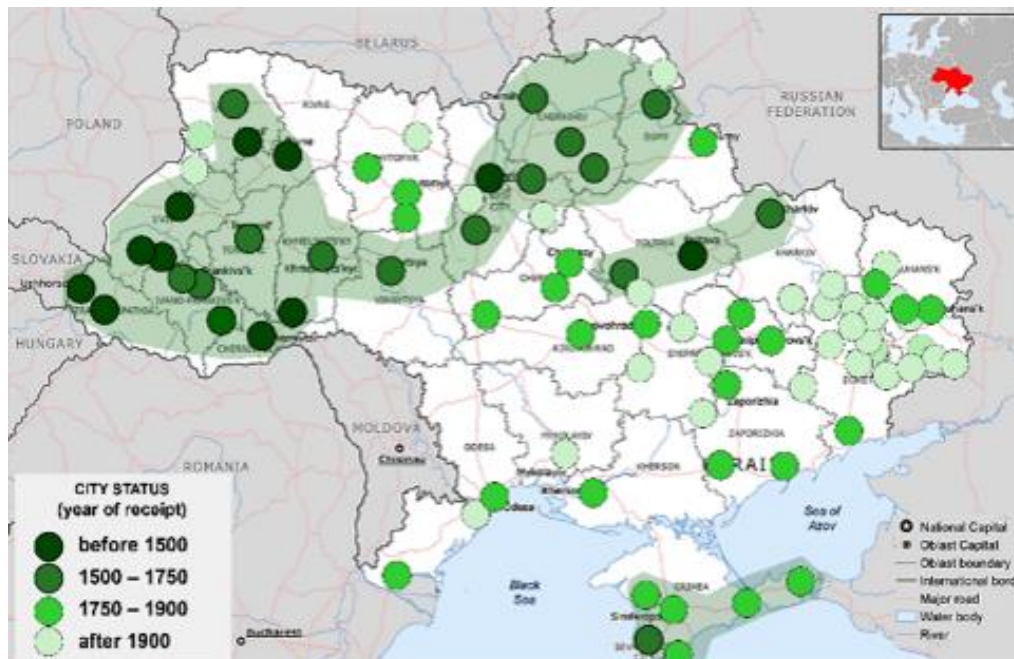
The active formation of the primary network of settlements on the territory of modern Ukraine took place in the southern part of the Crimea (the oldest Scythian and Tatar settlements of the 12th–3rd centuries AD; Greek colonies of the 6th–5th centuries BC) and in the northern part (Kievan Rus – 9–13 centuries AD) and the western parts (as part of the Grand Duchy of Lithuania, beginning of 12–14 centuries AD; Galicia-Volyn principality, 12–14 centuries AD). The gradual development and acquisition of political, military, trade and economic independence and the importance of most settlements in the western, northern, and central parts of Ukraine was secured by the acquisition of the status of “city” and the receipt of the Magdeburg Law, that is, the right of urban self-government, which contributed to the revival of the economic and cultural life of the city (Manulova, 2016). The period of active formation of large urban settlements coincides with the development of the southern and eastern parts of Ukrainian lands in the late 18th and early 19th centuries (see Figure 2). At this time, such cities as Dnipro, Donetsk, Mariupol, Zaporizhian, Kherson, Nikolaev and others were formed. It was this network of cities that formed the basis of the industrial foundation of Ukraine in the 20th century. The next period of active formation of large urban settlements coincides with the development of the southern and eastern parts of Ukrainian lands in the late 18th and early 19th centuries (Figure 3).

Figure 2. Stages of formation of the network of settlements in Ukraine



Source: elaborated by the authors based on the map of the administrative division of Ukraine.

Figure 3. Stages of formation of a network of capacious settlements of Ukraine (acquiring the status of “city”)



Source: elaborated by the authors based on the map of the administrative division of Ukraine.

By the beginning of the 19th century, the first five largest cities within the territory of modern Ukraine were Lviv (38.0 thousand), Kharkiv (30.0 thousand), Kiev (27.2 thousand), Kherson (25.0 thousand), Sevastopol (20.0 thousand). By the end of the 19th century (1897), the top five already included Odessa (403.8 thousand), Kyiv (247.7 thousand), Kharkiv (174.0 thousand), Lviv (127.9 thousand), Dnipro (112.8 thousand).

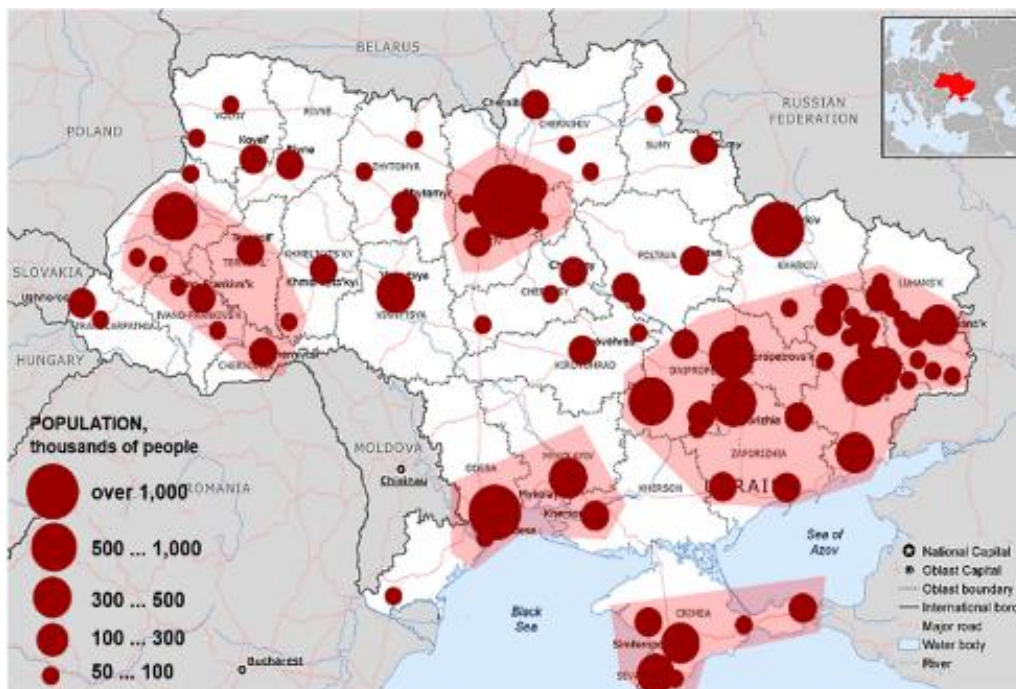
The final formation of the network of settlements in Ukraine was completed in the second half of the 20th century, with the foundation of the last new cities based on large energy and industrial facilities – the port city of Yuzhne (1978), Enerhodar (1970) and Pripyat (1970) based on the Zaporizhzhia and Chernobyl nuclear power plants, Slavutych (1986) – the youngest city of Ukraine, founded after the accident at the Chernobyl nuclear power plant.

In the 90s of the 20th Century, when the country's population reached its maximum – 52.2 million people, the network of cities was headed by millionaire cities – Kiev (2,637.9 thousand), Kharkiv (1,610.0 thousand), Donetsk (1,121.4 thousand), Dnipro (1,177.9 thousand) and Odessa (1,115.0 thousand). But by the beginning of 2021, only 3 cities on the territory of Ukraine had a population of more than 1 million inhabitants – Kiev (2,962.2 thousand), Kharkiv (1,433.9 thousand) and Odessa (1,015.8 thousand), Donetsk and Dnipro lost this status (905.4 thousand and 980.9 thousand respectively). Despite the later period of formation of the network of cities, the eastern region of the country is the most urbanized (Figure 4).

The maximum number of large cities is concentrated in the eastern part of the country. The level of urbanization of the eastern regions at the end of the 20th century was 80-90% compared to the national average of 68.0%.

Detailed information on the period of origin, acquisition of the status of a city or obtaining the Magdeburg Law, as well as on the population of the cities in question, is collected in Appendix A.

Figure 4. Localization scheme of the most urbanized regions of Ukraine (as of 01.01.2021)



Source: elaborated by the authors based on the map of the administrative division of Ukraine.

3.2.2 Factors affecting the population dynamics of Ukrainian cities (Functioning of the cities).

As already noted, the present population of Ukraine as of January 1, 2021, is 41.6 million people. (Excluding temporary occupied territory of Autonomous Republic of Crimea and city of Sevastopol). However, the last official population census in Ukraine took place in 2001, and therefore the country's population data is not absolutely accurate. According to specialists from the Institute of Demography and Social Research named after N.V. Ptukhi of the National Academy of Sciences of Ukraine, now the population is approximately 34-35 million people, and by 2030 it may be reduced to 30 million people (Post-war revival of Ukraine, 2023).

The population of Ukraine was first noted at the beginning of the 17th century, in 1629, at 5-6 million people. In the feudal era, population growth was hampered by frequent wars, devastating epidemics, and crop failures. An important factor in demographic development was the development of new lands in the 17th century in the northeast and in the 18th century in the south of modern Ukraine. In 1870, the population reached 18.7 million people. The agrarian overpopulation of Ukraine at the end of the 19th – beginning of the 20th century led to mass migration of the peasant population outside Ukraine – mainly to Siberia and the Far East of the Russian Empire (about 1.6 million people moved).

Resettlement across the ocean was also significant (in 1895-1913 – 413 thousand people) from Western Ukrainian lands – Galicia, northern Bukovina and Transcarpathian Ukraine, which were part of Austria-Hungary. Emigration from Western Ukrainian lands continued in 1919-1939.

Over the past century, several tragic waves have swept across Ukraine, which have significantly affected the demographic situation. The First World War, the revolution of 1917, and the Civil War of 1917-1921 caused numerous casualties and emigration because of hostilities, pogroms of the civilian population, mass repressions against the aristocracy, clergy, intelligentsia, which led to a reduction in the population (from 35, 2 to 25.6 million people).

The next period – 1930-1939 – was characterized by several multi-vector trends. The famine of 1932-1933, which took the lives of millions of people, mostly rural residents; political repressions of 1936-1939, which affected all categories of the population, led to a general reduction in the population of Ukraine. Nevertheless, the process of industrialization that had begun caused a relative increase in the urban population, especially in the major industrial centers of the country.

World War II, which claimed tens of millions of lives around the world, Europe and in Ukraine, and the subsequent famine caused another decline in the population from 41.2 to 32.3 million people. And only since the end of the 40s there has been an increase in the population almost until the mid-90s of the last century. The maximum population of Ukraine reached 52.2 million people in 1993 (Figure 5).

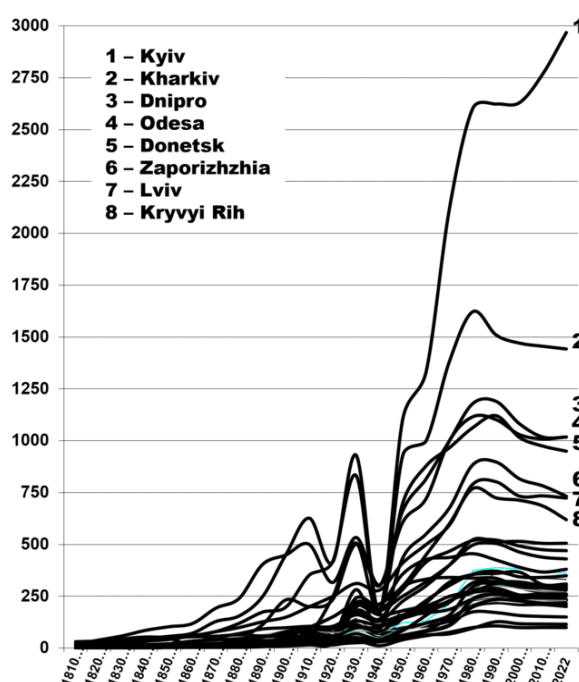
As already noted, a detailed analysis of urbanization processes, as a factor in stimulating the development of cities, was carried out on the example of the 34 main cities of Ukraine, which form the urbanization framework of the country. Graphs of population dynamics in the period from 1800 to 2020 clearly demonstrate that almost until the end of the 19th century, population growth was quite slow, but in the 20th century there are significant fluctuations in the population. At this time, three periods of significant population growth, especially in large cities, can be distinguished – 1890-1914, 1926-1940, and 1947-1990.

A sharp reduction of the population was recorded in the periods 1915-1925 and 1941-1946, and starting from the mid-1990s until today, a slow but constant decrease in population is observed in almost all cities (except for Kyiv).

These processes have a general character inherent in different categories of cities and differ only in the rate of growth or decline in the population – the larger the city and the more important its role in the settlement system, the more these fluctuations are manifested.

An analysis of the sharp decline in the population of Ukraine because of the Russian invasion in the period 2022-2023 was not carried out in this study. Data on the number of dead (military and civilian) individuals, as well as those who emigrated to other countries, are not completely known and differ significantly. According to experts, only the flow of external migration is estimated at 5 to 8 million people, and mainly due to residents of large cities; Kyiv, Kharkov, Zaporizhzhia (Libanova, 2023).

Figure 5. Dynamics of urbanization processes in Ukraine since 1800



Source: own development based on population censuses data.

3.3 *Death of the city; the end or the beginning of a new stage of development?*

Suspension of the city's performance of its functions, destruction of city buildings and infrastructure facilities, which leads to partial or complete stagnation and even death of the city, may be due to the action of various external and internal factors, namely:

- socio-political (political or managerial decisions, military actions, revolutionary events, terrorist acts);
- natural (earthquakes, tsunamis, floods, mudflows, tornadoes and others);
- technogenic (explosions at industrial and production facilities, energy facilities (blast wave), undermining and subsidence soils, flooding of foundations);
- environmental (chemical and radiation pollution, epidemics and pandemics);
- economic (depletion of natural resources, minerals, bankruptcy of basic production and financial facilities).

The process of the death of cities can occur according to two basic scenarios. The first is when, under the influence of certain factors, the material infrastructure of the city is destroyed, living in the city becomes impossible and dangerous and the population is forced to leave the remains of the city. The second is when external or internal reasons force residents to leave the territory of the city, because of which the city's buildings and infrastructure are gradually destroyed, and the city begins to die. If we look at the features of the existence of Ukrainian cities from this point of view, we can single out several periods when the stagnation and destruction of cities occurred most of all.

3.3.1 *War as a factor in the city's demise*

The geographical location of modern Ukraine, almost in the geometric centre of Europe, and at the intersection of the main trade routes, caused great interest in its territory. Over the centuries, the settlements on this territory were subjected to devastating military destruction, first by the Mongol-Tatar hordes, and later by the Crimean-Tatar and Turkish troops. According to E. Rulykovsky, even in the 16th-18th centuries, because of Tatar raids, every small settlement disappeared approximately once every twenty years (Rulikowski, 1853). The revival and existence of such settlements, as well as small towns, required constant reconstruction measures and was possible only under the protection of defensive fortresses.

The end of the 18th and 19th centuries were relatively calm and marked by a significant activation of the process of creation and establishment of new cities, mainly in the south and east of modern Ukraine (see Appendix A). On the other hand, the Peasant Reform (the abolition of slavery), which began in 1861 in the Russian Empire, and included Ukraine, freed more than 22.5 million peasants (Lazanska, 2012). Some of them replenished the urban population and contributed to the active growth of cities, and the development of capitalist relations in the second half of the 19th century. Large volumes of new construction of residential and public buildings, manufactories, factories, and plants in existing and newly created cities largely dominated the reconstruction activities.

The next period of massive destruction of Ukrainian cities is associated with the consequences of World War I, the revolutionary events of 1917, and the civil war of 1917-1921. During this period, up to 40% of residential and civil houses, and almost 2,000 enterprises were destroyed, mainly in Western Ukrainian cities. About 500 thousand people died (Gisem & Martyniuk, 2007).

However, the consequences of World War II became the most catastrophic for the country. The wave of war swept through the territory of Ukraine twice, causing devastating destruction to Ukrainian cities. 28,000 villages, 714 cities and towns (40% of all urban settlements in the Soviet Union) were ruined, and 250 of them were completely destroyed. 2 million houses were damaged, leaving more than 10 million people homeless. Kyiv was destroyed by 85%, Kharkiv – by 70%, the Dnipro, Zaporizhzhia, Poltava, and others suffered great devastation (Ukraine – 71 year after World War II, 2016).

Periods of crushing destruction because of hostilities gave way to periods of large-scale reconstruction activities for the restoration and further active development of cities. So, in the 20s and 30s of the 20th Century, the stage of industrialization of the country began, associated with the creation of a powerful industrial complex of cities (new construction) and large-scale reconstruction of urban space in accordance with the ideological and socio-political requirements of the new socialist society. There is a transformation (reconstruction) of administrative and city public spaces in accordance with the ideologies of the new government. The revival of cities, and the country, after World War II was marked by a powerful reconstruction of urban areas and urban development (Figure 6).

Figure 6. Khreshchatyk street, Kyiv.
a), b) Ruined Khreshchatyk, 1943. c) Restored Khreshchatyk, modern view



Source: photos in the public domain on the Internet:

a) https://rus.lb.ua/society/2011/03/28/90163_inna_deleur_ot_kieva_40h_godo.html; b) <https://moi-stroki.livejournal.com/152953.html>; c) <https://kiev.in.ua/kreshhatik/>.

The implementation of the Program of mass housing construction begins to resolve the post-war housing crisis (Biriuk & Pleshkanovska, 2021). The use of industrial housing construction led to the formation of residential development according to standard designs of both individual houses and entire blocks, microdistricts and residential areas. This formed a new planning and spatial solution for residential areas and the modern look of most Ukrainian cities.

3.3.2 Industrial activity as a factor of the city's demise

The territory of Ukraine barely falls into the zone of active tectonic processes (landslides, earthquakes, volcanoes, etc.), which can lead to a powerful destruction of the cities. Except for small areas of the Carpathian and Crimean Mountains, most of the territory of Ukraine belongs to the 5-6-point zone of seismic activity on the Richter scale. However, Ukrainian cities and villages have repeatedly suffered from negative man-made processes. For example: large-scale flooding of territories to develop energy; industrial disasters; floods in the Carpathians due to massive deforestation.

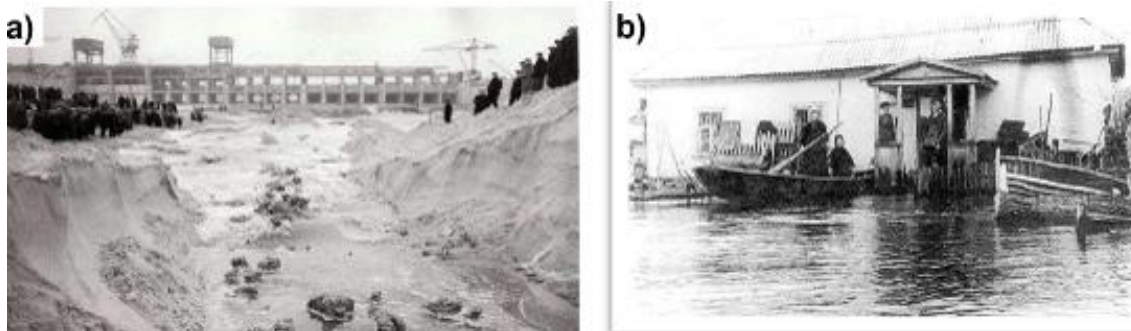
The positive aspect of the period of industrial development of Ukraine as part of the USSR (1928-1941), which contributed to the active development of cities, was also connected with the beginning of a specific process of mass destruction of populated areas of Ukraine.

The beginning of the implementation of the State Electrification Plan (adopted in 1920), as the basis for the formation of the country's energy base, was the Dnipro HPP and several other hydroelectric plants on the Dnipro River.

The construction of these hydroelectric plants required the creation of several artificial reservoirs to ensure their functioning – the Dnipro Cascade of Reservoirs. This construction lasted almost half a century. The Dnipro Cascade included the Dniprovskoe (1932), Kakhovskoe (1955-1958), Kremenchutskoe (1959-1961), Kamianske (1963-1964), Kyivskoe (1964-1966) and Kanivskoe (1974-1976) reservoirs.

It is known that during the implementation of this large-scale project, 709,900 hectares of land were used. Also, more than 6,000 villages and towns were flooded and destroyed throughout the cascade (Figure 7); more than 3 million people were relocated (1939-1945. We Remember. We are Winning, 2016).

Figure 7. Construction of reservoirs of the Dnipro cascade. Flooding of settlements



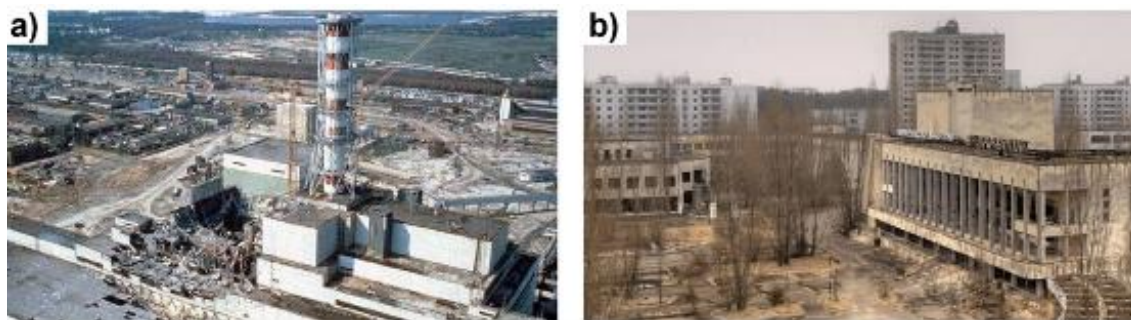
Source: photos in the public domain on the Internet:

a) https://zn.ua/energy_market/tolko-ruiny-.html; b) <https://olddnieper.org.ua/village/pidsinne/item/35-spohady-pro-zatoplene-selo>.

Around the destroyed nuclear power plant, a 30 km (19-mile) exclusion zone was created – a zone of forced resettlement of the population from settlements that suffered the greatest defeat. The exclusion zone within Ukraine in the north of the Kyiv region occupies an area of 365.45 thousand km. sq. There were 76 settlements in this territory, including Pripyat cities (the number of residents was 49.4 thousand people) and Chernobyl (16.7 thousand people). The total number of residents resettled to other settlements amounted to more than 90 thousand people (Baranovska, 2004). After 40-50 years, up to 60% of the area of the exclusion area will become suitable for living, but 40% of the zone, including the city of Pripyat, will remain contaminated with dead settlements for hundreds of years.

Another example of a large-scale technogenic disaster that caused the death of settlements is the accident at the Chernobyl nuclear power plant in 1986 (Figure 8). As a result of the explosion of the atomic reactor, almost the entire territory of Europe fell under the influence of radiation pollution, but Ukraine and Belarus were most affected. After 40-50 years, up to 60% of the area of the exclusion area will become suitable for living, but 40% of the zone, including the city of Pripyat, will remain contaminated with dead settlements for hundreds of years.

Figure 8. Consequences of the accident at the Chernobyl nuclear power plant. Collapsing Pripjat



Source: photos in the public domain on the Internet:

a) <https://armyinform.com.ua/tag/chornobylska-tragediya/>; b) <https://kulturologia.ru/blogs/210716/30551/>

3.4 Urban revival – modern challenges for Ukraine

3.4.1 Urbicide of Ukrainian cities.

Despite the aspiration of humanity after the sad experience of two world wars to become a globalized post-conflict society in the 21st century, the beginning of the third millennium turned out to be overshadowed by several powerful military conflicts and world-class terrorist acts. These are

the war on terrorism provoked by the September 11, 2001, terrorist attack, the wars in Iran, Iraq, Afghanistan, Yemen, and the civil war in Syria (Hale & Sadler, 2012).

The last powerful and bloody war is the war between Russia and Ukraine, which began on February 24, 2022, and continues to this day. It has already led to the death of hundreds of thousands of people, millions of both internal and external migration flows, the destruction of housing and public buildings, industrial and energy facilities, engineering and transport infrastructure, the destruction of entire cities and villages.

Unfortunately, it is precisely this stage of the recent history of Ukraine, when cities and towns are subjected to merciless, large-scale, and deliberate destruction of Russian troops, that can be called the “urbicide” of Ukrainian cities. Urbicide is a specific form of mass violence, the concept of urban destruction genocide, first described in post-Cold War studies during the Bosnian War of 1992-1995. Urbicide means “violence against cities”, at stake in which are thousands of destinies, a century of cultures falling into ashes and the urban way of life of human communities as such (Coward, 2008; Clements-Hunt, 2022).

From the beginning of Russia's military aggression in 2014 to 2022, 43,300 sq. km or 7% of the Ukrainian territory was under temporary Russian occupation, namely: the Autonomous Republic of Crimea, the city of Sevastopol and parts of the Donetsk and Luhansk regions. Since the beginning of the full-scale war, the maximum area of the occupied territories has reached 125,000 sq. km, or about 20.7% of the territory (see Figure 9), within which 3,649 settlements of Ukraine are located. During the year of full-scale war, 1,888 cities and villages have already been liberated (Report on the Direct Damage to Infrastructure from Destruction as a Result of Russian military Aggression against Ukraine for the Year since the Start of a Full-scale Invasion, 2023). Cities such as Mariupol, Irpin, Bucha, Kharkiv, Chernihiv, Severodonetsk, Rubizhne, Bakhmut, Maryinka, Lysychansk, Izyum, Volnovakha and others suffered the greatest destruction. For example, according to preliminary estimates, 75% of houses in Irpin are destroyed, 90% of the housing stock is damaged in Severodonetsk, and cities such as Bakhmut and Maryinka have almost no intact buildings (Figure 10).

Figure 9. Territories affected by negative factors for the existence of cities



Source: elaborated by the authors based on the map of the administrative division of Ukraine.

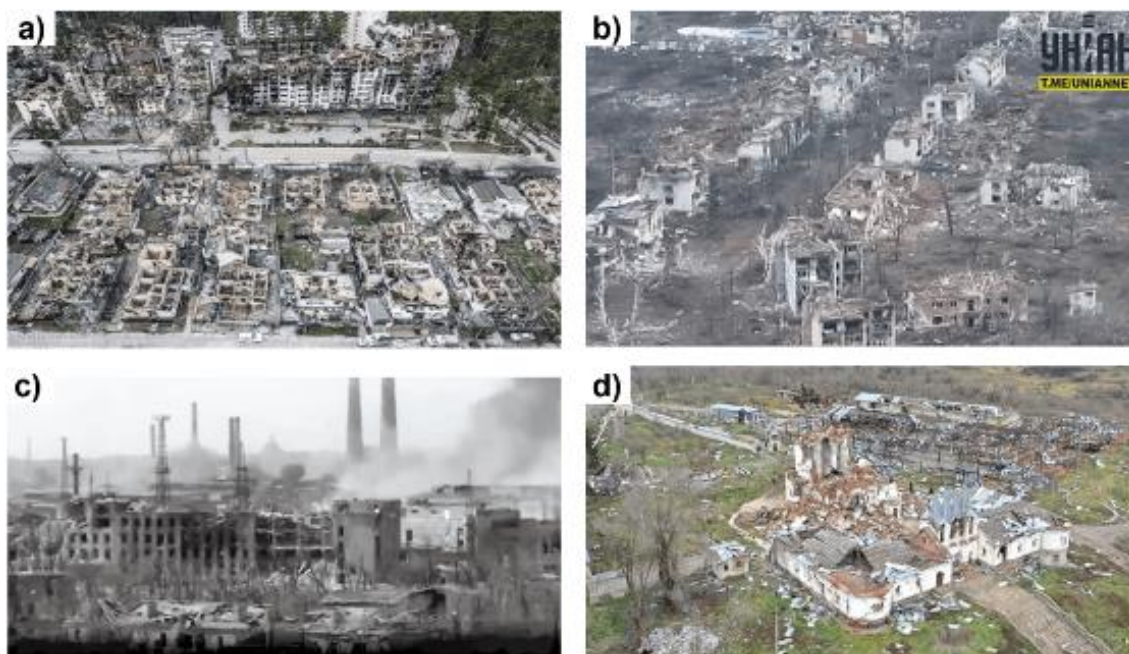
3.4.2 Possible directions of reconstructive activity for the restoration of Ukrainian cities

Based on the basic opinion that cities are complex socio-technical systems, where the main volumes of material infrastructure objects and the vital interests of millions of inhabitants are concentrated, it is the integrated approach to urban recovery that should be emphasized. It is the city complex reconstruction that should ensure its transition to a new round of evolutionary development.

Depending on the degree and type of damage and deterioration of urban subsystems, city reconstruction may include the following functionally oriented types of reconstruction (quantitative indicators are given according to the Report on the Direct Damage to Infrastructure from Destruction as a Result of Russian military Aggression against Ukraine for the Year since the Start of a Full-scale Invasion as of March 2023):

- Reconstruction of residential buildings – formation of a friendly living environment with a full range of service facilities. The total number of destroyed or damaged housing stock amounted to about 153.9 thousand buildings, including 135.8 thousand private (individual) houses, 17.5 thousand apartment buildings, which is estimated at \$53.5 billion or 37.3% of the total direct losses. More than 1,497 schools and 909 kindergartens were also affected (see Figure 10, a, c).
- Reconstruction of public buildings as a component of public centres that ensure the functioning of the city population service system. This type includes measures to restore destroyed administrative buildings (630 units), scientific facilities (213 units), health care facilities (1,216 units, of which 362 hospitals), culture (1,800 units, of which 703 houses of culture, 82 museum), tourism (164 units), sports (343 units), religious buildings (348 units), trade establishments (40,277 units). The amount of direct damage is about \$14.0 billion or 10.2% of the total.

Figure 10. Ruined cities of Ukraine. a) Irpin; b) Mariupol, Azovstal Metallurgical Plant; c) St. George Skete of the Holy Dormition Svyatogorsk Lavra; d) Bakhmut



Source: photos in the public domain on the Internet:

a) <https://www.dialogtut.org/uezzhajite-buchi-i-irpenya-ne-ostanetsya/>;

b) <https://www.pravda.com.ua/news/2022/05/3/7343824/>; c) <https://kulturologia.ru/blogs/210716/30551/>;

d) <https://svlavra.church.ua/2022/12/09/svyato-georgievskij-skit-v-s-dolina-v-nastoyashhee-vremya-foto/>

- Reconstruction of industrial territories – restoration, development, restructuring of objects of the industrial and production complex of the city in accordance with new technical and technological capabilities, changes in the economic conditions of society and the structure of employment of the population, the introduction of new forms of organization of economic activity (technoparks, technopolises, industrial parks, innovation centres). In total, more than 426 large and medium-sized enterprises were partially or completely destroyed (see Figure 10, b) as a result of hostilities (approximately \$11.3 billion).
- Historical and architectural reconstruction aims to restore the lost, preserve and actively include valuable cultural heritage in the life of the city. There are about 15.5 thousand objects of cultural heritage in the National Register of Cultural Heritage Objects of Ukraine. Of these, about 1.2 thousand are objects of national importance and 14.3 thousand are local. It is extremely difficult to estimate the amount of direct economic damage from these losses. According to World Bank estimates, the loss of immovable cultural heritage is tentatively estimated at more than \$900 million, movable – at \$200 million (Figure 10, d).
- Reconstruction of the road network and transport infrastructure of the city, which should ensure the functioning of the system of transport and pedestrian links between planning elements to minimize the time spent on movement, maximize comfort and traffic safety. Since the beginning of hostilities, 17,341 km of state and local roads, 7,717 km of communal roads (cities and other settlements), 344 bridges and bridge crossings, 19 civil and military airfields have been damaged; 126 railway stations and stations, which, according to preliminary estimates, is \$ 36.2 billion in direct losses on the transport infrastructure of Ukraine.
- Reconstruction of the engineering network system – restoration, reconstruction, and modernization of the engineering infrastructure (heat, water, gas, electricity, sewerage, etc.) considering the prospective development of the city and the requirements for saving energy resources. In recent months, engineering infrastructure facilities have been hit the hardest by Russian rocket attacks and are valued at \$8.1 billion.
- Landscape reconstruction. It includes the restoration and development of a system of public green spaces, recreational and resort areas based on the preservation and restoration of the historical landscape of the city. About 3 million hectares of forests in Ukraine fell into the war zone. The fires caused by this covered 7,109.1 hectares of forests. 105 thousand sq. km of soils, about 46 thousand sq. km of the area of objects of the natural reserve fund and the Emerald Network, which is 43% of the total area of these objects in Ukraine, have a high risk of damage and pollution.

Each individual type of reconstruction is an integral part of a holistic complex reconstruction of the city as a set of purposeful successive reconstructive actions to restore and ensure the further sustainable development of the city in accordance with the ever-growing socio-economic standards of society.

4. Conclusion

A generalization of the dynamics of urban development in the foreseeable historical depth allows us to assert that the urban life cycle covers several phases of development: from the emergence, through its functioning (formation, development, stabilization or stagnation) and to a possible, in some cases, final – death, disappearance in system of settlements as a result of a number of external and internal factors. An important phase of the city's life cycle is the phase of its reconstruction (revival) based on reconstructive activities. This article presents the results of a study of the place of reconstructive activity at different stages of the life cycle of Ukrainian cities as a driving force for their restoration, the formation of a comfortable urban environment and ensuring further sustainable development.

The transition from one state, one phase to another is accompanied by positive or negative qualitative and quantitative changes in the structure of the city with different dynamics (rates and

scales) of these changes. Analyzing the dynamics of the development of Ukrainian cities (through fluctuations in their population), we can draw the following conclusions:

1. A sharp increase in the population, as a rule, coincides with or at least entails an increase in urban development activity, mainly in the form of new construction in free territories and active reconstruction activities in relation to the existing subsystems of the city and the existing urban development. For example:
 - the first period (1860-1914) corresponds to the period of capitalist relations formation and mass construction of industrial and production enterprises in cities, which attracted the influx of the rural population into the cities after the abolition of serfdom,
 - the second period (1926-1940) corresponds to a similar process of socialist industrialization of the country,
 - third (1947-1980) – the period of the country's restoration after World War II and the beginning and deployment of mass industrial housing construction in cities.
2. A sharp drop in population, because of destructive wars, entails a slowdown in the functioning of all subsystems of the city, sometimes almost to their complete suspension. Selective reconstruction prevails, aimed primarily at eliminating emergencies and maintaining individual facilities (buildings and structures, engineering, and transport infrastructure, etc.).
3. Fluctuations in the city's population are closely related to the intensification or decline of urban planning and reconstruction activity to create an adequate material and immaterial infrastructure of the city and a comfortable urban environment.
4. Currently, Ukraine is in a state of catastrophic destruction of cities because of full-scale Russian aggression. Hundreds of cities and towns are experiencing crushing destruction, which can lead to their complete death and disappearance. At the same time, both the reconstruction of existing buildings and new construction on the territories cleared of the remains of the destroyed cities act as elements of the overall process of the comprehensive reconstruction of the city, as a continuous process of its existence.

Considering the events associated with the Russian invasion of Ukrainian territory, and the catastrophic destruction of Ukrainian cities, their buildings and infrastructure, the significance of reconstructive activity for the restoration of cities comes to the forefront. Design solutions for the restoration of cities that have suffered destruction or are in the stage of stagnation should be based on the following basic principles for the formation of a renewed urban environment:

- application of innovative solutions in the planning and development of cities being restored,
- preservation of the “genetic code” of the city – a complex of cultural heritage objects, the integrity of the historical environment, embodying a sustainable image of the city,
- optimization of the functional purpose of urban areas for the purpose of their effective use, taxation, and filling of local budgets,
- introduction of energy efficient technologies to ensure the functioning of the city and urban subsystems,
- development of the green space system, maximum environmental friendliness, and safety of the urban environment,
- formation of an inclusive urban space.

The formation of a harmonious urban environment based on the above principles will ensure the attractiveness and further sustainable development of Ukrainian cities.

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Author Contributions

All authors are responsible for the preparation, writing and editing of the article. The first author - development of the case study, preparation of the text. The second author performed the review, provided conceptual comments and references. The third author - data processing and production of graphic materials. The fourth author - writing and editing the text.

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Appendix A. General characteristics of the main cities of Ukraine (population more than 50 thousand people)

Region*	Locality name*	Founded, first mentioned**	Year of granting city status** / Magdeburg law***	Population, thousand people*
Autonomous Republic of Crimea	Simferopol	2st. BC, early 16th century	1784 / -	342.1
	Kerch	530 B.C.	1821 / -	151.5
	Yevpatoria	497 B.C.	1784 / -	108.2
	Yalta	1154	1837 / -	74.1
	Feodosia	355 B.C.	1787 / -	68.0
Vinnytska oblast	Vinnytsia	1355	1640 / -	370.6
Volynska oblast	Lutsk	1000	1085 / 1287	217.2
	Kovel	14th century	1518 / 1518	68.0
	Novovolynsk	1951	1957 / -	50.4
Dnipropetrovska oblast	Dnipro	1776	1776 / -	980.9
	Kryvyi Rih	1775	1775 / -	612.8
	Kamianske	1750	1923 / -	229.8
	Nikopol	1644	1915 / -	107.5
	Pavlohrad	1779	1784 / -	103.1
	Novomoskovsk	1576	1688 / -	70.2
Donetska oblast	Donetsk	1869	1917 / -	905.4
	Mariupol	1778	1779 / -	431.9
	Makiivka	1690	1917 / -	340.3
	Horlivka	1779	1932 / -	242.2
	Kramatorsk	1868	1932 / -	150.1
	Sloviansk	1676	1794 / -	107.0
	Yenakiieve	1782	1925 / -	77.1
	Bakhmut	1571	1783 / -	72.3
	Kostiantynivka	1870	1932 / -	68.8
	Pokrovsk	1875	1938 / -	61.2
	Khartsyzk	1869	1938 / -	56.4
	Druzhkivka	1781	1938 / -	55.1
	Chystiakove	1778	1932 / -	53.7
Zhytomyrska oblast	Zhytomyr	884	1884 / 1444	263.5
	Berdychiv	1430	1845 / -	74.0
	Korosten	1589	1926 / r1589	62.3
	Zvyagel	1257	1795 / late 16th y	55.5
Zakarpatska oblast	Uzhhorod	1154	1430 / 1430	115.5
	Mukachevo	896	1445 / 1445	85.9

Zaporizka oblast	Zaporizhzhia	1770	1806 / -	722.7
	Melitopol	1784	1842 / -	150.8
	Berdiansk	1827	1835 / -	107.9
	Enerhodar	1970	1985 / -	52.9
Ivano-Frankivska oblast	Ivano-Frankivsk	mid-15th century	1662. / 1662	237.9
	Kalush	1437	1549 / 1549	65.8
	Kolomyia	1245	1405/ 1405	61.1
Kyivska oblast	Bila Tserkva	1032	1589 / -	208.7
	Brovary	1120	1630 / -	109.5
	Boryspil	1015	1956 / -	63.7
	Irpin	1648	1956 / -	62.5
Kirovohradska oblast	Kropyvnytskyi	1754	1784 / -	222.7
	Oleksandriia	1754	1784 / -	77.3
Luhanska oblast	Luhansk	1795	1882 / -	399.6
	Alchevsk	1895	1932/ -	106.6
	Sievierodonetsk	1934	1958 / -	101.1
	Lysychansk	1710	1938 / -	95.0
	Khrustalnyi	1895	1926 / -	79.8
	Kadiivka	mid-19th century	1932 / -	73.7
	Dovzhansk	1938	1938 / -	63.0
	Antratsyt	1895	1938 / -	52.4
Lvivska oblast	Lviv	1235	1336 / 1356	721.5
	Drohobych	1091	1422 / 1422	74.6
	Chervonohrad	1692	1434 / 1448	65.2
	Mykolaiv	1385	1431 / 1460	59.6
Mykolaivska oblast	Mykolaiv	1570	1789 / -	476.1
	Pervomaisk	1765	1920 / -	63.4
Odeska oblast	Odesa	1324	1794 / -	1 015.8
	Izmail	1589	1830 / -	70.7
	Chornomorsk	18th century	1973 / -	58.5
Poltavska oblast	Poltava	899	1174 / 1752	283,4
	Kremenchuk	1571	1649 / -	217.7
	Horishni Plavni	1960	1972 / -	50.4
Rivnenska oblast	Rivne	1283	1492 / 1492	245.3
Sumska oblast	Sumy	1652	1780 / -	259.7
	Konotop	1634	1648 / -	84.8
	Shostka	18th century	1924 / -	73.2
Ternopil'ska oblast	Ternopil	1540	1548 / 1548	224.0
Kharkiv oblast	Kharkiv	not exactly known	1654 / -	1 433.9
	Lozova	1869	1939 / -	54.0
Kherson oblast	Kherson	1737	1778 / -	283.6
Khmelnyskiy oblast	Khmelnyskiy	1431	1566 / 1568	274.6
	Kamianets-Podil'skiy	late 12th century	1374 / 1374	97.9
Cherkasy oblast	Cherkasy	13th century	1795 / 1791	272.7
	Uman	1616	1795 / 1663	82.2
	Smila	1542	1793 / 1773	66.5
Chernivtsi oblast	Chernivtsi	12th century	1488 / 1488	265.5
Chernihiv oblast	Chernihiv	907	1623 / 1623	285.2
	Nizhyn	1078	1625 / 1625	67.0
	Pryluky	1085	1582 / 1582	52.6
Kyiv	Kyiv	5th century	1494 / 1494	2 962.2
Sevastopol	Sevastopol	1783	1783 / -	403.9

Source: elaborated by the authors using data: *Statistical Yearbook of Ukraine for 2020. (2021). State Statistics Service of Ukraine. Kyiv, 453. https://ukrstat.gov.ua/druk/publicat/kat_u/2021/zb/11/Yearbook_2020_e.pdf; **Information of the official sites of the respective cities; *** Settlements of Ukraine Granted Magdeburg Law.

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