

**PECULIARITIES OF THE FORMATION
OF REGIONAL WASTE MANAGEMENT SYSTEMS
UNDER THE CONDITIONS OF TRANSITION
TO THE PRINCIPLES OF SUSTAINABLE DEVELOPMENT**

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Abstract. This work presents a system analysis of modern tendencies of civilizational development, defines principal characteristics of the concept of sustainable development. It substantiates the provision that one of the most pressing problems of sustainable development is the global environmental problem, that concentrates in it particularities of the numerous problems of socio-economic nature. *There are two blocks of environmental problems* – problems related to the contradictions between the society and the environment (functioning of the system «society-nature») and social problems associated with contradictions within the society (functioning of the system «man-society»). The conclusion has been made that any economic development must be correlated to the ecological potential, that is interpreted as the amount of natural resources sufficient for the continuous economic growth, as well as stability of the established, life-friendly relationships in the natural environment ensuring reproduction of conditions of the environment disrupted by human activity, and reproduction of natural resources used in the process of economic activity. Proceeding from the generalized existing interpretations of sustainable development, it is stated that the concept of sustainable development can be considered as a paradigm of further development of civilization that gives the opportunity to comprehend the problems of modern civilization in the global context;

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helps to systematically comprehend the regularities of development of the society; encourages resolution of local, regional problems in terms of the global context.

It has been established that transition of functioning of the socio-economic systems to the principles of sustainable development must be a totally controlled process that has to be implemented with a high degree of scientific foresight. There has been backed up the statement that modern society is a powerful source of production and consumption waste and the substance and particularities of waste management system formation have been defined. There have also been proposed ways to resolving the problem of waste and the principles of formation of the waste management system have been formulated:

a) «the principle of taking precautionary measures» – measures must be taken to prevent the threat created to the environment by waste even in the absence of scientifically confirmed data;

b) the principle – «the polluter pays» – producer or owner of waste must bear the costs connected with waste management;

c) «proximity principle» – waste must be treated at the nearest waste treatment facility, taking into account environmental and economic efficiency;

d) «principle of self-sufficiency» – necessary formation and operation of an integrated and adequate municipal network of facilities for the placement and recovery of municipal waste.

The work proposes strategies for resolving the problem of waste. Strategy I – reducing the need for the product; strategy II – changes in the product; strategy III – changes in the use of products. The choice of waste management strategy has to be determined on the basis of analysis of the processes of production and consumption of a particular product. The waste management system has to be based on the fundamental principles of environmental management, on the basis of the adequate strategy and tactics. It is determined that the problem becomes urgent of developing measures of economic incentives in the field of waste management.

1. Introduction

The beginning of the 21st century is characterized by aggravation of contradictions between the ever growing social needs and the limited capacity of the biosphere to meet them, which threatens the continued

existence of humans as a biological species. Throughout the entire period of establishment of modern civilization the main strategy for ensuring viability of the society is transformation of nature that started with the first scientific and technological revolution – the transition from gathering to agricultural production. Its main feature is production of surplus fringe benefits whose acquisition becomes the driving force of progress. Formation of the concept of sustainable development is a confirmation of the fact that now an active search for new forms and new content of the society's relations with nature is taking place. Many researchers note that throughout the entire period of its formation the society has been trying to resolve as a matter of fact the unsolvable problem – to create a stable environment for its existence by destroying the environment. First of all, this is manifested through the ecological consequences of human activities that are continuously manifested throughout the entire historical period. The ecological danger looming over humanity today is connected not only with the excessive pollution and deterioration of natural environment, but also with the uncontrolled and poorly predictable consequences of the enormous human nature-changing activities. In the second half of the twentieth century the environmental problem appeared to be in the center of research of numerous scientists, who identify two main blocks of the problem:

- 1) problems connected with contradictions between the society and the environment (functioning of the system «society – nature»);
- 2) social problems connected with contradictions within the society (functioning of the system «man – society») [1].

By its urgent imperative the problem of waste – the great volumes of production and consumer wastes and the inadequate level of their recycling, processing and disposal, that pose real threats to the population and the environment – stands out within the global environmental problem at the present stage of social development. The peculiarity of the problem of wastes is that improving living conditions of the society from the standpoint of the consumer of goods, production simultaneously disrupts the global balance of ecosystems. This is why the problem of developing the management systems and elaboration of the approaches ensuring a balance between the volumes of waste generation and utilization capacities of the territories becomes exceptionally urgent.

2. The concept of sustainable development as a strategy of civilizational development in the 21st century

The search for a new model of socio-economic development continued during the second half of the 20th and in the beginning of the 21st centuries against the background of the steady population growth, ambiguity of the progressive development of the results of scientific and technological advances and emergence of the new global problems. One of the most pressing problems of social development in the early 21st century becomes the global environmental problem, that, to one degree or another, concentrates in it particularities of the many problems of socio-economic nature. This is determined by the fact that economic, social, technological and biological processes are closely linked and interdependent. Today, the biosphere and its ecosystems are a defining element of the meta-infrastructure of social production and consumption on which the system of ensuring livelihood of the society is based. That is why conclusion of the analysis of trends in civilizational development that the development of ecological systems and socio-economic development should not be considered as two isolated processes becomes relevant.

In determining strategy of socio-economic development it is necessary to proceed from the fact that the economic, social and ecological systems are closely interdependent. Ecological space performs two defining functions regarding the social and economic systems – on the one hand, it is the source of natural resources, a base for the construction, transport, etc.; on the other hand, it creates intangible benefits to meet biological, aesthetic and scientific needs of humans. At the same time, the adverse effects of economic activity suggest that any economic development must be matched with the ecological potential. “...Ecological potential is a sufficient amount of natural resources for the continuous economic growth, as well as the stability of the established, life-friendly relationships in the natural environment, ensuring reproduction of human-disrupted conditions of the environment and reproduction of natural resources used in the process of economic activity” [2, p. 20]. Ecological capacity determined by the ecological potential of biosphere is one of the most important dimensions characterizing parameters of the acceptable limits of destruction of the biosphere determined by economic activities of humans. Overriding these limits means the beginning of disruption of biotic regulation and transition

of the system into the unstable state that leads ultimately to degradation of the biosphere. This is why under modern conditions the problem formulated by Adam Smith, one of the most prominent representatives of the classical school of economics, becomes exceptionally relevant: if the cost depends on utility, then why the goods that have the highest useful effect (for example, water and air) are valued, as a rule, very low or have no value at all, while the goods, the benefit of which is not obvious from the point of view of human natural needs (diamonds, etc.), have a very high value? [3].

In the context of the search for a new paradigm of social development, the UN Secretary General W. Tang back in 1969 combined in one block the problems of population explosion, depletion of natural resources and pollution of the environment for the first time from the standpoint of system approach to the global problem of relationship between the human society and nature. The UN Conference on the Environment, held in Stockholm in 1972, was the first to address on the UN level the issue of interdependence of the development of mankind and conservation of natural environment, and the need to include in the program of actions on the government level measures to resolve the problems of protection of the environment. It is such approach that is at the core of the concept of sustainable development.

The materials of the report of the UN International Commission on Environment and Development, chaired by the Prime Minister of Norway G. H. Brundtland, and documents of the International Conference on Environment and Development, held in 1992 in Rio de Janeiro became the basic documents defining the essence of the new paradigm of human development. According to these materials, sustainable development is *such development that provides for the needs of the current generation without compromising the ability of future generations to provide for their own needs*. From the standpoint of systems analysis, sustainable development can be interpreted as a dynamic state of the society in which economic, social and environmental criteria of development have been balanced. The most important conditions and prerequisites for such development are competitiveness and propensity for self-development [4].

Many researchers compare transition of socio-economic systems to the principles of sustainable development only with the two historical events in the development of human civilization: the agricultural revolution in the late New Stone Age and the industrial revolution of the last two centuries.

The uniqueness of the current stage of development is that, unlike the two previous revolutions, that were gradual and largely unperceived, the new revolution must be a fully controlled process that will be accomplished with such a high degree of foresight that only science can provide.

Summarizing the main characteristics of the concept of sustainable development, it can be said that there is every reason to consider it as a paradigm of further development of civilization that:

- gives the opportunity to comprehend problems of modern civilization in the global context;
- helps to systematically comprehend patterns of development of the society;
- encourages solution of local, regional problems in line with the global context.

It is generally accepted that sustainability of society depends to a great extent on sustainability of the biosphere. V. I. Vernadsky in his theory of biosphere noted that neither life itself nor evolution of its forms can be independent of the biosphere that is the only possible environment for life and practical activity of humans [5]. Biosphere has been functioning stably from the time when life itself appeared on the planet – for almost 4 billion years. With all random external fluctuations, biota does not allow the environment to deviate significantly from a certain optimum. This is a kind of an analogue for the biosphere of the principle of Le Chatelier-Brown: external influence that brings the system out of equilibrium causes in it processes aiming at weakening the results of action of such influence. It can be assumed that biosphere is a holistic natural system that ensures stability of the living environment when the values of its parameters deviate from the optimal parameters. This is why preservation of biota in the amounts ensuring compliance with the principle of Le Chatelier-Brown with respect to the global fluctuations of the environment is the main condition for preservation of life on Earth [6].

Now it becomes increasingly problematic to ascertain and study natural ecosystems whose functioning is completely isolated from anthropogenic activities. Intervention of humans has become a significant factor of existence of the majority of ecosystems. Ecological processes and natural resources continue to be the important factors in human activities. Interaction of the flows of matter, energy and information of natural and anthropogenic

systems is taking place in real space. Production is always based on the use of nature – transformation of natural resources that are the component parts of the natural potential of the ecological subsystem. The flow of matter and energy passing through the production system has almost no negative feedback. At the input – this is the ever increasing consumption of resources and energy that leads to the degradation of natural systems, at the output – is the enormous amount of wastes that enter the environment and cause its pollution. Moreover, the increasing use of natural resources causes also the increase in the variety of human and social needs that production is aiming to satisfy [7].

Within certain limits of anthropogenic activities terrestrial ecosystems function in accordance with the principle of Le Chatelier-Brown, quickly recover from all disruptions of the environment, ensuring its sustainability. The ability to recover in absolute values, like the limit of economic capacity, varies from region to region depending on the absolute value of productivity (biota capacity): in deserts, this ability is the lowest, and in forests it is the highest. Excessive economic capacity leads to putting out of action the principle of Le Chatelier-Brown – to disruption of nutrients circulation, transformation of biota itself into the source of pollution (emissions of carbon dioxide, nitrogen and phosphorus compounds) and distortion of the environment that is observed today. At present, there is no clear evidence that the dangerous critical limit has already been crossed – the environment is unstable and moving rapidly to destruction. At the same time it is clear that further economic growth with current trends in the growth of energy and natural resources consumption will lead humanity to the collapse and degradation of a considerable part of the biota.

The ecological factor plays an important role in the functioning of social production for regulation of the supply-demand ratio. To maintain the unbalanced state of supply and demand it is necessary to use matter, energy and information on an ever-increasing scale. This being said, consumption is determined by the consumption needed to maintain balance of supply and demand corresponding to the available amount of capital, to maintain in working order the capital itself (equipment, machinery, real estate, etc.), to compensate for the irretrievable consumption of natural matter and energy. In such case, consumption of matter, energy and information for the renewal of capital is much higher than that for its initial formation, because the

sources of natural resources are being depleted, and replacement of capital requires additional consumption of energy.

Market economy is to a certain extent a sufficiently effective mechanism for the «supply and demand» regulation. At the same time, these are the market mechanisms of the economy that have certain blemishes of inefficient use of resources. Frequent change of supply leads to excessive use of resources: the goods that have not lost their utility and have not achieved their physical wear and tear in the manufacturer's race for a profit are withdrawn from use and devalued in a timely manner. It could be said that this initiates the process of development, industrial evolution, the search for the more advanced production technologies, that is, the process of evolutionary development. In fact, on a planetary scale, this process leads to depletion of resources and degradation of the environment. Countries with the ineffectively working economies are generally ineffective, and owing to them economies of other more prosperous countries function effectively. This is the essence of the «rule of 20%»: one-fifth of the world's population uses up to 80% and more of all resources; one-fifth of the population in each state owns 80% of all material goods, etc. [8].

The market is an effective mechanism for distribution of resources and leveling-off supply and demand, but it does not take into account the existence of limits on the use of resources from the natural systems. In the world, where the needs of economy approach the uttermost limits of natural systems, it is improperly to rely solely on the economic indices when taking decisions on investment. As H. Daly notes, while in the past, when the presence of man in biosphere was insignificant, the capital created by him was a constraint on the growth, and now, after the unprecedented increase of anthropogenic capital, the natural capital has become the constraint. In fisheries, it is the reproductive capacity of fish populations and not the number of fishing vessels and their capacity; in the oil industry these are accessible reserves and not capacities of the extracting, transport and processing enterprises, etc. [9].

Many economists recognize that capacities of nature in terms of providing resources for the society are great, but not unlimited. Analysis of the scale of use of natural resources shows that human civilization has already come close to these limits, and for that reason the system of economic thinking and activities that ignore them must be cardinally

changed. To assume that economic growth can last without ever stopping is to believe in the impossible. Arguments that modern technology liberates society from these limits are based on the assumption that physical capital can serve as an adequate replacement for natural resources. Many scientific publications state that this is correct to some extent, but in most cases natural and man-made capital complement rather than replace each other. Thus, for example, a sawmill cannot operate without a forest, and a fishing boat loses half of its value in the absence of fish. But many economists continue to argue that natural and anthropogenic capitals are interchangeable. While acknowledging some irreversibility of loss of the ecosystem, they argue that market forces in combination with human ingenuity will provide the necessary technological adaptation that will help to compensate for the losses. Efforts to create substitutes, in their opinion, will stimulate research and investment, increase the number of jobs and ensure economic development.

To form the ecological and economic strategy for the development of civilization it is important to understand that humanity is in the middle, and not outside nature, as well as to understand the links between the nature of functioning of economy and the laws of development of natural ecosystems. The biosphere is not simply a source of resources for humans and a receiver of waste of their economic subsystem – it is a much more complicated system, the foundation of life in which biota ensures stability of the environment in order to maintain optimal conditions for its existence and quenches disturbances in accordance with the principle of Le Chatelier.

In political economy the narrative of boundlessness of the world transformed into the narrative of the boundlessness of the planet's natural resources. There was even no thought of the possibility and, moreover, of obligation of the society to intervene in the process of reproduction of natural resources. This situation existed as long as nature itself ensured reproduction of natural resources and the amounts of production waste was small and there was no essential adverse impact on the environment. At the same time, resource constraints on the development of economy manifested themselves continuously throughout the entire period of development of human civilization. However, combination of new technologies and relatively cheap energy allowed for some time (it can be argued to this day) to bypass these impediments. For example, the use of energy in agriculture

permitted to raise the level of food production, which has compensated for the depletion of agricultural land. «We are wasting the wealth of nature much faster than it can be restored», – said Claude Martin, WWF’s director general – «and thus it appears that we borrow resources from nature being unable to pay back. This will continue till our governments restore the balance between consumption of natural resources and the ability of the Earth to restore them» [10].

Sustainable development is determined by interaction of the three megaspheres: society, ecosphere and technosphere, each of which has its own set of resources: society – human and social resources, ecosphere – natural resources (renewable and non-renewable) and technosphere is associated with production, technological, financial and other resources. Sustainable development for a long time is possible on the mutually coordinated interaction of these megaspheres and the use of their resources. To ensure stability of development the society must comply with the principal provisions of the laws and principles of functioning of natural ecosystems, which determine stability of the biosphere in general. We attribute the following most important laws and principles of natural ecosystems, which determine the nature of functioning of the social system on the global scale [11–13]:

The law of internal dynamic equilibrium – matter, energy, information and the state of individual natural systems and their hierarchy are so interconnected that any change in one of these values causes functional-structural qualitative and quantitative changes that preserve the total amount of material-energy, information and dynamic qualities of the systems in their hierarchy.

H. Boumech’s law «All or nothing» – weak anthropogenic actions may not cause a reaction in the natural system in response, until they, having been amassed, lead to the development of a rapid dynamic process.

J. Liebig’s law of the minimum – life opportunities are limited by the ecological factors whose quantity and quality are close to the minimum required for the organism or the ecosystem, their further reduction leads to death of the organism or destruction of the ecosystem.

The law of evolutionary-ecological irreversibility – an ecosystem that has lost a part of its elements, can not return to its original state.

V. G. Gorshkov’s law of irreplaceability of the biosphere – decrease of natural biota in excess of the threshold value strips the environment

of stability, which can not be restored by way of establishing purification facilities and transition to the waste-free production.

This is exactly non-observance of the provisions of such kind of laws that causes emergence of global environmental problems, among which a particular place in the beginning of the 21st century occupies the problem of industrial and domestic waste.

3. Waste as a determining factor global environmental problem

Throughout the entire time of the formation of modern civilization, security has always been one of the most important problems of humans, society and the state. In the beginning of the 21st century, despite the great achievements of scientific and technological progress, it still remains to be one of the central problems of civilizational development. For a long time most security issues have been focused primarily on the problems of military danger or threats connected with the notion of the external enemy and were determined by the degree of success of the state in the structure of regional or global military confrontation. However, in the second half of the 20th century it became obvious that the most fundamental threats to security of social development are not formed in the military sphere – at the turn of the millennium humanity has faced serious problems called «global» and spread all over the complicated system of contradictory processes that are the cause of today's global crisis. Global problems create a threat to the normal development and even existence of the world, they require joint efforts to prevent these catastrophic consequences and have an all-embracing planetary, global significance. Under modern conditions depletion of material and energy resources, population explosion, pollution of the biosphere as a human habitat having no alternative, etc., become such threats. One of the main threats is the global environmental crisis, connected with the increasing pressure on the life support systems and natural resources of the planet, environmental degradation and undermining stability of the biosphere. This threat is no less serious than the traditional threats of military character – further development of the crisis threatens not only existence of humans, but even life itself on the planet [14].

The problem of ecological security holds one of the main places in the concept of sustainable development as a strategy of socio-economic development of humanity in the 21st century, whose main objective is

achievement of global security of the planet through limitation of the scale of use of natural resources, pollution of the environment, ensuring social and ecological-economic sustainability of countries, improving quality of life of all mankind. This strategy envisages preservation of local and regional ecosystems to ensure regional sustainable development, within the framework of which economic activity must be conducted in the appropriate ecological corridor while balancing the economic and environmental interests of economic entities.

Today, the problem of waste – industrial and domestic – prevails in the system of environmental problems. With constant development of the productive forces of the society, continuous growth of population, expansion of the sphere of consumption the problem of waste becomes more and more aggravated. Presence of the tremendous amounts of man-made waste transforms into the global problem and becomes a direct increasingly dangerous threat to the environment and public health in most countries of the world.

There can be distinguished two aspects of the problem of waste: 1) inefficient waste management leads to irreversible disruption of ecological equilibrium and decline of biodiversity; 2) irrational use of natural resources in combination with huge accumulated environmental losses. The problem of waste in the program document on the development of mankind “Agenda for the 21st Century” is determined as such that impedes sustainable development of the world economy, and was recognized as the major environmental problem in the sphere of environment protection at the International Conference on Sustainable Development in Johannesburg in 2002 [15].

Generation of waste makes anthropogenic circulation of resources open-ended and leads to disruption of biosphere stability in the result of depletion of natural resources and an adverse impact on the natural ecosystems. Generation of waste per unit of production increases as we approach the beginning of production chain, which predetermines the greatest load on ecosystems in the regions with the prevailing development of industries engaged in extraction and primary processing of natural resources.

Waste presents a serious problem for all countries because even with the most advanced technologies it is impossible to prevent generation of waste. However, the high level of waste generation is the result of inefficient use of

natural resources in the production activities. Experience of the developed countries has shown that humanity can develop successfully by reducing considerably consumption of natural resources. It is known [16; 17] that the resource and energy intensity of a GDP unit in the USA is 2 times, and in Western Europe and Japan 3-4 times lower than in other countries. This means that 2-4 times less natural resources are used in production in these countries with the corresponding reduction of waste generation. According to some estimates annual economic losses from pollution of the environment with waste products can be at the level of 10% of GDP [18].

The wastes mount up in the result of functioning of all sectors of economy and are regarded as the inevitable by-products of economic activity (wastes associated with insufficient effectiveness of technological processes, low service life of goods and ecologically burdensome character of consumption). Waste generation leads to the loss of materials and energy as well as to additional economic and ecological costs for the society connected with collection, processing and disposal of waste. The impact of wastes on the environment, resources and human health depends on their quantity and nature. Ecological impact of waste generation and waste management includes emissions into the atmosphere (including greenhouse gases), water and soil, which has a potential impact on human health and nature. Most municipal waste is disposed of by way of landfilling, which leads to a considerable load on the environment. At the same time, only a small part of waste is utilized.

In the most general case all waste can be divided into industrial, municipal, medical and military. «Industrial waste or production waste – is the waste of raw materials, semi-finished products generated in the result of production of goods or execution of works, as well as associated substances that are not used in the specific production: overburden rocks appearing after extraction of natural minerals, agricultural waste, solid particles deposited during treatment of process gases and wastewater, etc. Municipal solid waste (MSW) generated in the result of human vital activity presents a special sanitary and biological hazard. Let us consider in greater detail the tendency of their origin [19].

In recent years the problem of forming a system of industrial and household waste management dominates in the environmental policy of the developed countries [20]. The problem of waste management is systemic

and has to take into account various aspects of waste existence. Firstly, from the ecological point of view, waste is a source of environmental pollution. Secondly, from the point of view of functioning of the social system waste management must provide conditions for the formation of physically and spiritually healthy labor resources. Thirdly, economy necessitates the rational use of natural resources as the mandatory factor of sustainable development.

The crucial role in solving the problem of waste lies with the bodies of state power. Changing the nature of state participation in economic activity, reducing the share of state property create economic conditions for high business activity. This being said, the role of the state as the guarantor of the environment preservation and ensuring ecological safety, effectiveness of state administration and control in the sphere of nature protection follows an upward trend. The state must promote the use of energy- and resource-saving production technologies; stimulate the reuse of waste and encourage production of goods made of recycled materials; improve the system of norm setting and control in the sphere of waste management, apply sanctions for disposal of waste to be reclaimed in the environment, etc. The appropriate combination of all forms of influence of state power on the society creates prerequisites for sustainable development of the national economy [21].

Based on generalization of modern approaches to the formation of the waste management system, it can be said that the effectiveness functioning of the waste management system is ensured by way of taking into consideration the following fundamental principles:

- waste management must be an integral component at all hierarchical levels of management;
- the general purpose of waste management is to ensure the protection of human health, to provide or restore a favorable state of the environment and preserve biological diversity;
- scientifically substantiated balancing of ecological and economic interests of the society in order to ensure sustainable development of the society;
- application of methods of economic regulation of activities in the field of waste management in order to reduce the amount of wastes and drawing them into economic circulation;
- compliance with the generally accepted hierarchy of waste management: maximum use of the source materials and raw materials;

prevention of waste generation;
reduction of waste generation and reduction of hazard class of waste in the sources of their generation;
waste treatment;
waste disposal;
waste detoxification.

Based on the principles of environmental management, formation of a waste management system must be made taking into account the following principles:

a) «precautionary principle» – measures must be taken to prevent the threat produced by environmental waste even in the absence of scientifically confirmed data;

b) principle – «the polluter pays» – producer or owner of waste must bear the costs associated with waste management;

c) «proximity principle» – waste must be treated at the nearest waste treatment facility, taking into account environmental and economic efficiency;

d) «principle of self-sufficiency» – formation and functioning of an integrated and adequate municipal network of facilities for disposal and recovery of municipal waste.

Since waste management is an element of environmental management, the waste management system must be based on the generally accepted principles of environmental management. Given the specific nature of waste as the object of management we distinguish the following principles among the principles of environmental management [22, p. 577]:

– *integrated approach*, that necessitates consideration of the integrated effect in the entire chain of the commodity production and consumption;

– *focus on the causes*, that envisages elimination of the causes, rather than combating consequences of waste generation;

– *division of responsibilities*, that determines establishment of targeting and degree of responsibility of the subjects and objects of waste generation processes;

– *correspondence of tools*, that envisages motivational tools in line with the circumstances of resolving the problem of waste;

– *a systemic approach*, that envisages a systemic impact on all objects and subjects of waste generation processes, that may directly or indirectly contribute to resolving the problem of waste;

– *maximum efficiency*, that determines achievement of specific goals in solving the problem of waste with minimal costs and the maximum return on funds applied towards resolving specific tasks.

The main principle of the strategy of sustainable development is the principle of balancing social needs with the potentials of the environment to meet these needs. Economic science has recognized a long time ago that human needs are endless and the potentials of the environment are limited. Man is unable to expand potentials of the environment to meet his own needs, while at the same time man can form his own needs in accordance with the ecological capacity of the planet.

Transition to a fundamentally new strategy of nature management based on the restoration of resources envisages compliance with the two main requirements: 1) transition to the rational nature management; 2) elaboration of fundamentally new resource regenerating technologies.

In accordance with the above said principles, there can be proposed three basic and three intermediate strategies for resolving the problem of waste. Strategy I – cutting back the need for the product; strategy II – changes in the product; strategy III – changes in the use of products [22, p. 578–580]. The choice of waste management strategy has to be determined on the basis of analysis of the production processes and consumption of a particular product. Strategy I envisages refusal from consumption of certain products or a reduction of the need for them, which will ultimately lead to the reduction of the volumes of use of natural resources and volumes of waste. Strategy II envisages elimination of those properties of the consumer product that contribute to the increase of waste or its toxicity. Strategy III deals with the processes of product use and is oriented towards application of such methods of consumption that would minimize the adverse ecological consequences of the use of this or that product. In practice, there can be also used certain combinations of these basic strategies.

It should be noted that the problem of waste is determined not only by the production technologies but also by a relatively low level of culture and imperfect approaches to the formation of personnel for the waste management systems, lack of qualified professionals employed not only by the natural resource users, but also by the environmental organizations.

4. Conclusions

Solution of the environmental issue is among the priorities identified by the UN Sustainable Development Goals by 2030. An important task in this area is to reduce generation of industrial and domestic waste, increase the share of their processing and recycling. Achieving the goals of sustainable development in terms of solving the problem of waste necessitates formation of a waste management system as an important factor in the overall management of socio-economic systems, as an effective tool for the ecological and economic assessment of waste management and development of tariff policy criteria in the waste management.

Systems analysis of the state of solving the problem of waste management showed a low level of economic and legal support of waste management, which gets in the way of normal planning, accounting, collection and analysis of information contributing to introduction of the fully functional environmental and economic tools for the waste management. In such a situation, it is difficult to elaborate and take adequate managerial decisions. The result of this is insufficient financing of the up-to-date technological level of waste disposal, which increases the level of ecological hazard of most waste disposal sites. The lack of effective incentives in the field of waste management has led to the actual termination of innovation activity, development of new technologies in the sphere of waste management.

The waste management system must be based on the fundamental principles of environmental management, on whose basis there must be built an adequate strategy and tactics. The existing environmental policy of production and consumption waste management is based as a rule on the fiscal only incentive – collection of environmental charges for waste disposal. This is not so much conducive to the introduction of low-waste technologies and minimization of waste generation, as it forces nature users to hide actual data on waste generation in order to reduce the amount of environmental charges for waste disposal. In view of this, development of measures to stimulate economic activity in the field of waste management is quite relevant.

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