Principles and strategies of sustainable development of regions

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Summary. To determine the principles and strategies of sustainable development the analysis of general trends in human development in ecophysical sense of this phenomenon were made. The following concepts were considered: ethnogenesis, ecosystem autoregulation, demographic and dynamics of urban development. The comparative analysis of general trends in ethnic-, eco-, demo- and urbosystem testified that based thermodynamic model, results in successive changes of phases and phase transitions. The notions of ethnic homeostasis", "stable population" and "balance in urban areas" expose the essence of the phenomenon of "ecological balance" in public and environment interaction. The considered development is an oscillatory process, where the criterion of “best” is excluded, where only the rhythm of change conditions, with more or less intensity, speed and capacity development exist. It is established that the regularity of self-regulation defines the development of urban areas as the environmental and urban systems. In this regard the development of these areas is purposeful and predictable and therefore is a manageable process with a given goal – the sustainable development in a range of ecological balance. The equilibrium is described by a ratio of 1:1 between population size and demographic capacity of the territory.

Key words: sustainable development, self-regulation ecosystem, ecological balance, demographic capacity, environmental and town-planning system.

INTRODUCTION

The achievements of conditions of sustainability of environmentally sound development, after the UN Conference on Environment, gained the characteristics of guiding humanitarian activities of the international community. The problem is actual for Ukraine, where the depopulation is taking place along with the further growth of urban areas. Today the sustainable development is generally interpreted by the definition, provided in the report of the UN Commission of the Environment "Our common future" (H. Brundlandt, 1989): "... is a development that allows to ensure steady economic growth for long-term basis and that does not lead to degradation changes in the environment; the access to the level of sustainable development designed to meet the needs of both current and future generations ..." [1, p. 4]. The economic orientation of the modern ideology of sustainability is defined from the abovementioned. However, there is another opinion.

According to the "Limits to Growth" (D. Meadows, 1972) – first report for "the Roman club", the world development is defined differently at different stages. Firstly - by the established quantitative growth of system’s parameters (population, consumption of natural resources that is not renewed, food and commodity industries, pollution), then – by a global resource crisis and the inertia period of population growth in a worsening economic and environmental crises, and as likely result – a global demographic collapse. The conclusion of the report is warning mankind about environmental constraints of

economic growth because of the limits of growth and the need to support (in these limits) of global equilibrium, which is possible only after stabilization ("zero" growth) of population and capital [2].

And here the difficulties begin, because the terminological ambiguity of the concept essence of "sustainability" nullifies the efforts of management in this area. As we know from physics, some definitions have made a great change to the meaning of this theory. Enough to remember the famous example of “simultaneity" definition in classical physics and relativity. Ambiguity in the concept of "sustainability" (quantitative growth – development within certain limits) is a consequence of the modern state in science, where a change of paradigm thinking takes pace. In this respect, the Director of the Institute of European Environmental Policy Ulrich von Vaytszeker notes that "we live on the eve of a new paradigm, so the economic paradigm will soon give way to environmental one” [3, p.27]. The ecological crisis of depletion of planet resources makes the international community to abandon the quantitatively oriented economic paradigm of our time, which comes from the desire to increase consumption of as many people as possible and move to environmental, quality oriented paradigm which is based on the need to ensure the survival of humanity as a biological species in an environment that is influenced by his activities and life support functions which due to depletion of natural resources may be inadequate with the needs and possibilities of adaptation [3-5].

The status defined in the social sciences of the early twenty first century resembles the situation in physics of the early twentieth century when there was a change of its conceptual frameworks and classical physics was complemented by quantum one. In these conditions the finding of appropriate conceptual foundations of the adoption of national and regional sustainable development programs becomes very important. To determine the required principles and strategies the comparative analysis of general trends of ecophysical development of ethnic, environmental, demographic and urban systems of various levels of hierarchical integrity was conducted.

MATERIALS AND METHODS

The aim of the study is to develop a methodology for urban management for sustainable development of the territory. The method of analogy was used as the base, which allows not to experiment with the system, a part of which is the man himself.

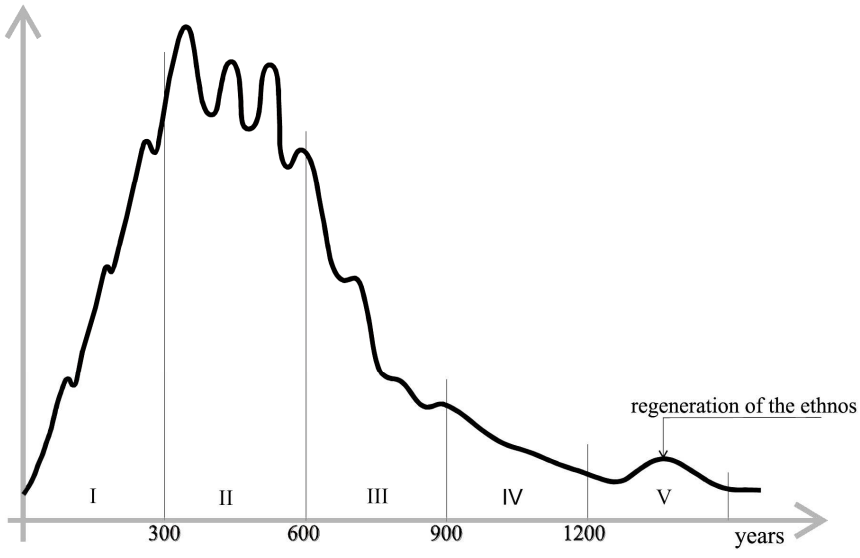

Fig. 1. The ethnogenesis by L. Humelov: *I – V* – phase of ethnogenesis

ETHNO-, ECO-, DEMO- AND URBO-GENESIS IN THE CONTEXT OF PHYSICAL THEORIES

According to the ethno genesis concept of L. Humyelov, the life cycle of ethnic (Fig. 1), consists of the next sequence of stages: growth (Phase *I*), strained stabilization (*II*), decay (*III*, *IV*) and revival (*V*). This cycle usually lasts for 1000-1200 years. However, in our accelerated time the USSR passed the stage for 74 years. At the end of the cycle ethnicity either disappear because of depopulation or divide into several ethnic groups, or enter the phase of homeostasis (*V*), which can reach and ethnic regeneration [6].

The environmental theory. The regularity of self-regulating ecosystems was experimentally established, according to which the population of any species can quickly increase their quantity in favorable environmental conditions (Fig. 2) *I* stage [7].

Due to the inertia the quantity exceeds the environment capacity (*I*, *a)*, which causes the ecological crisis and environmental degradation. During the crisis (*II*) the environmental conditions become unfavorable for the quantity growth which causes its decline to a level lower than the capacity (*III*). There comes a depopulation during which the environment gradually restores. His conditions become favorable (*IV*) again, and as a result the quantity rises (*V*). The population can enter into a phase of stabilization (*VI*) – a state of dynamic ecological equilibrium, subject to the slower growth in population. In the equilibrium state (in balanced and environmentally sustainable development) the existence of populations in the area subject to fluctuations in its quantity in the proper range of ecosystem sustainability by self-healing resources environment is possible in conventionally infinite time [4, 5].

This phenomenon, called "demographic transition", acknowledges our humanity. This event firstly manifests in the sharp increase of population, then in equally rapid decrease and stabilization of its quantity (Fig. 3).

Demographic transition is accompanied by economic growth, urbanization and aging of population. This transition has already culminated in developed countries and is completing in developing countries nowadays. As a result of the transition a new mode of human development should appear [8].

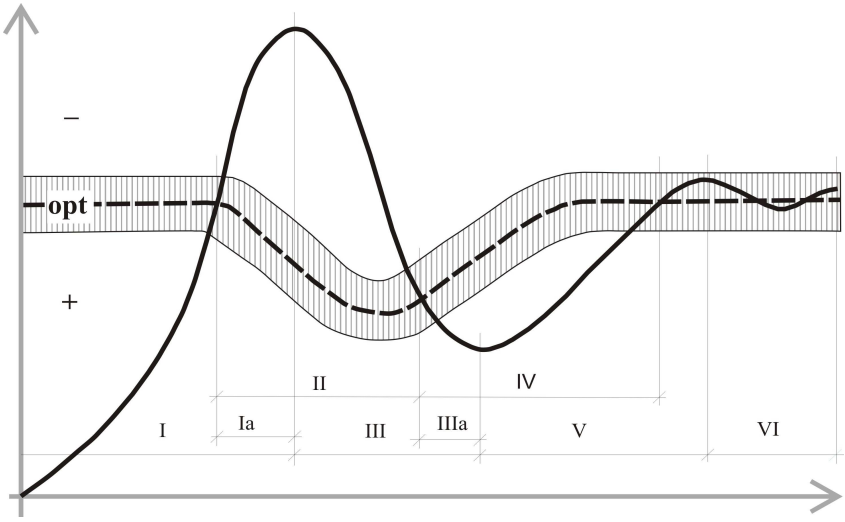

Fig. 2. The self-regulation ecosystem by V. Dolnyk:
I-VI – stages of ecosystem population capacity of the environment range of equilibrium,
—— – population,
- - - – capacity of the environment,
||||||| – range of equilibrium,
± opt – quality of environment

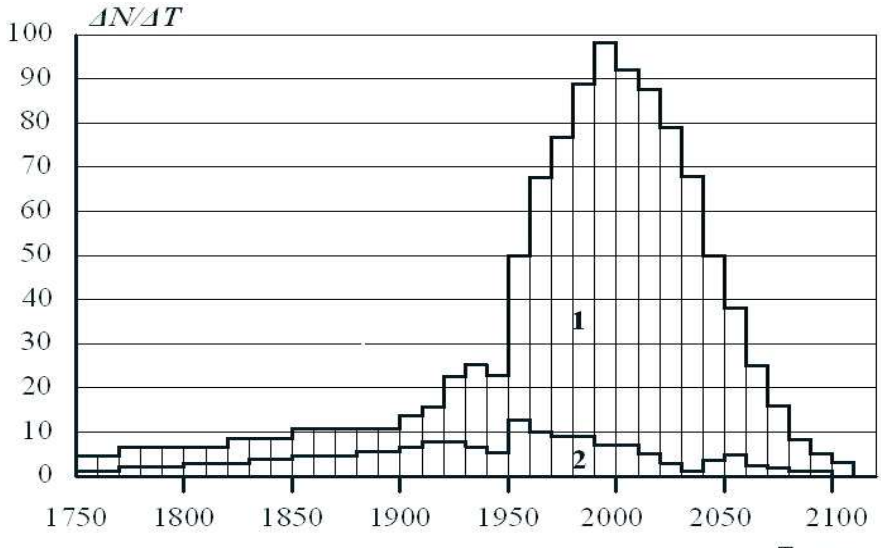

Fig. 3. Demographic transition, according to the UN:
1 – developing, *2* – developed countries

The concordant development stages were highlighted by Dzh. Forester in his investigation of dynamics of city development, as the social system, located in the"... endless external environment" [9, p.13, 14, 26]. According to his results, the urban areas (a system where people, business and housing interact) are a self-regulating system that tends to the equilibrium [9, p.118, 139]. Thus, when the city passes its 250 year cycle (from growth and through stagnation to the balance) its structural and functional elements will undergo qualitative and quantitative changes (Fig. 4) [9, p.15, 16].

The comparative analysis of general trends in ethnic-, eco-, demo- and urban systems showed that all models have the stages of rapid growth, resource crises, decline and stabilization, accompanied by consistent changes in terms of development and population. That means that the development based on single thermodynamic model, which results in successive changes of phases and phase transitions. The concept of such notions as "ethnic homeostasis", "stable population" and "balance in urban areas" expose the essence of a single phenomenon – the ecological balance in the interaction between population and environment. The development of considered

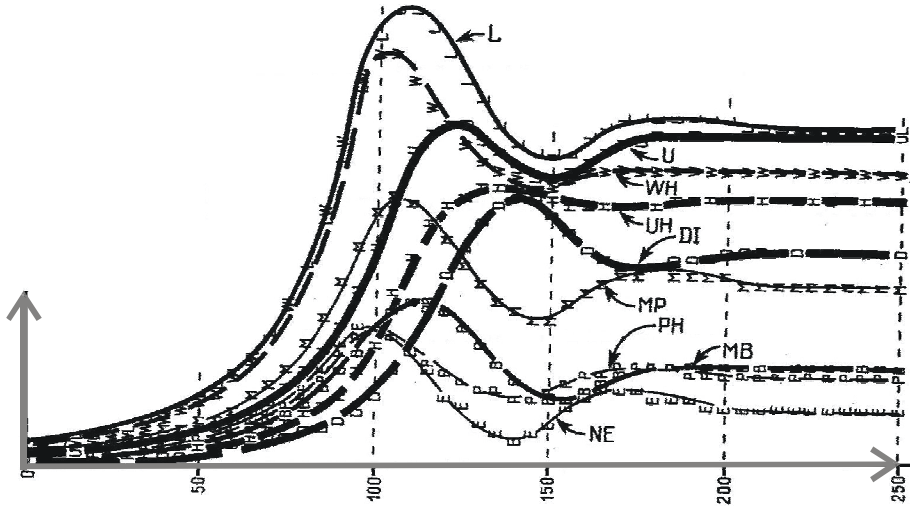

Fig. 4. The city development by Zh. Forester

systems is an oscillatory process, where the criterion of "best" is missed but the rhythm of states' change exist as well as more or less intensity, speed and capacity development

Concerning the quantification of the definite potential, which exists due to the nature of interaction between population and environment, it should be noted that the total extent of interaction is the energy (*enérgeia – action, activity,* from the Greek). As known, there are two "great formula" definitions of energy in physics. The first one is Einstein's formula, according to which the energy increases together with increasing body mass: $E = mC^2$. The second one is Planck's formula, according to which the energy increases together with increasing frequency radiation: $E = h\nu$ [10]. And reference to physics here is not random [11-14]. If carefully consider graphs on Fig. 1…4 one can notice that the dynamics of the initial stages of development of comparable systems is similar to the law of energy growth $E = mC^2$. The dynamics of the last stages can be compared with the law of energy growth $E = h\nu$. This inference coincides with the phenomenological theory of S. Kapitsa [8].

The analogy of the relativism in physics. According to S. Kapitsa research, the world's population grows in explosive, hyperbolic manner (Fig. 5) [8].

In both cases the growth laws are nonlinear with escalation mode. The theory of relativity covers the escalation of speed, and the phenomenological theory covers the escalation of time (2012 – 2025 years). The growth of world population always follows the quadratic law and at the late time period of explosive growth the critical period of changing paradigms and development strategies arose. The transition to a new paradigm should lead to profound qualitative changes in outlook and a new strategy for human development [8]. The similar results were obtained in the Institute of Applied Systems Analysis of Academy of Sciences of Ukraine (Fig. 6) [15].

According to M. Zgurovsky, in the period from the 705 year BC to the present, the world development had six waves of system world conflicts, the duration of which decreases and intensity increases according to a hyperbolic law. The ratio of wave length fluctuates around the "golden ratio" and their flow subordinates to the law of element changes of Fibonacci series [15]. The seventh wave, or "the

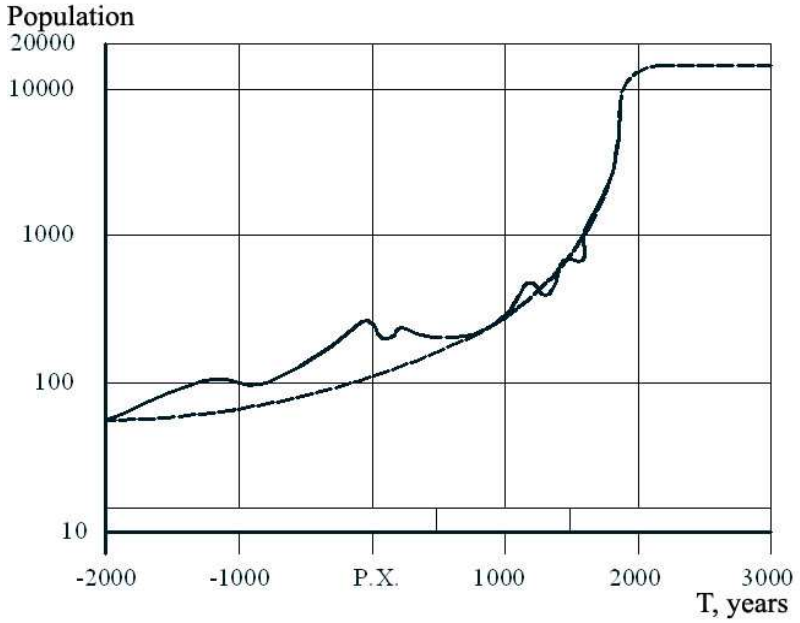

Fig. 5. Mathematical model of growth of world population by S. Kapitsa

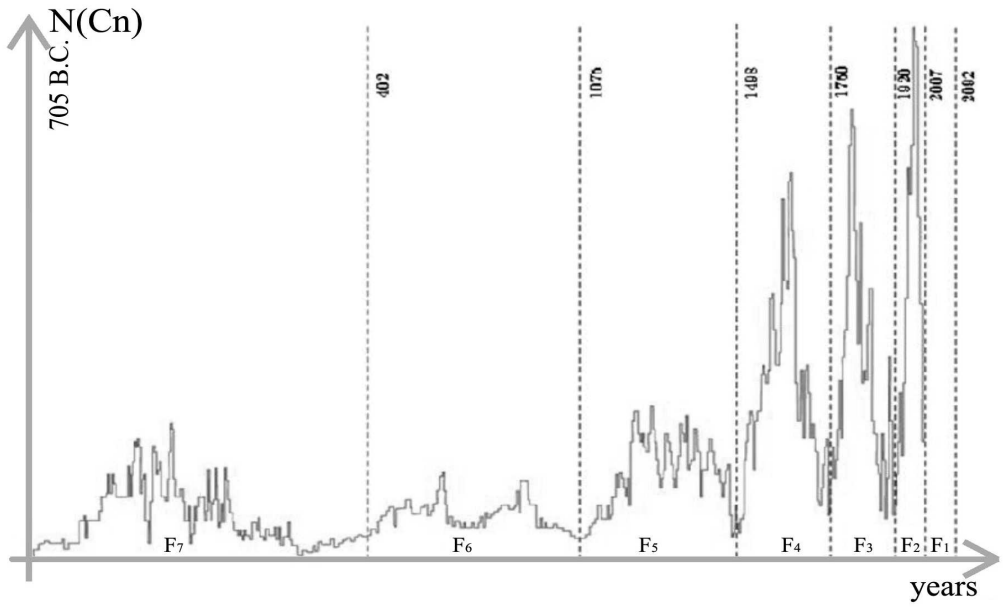

Fig. 6. Wave of global system conflicts by M. Zgurovsky

conflict of XXI century" may have (if the time will allow) the interval from 2010 to 2092 year [15]. However, when $n > 6$ for C_n the conflicts waves, the Fibonacci sequence degenerates. Naturally the next question arises: what might happen to humanity? Maybe, it's a final cycle of a series of evolutionary and therefore "...the historical time is compressed in an exceptionally short interval..." [8].

Concerning the quantum analogy it must be mentioned that the time "compression" during the demographic transition leads to "docking" of relativistic and quantum mechanics. By S. Kapitsa, the transition to quantum knowledge occurs when a continuous change of the system is determined by quantum conditions. In the case of "... increasing population it happens when the time of system change becomes a characteristic of the man ..." [8]. When growth rate for generation is compared with the population of the world, the growing self-similarity is violated, the demographic time-dependent system acquires a critical condition and there is a transition from the hyperbolic mode of development with particular reference to the other (may be macro quantum). The mathematical analysis of S. Kapitsa shows that after the transition the stabilized development of humanity becomes asymptotically stable [8].

PHYSICAL PARALLELS OF URBANIZATION AS ECOLOGICAL PHENOMENON

From the foregoing appears that quantitative growth is peculiar only for early stage of development of ecosystems on which they spend almost all available flow of energy [4]. These define the coincidence of economic growth goals and interests of "young" ecosystems. The stabilization of quantified growth and adaptation to development in the context of limited resources is favorable for "mature" system. At this stage, which, as already mentioned, can last indefinitely time, the quantitative growth strategy can be changed by the strategy of maximum preservation of ecosystem integrity. Now almost all available flow energy is expended for the ecosystem support [4]. At this point the economical becomes environmental [5]. Therefore the existence of two definitions of sustainability is not random. An economic understanding of sustainability reflects the tendency of quantitative increase of ecosystems in their reserve capacity. An ecological conception – is the tendency for transformation in depletion capacity. Behind the ambiguity of ide-

ologies of sustainability and changes of thinking paradigms, the reversibility of stages in the oscillatory cycles of ecosystems is hidden.

The management strategies. It should be noted that solving environmental problems today is complicated by the fact that "ecology" is usually understood as "environmental protection" and the avalanche of information concerning environmental pollution and degradation hide the knowledge about how nature arranged and processes that make it suitable for life. Consideration of general trends of ecosystem development at different levels of their structural and functional integrity: from individual cities and ethnic groups to humanity as a whole, showed some parallels with the processes that belong to "different physics" [11-14].

Within the subject-based knowledge, Physics is the science of nature; biology – is the science of wildlife ecology, in the literal sense – the science of organisms that studies the properties and establishes principles of joint interaction between living and inanimate nature [4, 5]. That means that ecology is a "great union theory" of biotic and abiotic interactions [12-14]. Physical theory, which seeks an unified basis to describe all four fundamental physical interactions (strong, weak, electromagnetic and gravitational) was called as a theory of super symmetry, or "super gravity theory" [16].

According to V. Vernadsky, the global ecosystem of Earth is in a state of dynamic equilibrium and is characterized by slow change of its system settings [17]. The same postulates and modern physics, according to which "... the stability of the main structural elements of the Universe – nuclei of atoms, stars and galaxies – are very critical regarding to the numerical values of constants", relatively small changes of which "could lead to the formation of a qualitatively different world in which, in particular, the formation of life would not be possible..." [16].

As found, the pattern of self-regulation determines the development of urban areas [9, 11]. In this aspect, the territorial development becomes focused and projected, and, therefore, controlled processes with a given goal –the sustainable development in a range of ecological balance [12-14].

The equilibrium is described by the ratio of symmetry – a ratio of 1:1 between population size and capacity of the environment (10% in the allowable range of deviation [5]). Same 1:1 ratio is a fundamental dimensionless constant of strong interactions in physics [16].

Concerning the weak interaction, which is responsible for radioactive decay of nuclei and moderate burning sun (the energy source and driving force of ecosystem) it must be mentioned that during the period of demographic transition the synchronization of human time leads to growth breach. The excessive nonstationary near the moment of escalation leads to stochastic "radioactive" decay complex structures threats [18].

The gravity. In the ecological theory the process of urbanization is similar with the strategy of creation of safe settlement, according to which, the gathering in a natural place covers its benefits in the form of increased viability of the group (defined by cooperation) and its disadvantages in the form of stress (caused by oversaturation, increased competition for resources protection, pollution and degradation) [4]. According to the principle of ecologically optimum density, the lack of population is unfavorable for the stability of populations, as well as his congestion [4, 5]. Therefore, urbanization is favorable for the population only in a certain range, frames of which depend on the demographic capacity of the environment (according to the Law of Ukraine "On Environmental Protection" – Article 51, 59, a demographic definition of capacity is required in planning urban and regional development).

This postulates the anthropological principle of modern physics, which requires the average density of matter in the Universe to be close to the critical $\rho \approx \rho_{cr}$. When $\rho \ll \rho_{cr}$ the condensation of matter in stars and galaxies cannot exist, and when $\rho \gg \rho_{cr}$ the lifetime of Metagalaxy could be so small that it has no time to develop life [16]. Thus, the anthropological principle and the principle of ecological optimum are essentially identical.

"Strangely enough, but the biological evolution and the evolution of the Universe have much in common. The formation of biological species and the creation of planets – are the creation of new information... The competition and natural selection are typical for alive and lifeless nature. The gravity discontinuities that signal the formation of stars and planetary systems compete with one another for condensed material" [16].

The surrounding areas compete with the cities for the population in convergent manner: "...when the city has more favorable conditions than the environment then it will concentrate people and commercial activities" [9]. The flow of people in the city "... will continue until overpopulation appears. Being unable to cope with overcrowding, the city will lose its appeal..." [9]. And here the other cities, regions, countries begin to "compete" for its people [14].

In the environmental aspects the increase of quantity reduction corresponds to the exhaustion – the restoration of the demographic capacity. In urban plane, this process can be identified in increasing – decreasing of population density. In an ecological sense the favorable conditions for economic recovery are caused by environment capacity reserve and "lack of territory populousness"; at the same time the unfavorable conditions are caused by the exhaustion of capacity, its overpopulation. Some favourable conditions have a certain "magnetism" that attracts people and leads to more quantity (natural, mechanical). Accordingly, the adverse conditions "push away" the population, which results in reducing of quantity [12, 14].

The electromagnetism. Exploring the properties and mathematically describing trends in urban areas as environmentally urban systems (EUS), some overlap in the frequency of changes of key parameters and other physical wave natured quantities are established [10, 12].

It may seem that the pendulum swings is not similar with a capacitor discharge through the coil inductance, and, especially, with ecodynamics of regional development. However, the urboecological processes, mechanical and electromagnetic waves are subject to the same quantitative laws. The determined fact comes to light when interested not in thing that vary (spring-load, the electric current in a circle or population of some region) but in sense of fluctuations. Similarity refers not to the nature of values, which change periodically, but to the processes of their changes [10, 18].

During the EUS stages development the ratio of capacity and population (C/P) periodically changes as well as the population dynamics (ΔP) (see Fig. 2). The body (mounted on a spring) free of mechanical vibrations periodically changes its coordinates (x) and projection speed (v_x), while electromagnetic – capacitor charge (q) and current intensity (i) (Fig. 7) [10].

The inanimate physical systems are balanced. In equilibrium, they are displayed: in mechanics – through rejection; in electrical circuit – through the process of capacitor charging. The living systems are not balanced at first, but their goal is to achieve a balance through the development [4-7]. Returning the body on spring to its equilibrium caused by elastic force ($F_x = -kx$), which is proportional to the body displacement from equilibrium position. The aspect ratio here is the spring stiffness (k). The capacitor discharge (current occurrence) is caused by the voltage (u) between capacitor plates, which is proportional to the charge (q). Because ($u = q/C$), then the aspect ratio here is the reciprocal capacity ($1/C$) [10].

The development of some area leads to the exhaustion of its demographic capacity and population growth, which can be compared with the discharge capacitor and the advent of electric current in a circle. The population growth is caused by the reserve capacity (availability of resources opportunity in the environment to fit and feed a number of stable populations [6, 7, 11]). So the population growth is caused by the kind of voltage – the difference of potentials between the possible ecological (capacity) and implemented demographic (population) potential of the territory. The return to the EUS equilibrium can be caused by resistance of environment

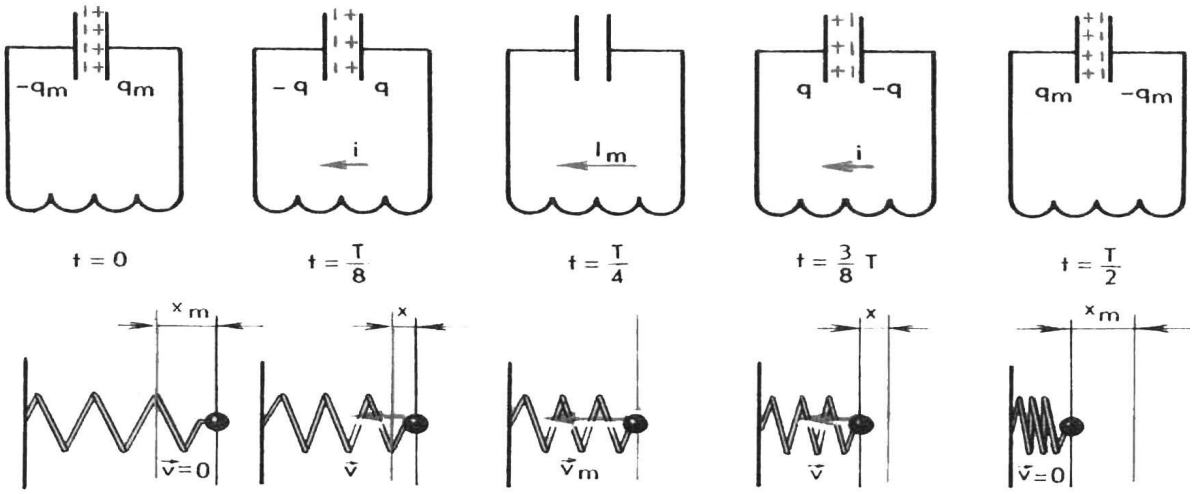

Fig. 7. The analogy between mechanical and electromagnetic fluctuations

(1-*P/C* [4]). This resistance is generated by a kind of inductive growth and increases when the number of dimensions approach and exceed the dimensions of the container. The aspect ratio here presented as correlation (*1/C*), which defines the "tightening of environment" [4]. The above mentioned appears as variability of small and relative constancy of large ecosystems [4, 5]. A gradual increase of urban territorial boundaries of the object (from city, urban area to the regions, their groups and of countries' territories) is a kind of "regulatory mitigation" of Human Environment by town planning measures.

Due to inertia, the body only gradually increases the speed under the force and this speed is not immediately becomes equal to zero after the termination of the force. Similarly, and electric current in the coil, through the self-inductance, increasing gradually under tension and does not disappear immediately when the voltage becomes equal to zero (see Fig. 7) [10]. Similarly, the population in favorable environmental conditions that caused a stock tank, gradually increases and decreases (stabilized) immediately when the capacity is low (see Fig. 4). The time delay in the growth-decline processes in favorable-unfavorable environmental conditions is caused by the inertia of EUS. The above mentioned procedures delay is inherent for all populations with complex life cycles and long-term individual development [4].

So circuit inductance (L) performs the same function as the body mass (m) in mechanics, in EUS its counterpart is the population (P). Accordingly, the kinetic energy of the body ($mv_x^2/2$) corresponds to magnetic field energy supply ($Li^2/2$) and realized energy EUS ($P_\Delta P^2/2$). The charging capacitor corresponds to the message body, which is sealed with spring by a potential energy ($kx_m^2/2$) at its shift from equilibrium position at (x_m) distance. In the capacitor this energy corresponds to the energy of the electric field ($q_m^2/2C$) [10]. In the phenomenon of self-regulation the initial coordinate (x_m) corresponds to the final – target parameters of environmentally safe, balanced and sustainable development of the EUS – the maximum number of its stable population (P_m), which is determined by the demographic dimensions of capacity (C). The considered compliance is listed in Tab. 1.

Table 1. The analogy between indicators of environmental and urban systems (EUS), echanical and electrical quantities

Mechanical	**Electrical quantities**	**Indicators of EUS**
mass (m)	inductance (L)	population (P)
coordinate (x)	charge (q)	capacity = maximum number of stable population ($C=P_m$)
speed ($v_x= x'$)	current ($i = q'$)	population dynamics ($_{\Delta}P$ *or* P')
acceleration ($a_x= x''$)	electromagnetic waves in the circuit ($q''= - q /LC$)	growth-rate decline ($_{\Delta}P'$ *or* P'')
elastic force ($F_x= -kx$)	resistance circuit *(R)*	environment resistance ($1 –P/C$)
spring stiffness (k)	reciprocal capacity ($1/C$)	stiffness of environment ($1/C$)
potential energy ($k x^2/2$)	electric field energy ($q^2/2C$)	potential «electric» energy $(C/2)^1$
momentum ($mv_x^2/2$)	energy magnetic field ($Li^2/2$)	implemented «magnetic» energy $(P_{\Delta}P^2/2)^2$

Notes.

1. Agreed with data of Y. Odum: "Optimal maintenance capacity that can be stored for a long time, despite the whims of the environment, below the theoretical limit, perhaps by 50%" [4, part 1, p.180].
2. May explain some mentioned attractiveness of urban areas.

Therefore, the area is a kind of “natural solar power capacitor”, which has a certain maximum charge (q_m) or demographic capacity (C). The moment when the capacitor discharge ($q = 0$) and reaches maximum strength of current (i_m), corresponds to passage of the body that is sealed with spring because of an equilibrium with maximum speed (v_m). Then the capacitor starts to recharge ($+ q \rightarrow -q$), and the body – rotates in the opposite direction. After a half period ($T/2$) the capacitor will fully recharge ($+q_m \rightarrow –q_m$) and the power supply will be equal to zero ($i = 0$).

This condition corresponds to the deviation of the limit in respect of the original, where his speed becomes equal to zero (see Fig. 7). The overcharging capacitor corresponds to changing parameters of stock – exhaustion of capacities and characteristics of area’s quality (±). When environmental conditions become “rechargeable” and environmentally unfavorable, the population’s dynamics first becomes equal to zero ($_{\Delta}P = 0$), and then enter the negative values ($_{\Delta}P < 0$) (see Fig. 2).

If there was no loss of energy, the oscillatory process in electrical circuit would have been a long term lasting and fluctuations would have been undamped. The defined notion is similar with the above mentioned definition ecological balance. In fact, the energy loss is inevitable. They are caused by the resistance circuit, in which the electromagnetic field of energy conversion in internal energy of conductor. In the absence of resistance, the total energy of the electromagnetic field can be kept [10]. And here is one more appropriate analogy. It is known that electromagnetic waves exist because the variable magnetic field generates an alternating electric field and vice versa [10].

As noted, each territory has a certain demographic capacity, which causes growth stock, and exhaustion – population decline (and it probably creates a kind of "wave of development" (see Fig. 1-6). For development purposes the territory's capacity usually exhausted – "the condenser is running out", and population size, number and attractiveness of cities increases (to a certain limit). A kind of conversion of potential energy of the region occurs in the realized power of its cities, which become "crystallized" over time in space. So the "electric field" of the region generates the "magnetic field" for the network of its populated cities. By analogy with a total energy of the electromagnetic field ($W = \mathrm{Li}^2/2 + q^2/2C = q_m^2/2C = Li_m^2/2$, Table 1 [10, p.28]), total energy of the EUS can be defined as follows:

$$W_{EUC} = P_{\Delta}P^2/2 + C/2 = C = P_{\Delta}P_m^2/2.$$

The foregoing is consistent with the main postulate of relativity, according to which, in all inertial frames of reference all processes flow equally and in all such systems the physical laws have the same form [10]. The determined facts point to the possibility of scientific forecasting, planning and purposeful management of development in urban areas.

CONCLUSIONS

The above mentioned similarities show that.

1. The self-regulation ecosystem, which is similar to "self-inductance of space-time development", characterized to the development of urban areas as environmental and urban systems;

2. The environmental problems of urbanization is a natural stage of a life cycle of oscillatory population of the ecosystem environment that strives for equilibrium – the main conditions of sustainable development, goals and the final phase of a cycle that can last indefinitely in time before a new cycle develop to another level of its hierarchical integrity;

3. The super complex ecosystems are stable. To maintain its integrity and periodically overcome the tendency to stochastic decay, they must exist in the vibrational mode, which allows the braking processes and establish the overall rate of development of components within these systems;

4. In the ecodynamics of the region, in any oscillatory process, the criterion of the "best" is absent. There is only rate changes states, more or less voltage, speed and capacity development, which is determined by its ecological age and environmental parameters of stock- depletion of demographic capacitance;

5. In the ecophysical context the urbanization phenomenon has some features of "super gravity", which also combine four fundamental physical interactions.

6. The Strategies for sustainable spatial-temporal development of urban areas (about 70% of Ukraine's population and over half of the world's population lives in cities) are proposed to build on the principles of conformity: the development phases (primary – growing, the ultimate – that transformed) and the territorial integrity of the ecosystem of the population-environment, which is regulated (region, country); economic programs and environmental development strategies that vary in time and measurements of the capacity due to the territory; the rate of fluctuation of population-environment ecosystem and its structural components – territorial, economic, social, demographic and urban systems.

Based on the abovementioned, the national and local strategies of environmentally safe, balanced and sustainable development is proposed to develop in view of potential of natural regions' growth of "young ecological age", which have a demographic stock capacity [19]. These regions were found during the study of possibilities, directions and parameters of sustainable development of Ukraine (Fig. 8).

The ecological age and potential of "mosaic asynchronous development" of its regions, as eco-urban city systems, are defined on the basis of comparison with the population demographic parameters of their capacity (calculated by the method of the author). These defined the possible regionalization of the territory and

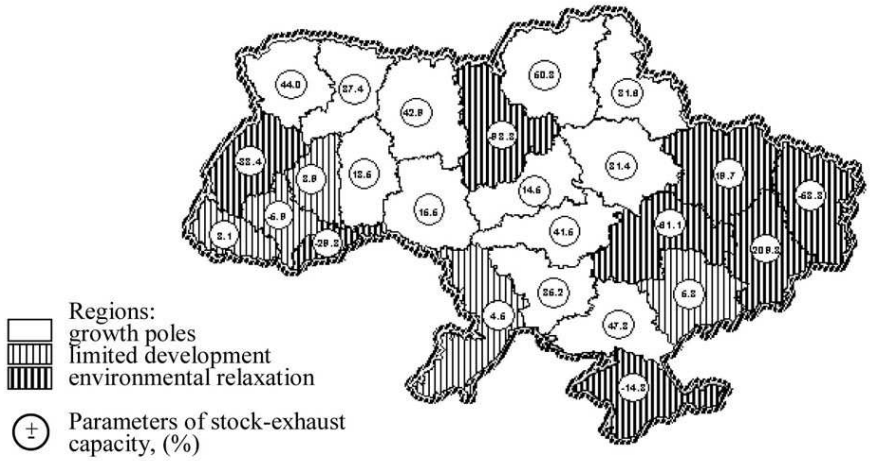

Fig. 8. Eco-city planning regionalization of the territory of Ukraine

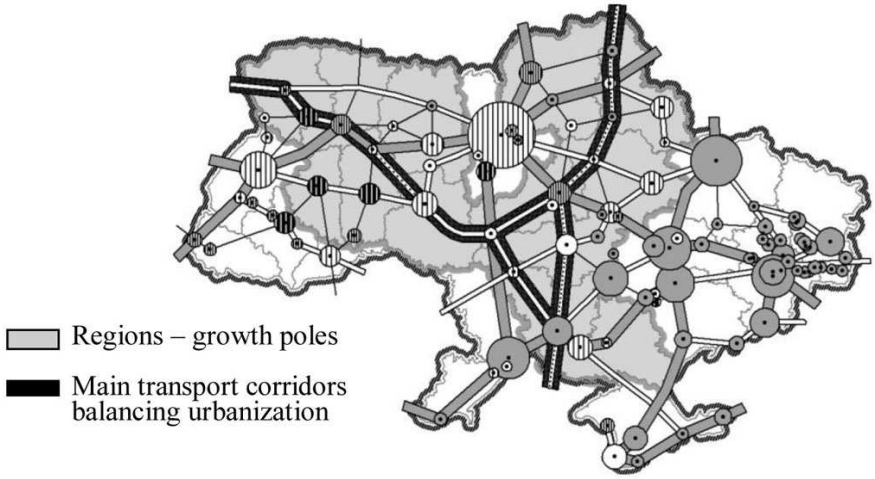

Fig. 9. A planning framework of the equilibrium zone of urbanization

helped to suggest a transformational model of resettlement planning, which ensures the spatial terms of environmentally sustainable, balanced and safe development of the country for which the question of stabilization of the population provides the guideline features in its national security [20-22] (Fig. 9).

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ПРИНЦИПЫ И СТРАТЕГИИ УСТОЙЧИВОГО РАЗВИТИЯ РЕГИОНОВ

Аннотация. Изложены результаты исследования основ и стратегий устойчивого развития человечества в экофизическом значении этого явления.

Ключевые слова: устойчивое развитие, экосистемная саморегуляция, экологическое равновесие, демографическая емкость, эколого-градостроительные системы.