Tools for Sustainability Management of Socio-ecological Systems in the Globalizing World

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Abstract. The article is devoted to solving the following problem: further development of human society with preservation of current rate of production volumes growth and increase of the number of population may lead to the global catastrophe. The purpose of the work is to develop effective tools of sustainability management of socio-ecological systems in the conditions of globalization. The methods of the research include modeling and multi-criterial optimization, with the help of which the authors formulate the task of provision of socio-ecological systems sustainability in the conditions of globalization and offer a managerial model for solving it. The basis of the sustainability management tools of socio-ecological systems in the globalizing world should be economic & mathematical model of multi-criterial optimization of sustainability of economic and ecological development of modern global economic system. The authors denote three directions of solving this optimization task and develop the corresponding instrumentarium and the proprietary model of sustainability management of socio-ecological systems in the globalizing world.

Keywords: Management · Socio-ecological systems
Sustainable development · Globalization

1 Introduction

Striving for satisfying various interests of various economic agents under the conditions of limitation of resources and possibilities of the environment over the whole history of humankind led to aggravation of the ecological situation in the world. The key problem consists in the fact that further development of humanity with preservation of the current rate of increase of production volumes and increase of population might lead to the global catastrophe.

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Modern culture of consumption dictates need for increase of volumes of GDP. Quick growth of population in combination with the idea of humanity also causes growth of total needs of humankind. All this does not allow refusing from the plans of economic development. However, it is impossible to ignore the ecological consequences of intensive development of economy.

Over the recent decades, developed countries actively use such tool of sustainability management of socio-ecological systems as transfer of hazardous production on the territory of other countries. It does not allow solving ecological problems in the global scale but only improves the position of certain countries as compared to others. At that, development of the global socio-ecological system is still unsustainable.

In the conditions of globalization, all countries of the world are in close interdependence, and the idea that lies in the basis of modern approach to sustainability management of socio-ecological systems, which consists in striving for solving the ecological проблем by means of other countries without significant limitations from their side, is false. This is reflected by ineffectiveness of existing and necessity for development of a new instrumentarium of sustainability management of socio-ecological systems in the conditions of globalization – which is viewed in this article.

2 Methods

Sustainable development supposes combination of interests of development of production – primarily, industrial (Grincheva 2016) – and environment protection (Hák et al. 2016). Unsustainable development of socio-economic and ecological systems leads to crises (Kopnina 2016), which could be manifested in the sphere of economy and in the sphere of ecology (Aznar-Márquez and Ruiz-Tamarit 2016).

Management of socio-ecological and economic systems supposes state interference with market processes (Moussiopoulos et al. 2010) for limiting the development of economy for the purpose of minimizing the damage to the environment (Ferrão et al. 2014; Frolov et al. 2015; Popkova et al. 2015; Nadtochey 2010).

In the conditions of globalization, the process of managing the socio-economic and ecological systems becomes complicated (Ren 2012), as it is influenced by more factors (Cheng et al. 2015), and it is necessary to take into account interests of a large number of interested parties (Sturn 2013; Marsh 2012).

Based on the performed literature overview on the topic of the research, it is possible to conclude that despite a high level of elaboration of certain aspects of the solved problem, modern authors study it primarily at the theoretical level.

At that, practical tools of sustainability management of socio-ecological systems in the conditions of globalization remain beyond the limits of the performed studies. It causes the necessity for development of empirical and methodological basis of management sustainability.

The research methods include modeling and multi-criterial optimization, with the help of which the authors formulated the task of provision of sustainability of socio-ecological systems in the conditions of globalization and offer a managerial model for its solution.

3 Results

The authors offer that the tools of sustainability management of socio-ecological systems in the conditions of globalization be based on the proprietary economic & mathematical model of multi-criterial optimization:

$$\begin{cases} S = (GDP/NP)/DE \rightarrow \max; \\ GDP \rightarrow \max; \\ NP \rightarrow \max; \\ DE \rightarrow \min. \end{cases} \quad (1)$$

where S – sustainability of socio-ecological system;

GDP – volume of GDP within system;

NP – number of system's population;

DE – damage to ecology of system;

In the formula (1), the sought variables are volume of GDP, number of population, and damage to the ecology of environment. The targeted function supposes that sustainability of socio-ecological system, determined as ration of GDP per capita to the damage to environment, should strive to maximum with the following limitations: GDP and number of population should strive to maximum, and loss to environment – to the minimum.

These limitations are dictated by the very idea of sustainable development of the socio-ecological system, according to which the number of population constantly grows, which leads to increase of needs and necessity for satisfying them, by growth of GDP. At that, provision of this level and living standards of the population requires preservation of favorable environment and minimization of the damage to ecology from production activities.

Obviously, the limitations set in the optimization task contradict each other – increase of GDP inevitable leads to increase of damage to the environment. This task could be solved in the global, national, and regional scales. With the help of modern software (for example, MathCad program), it is possible to obtain Pareto limit for non-dominating solutions (series of optimal solutions each of which corresponds to the given limitations).

While selecting the best solution, depending on the socio-economic, cultural, and political peculiarities of the viewed system, it is necessary to determine priority of each of the limitations. Thus, interests of the growth of population might prevail over the purposes of provision of favorable conditions of life. Then the number of population and GDP will increase, and the state of ecology will aggravate.

Or, quite on the contrary, the system might be interested in provision of maximally comfortable conditions for life. Then, either GDP per capita will decrease, or the number of population will reduce. In either case, there are three directions for solving this optimization task within sustainability management of socio-ecological systems in the conditions of globalization.

The first direction supposes reduction of each human's needs within change of GDP/NP ratio. At the first glance, this might seem unreal, as it is considered that needs

are unlimited and the possibilities of their satisfaction with the help of GDP growth are limited by existing resources and production capacities.

However, with more detailed analysis of this problem, it is possible to see that with improvement of technologies of production, the very product changes – and it can satisfy more needs, i.e., there is increase of feedback from production in the sphere of satisfaction of needs. Thus, while preserving the volume of production, it is possible to increase the level of satisfaction of society's needs. Within this direction, it is possible to offer the following tools:

- Modernization of technologies and equipment. This will allow increasing feedback from production and labor efficiency;
- Application of marketing for management of needs. With the help of marketing tools it is possible to create new needs and reduce the old ones;
- Implementation of innovations and creation of new types of products. Development of new products, which can satisfy more needs, will allow reducing the production volume with preservation of the level of need satisfaction.

The second direction is oriented at adaptation to new, less favorable conditions of the environment within the change of NP/DE ratio. This could be conducted within the evolution. As is known, human society differs from animals by the fact that it does not adapt to the environment but changes the environment. However, human can also adapt to the new ecology.

This supposes artificial creation of special closed areas with favorable environment for special groups of population, improvement of medical and biotechnologies for curing new types of diseases that emerge in the conditions of life in unfavorable environment, conquering space for relocation of part of the population, etc. The following tools could be offered within this direction:

- Development of innovations. Development of new technologies will allow creating and restoring favorable environment;
- Reduction of requirements to the environment. Within adaptation to new ecological conditions, it is possible to change a human's body with the newest technologies;
- Refusal from hazardous production. This tool supposes import of products manufacture of which supposes serious damage to the environment, or full refusal from consumption of such products.

The third direction is based on minimization of the damage done to the environment in the process of production activities within changing the GDP/DE ratio. This direction is the most realistic and perspective. It supposes development of innovational technologies for reduction of production wastes with preservation of its scales. The following tools could be offered within this direction:

- Attraction of investments. Implementation of the latest production technologies requires significant financial resources;
- Toughening of ecological standards. This measure is aimed at state stimulation of the process of business ecologization;
- Growth of demand for ecological responsibility of business. This allows the whole society to motivate business for increase of ecological compatibility of production.

In practice, it is possible to realize all the given directions simultaneously or some of them that fit the socio-economic system. Together, they form the model of sustainability management of socio-ecological systems in the conditions of globalization (Fig. 1).

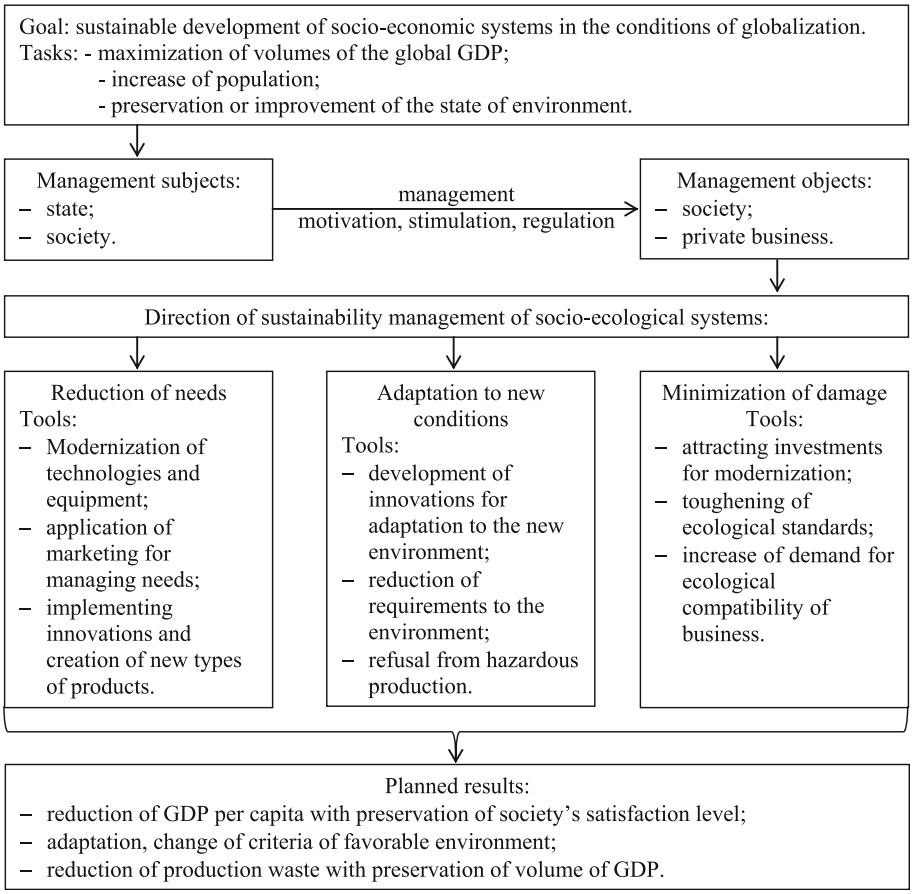

Fig. 1. Model of sustainability management of socio-ecological systems in the conditions of globalization

As is seen from Fig. 1, subjects of management in the offered model are state, which can regulate and stimulate society and business for increase of sustainability, and society, which can motivate private business for realization of the sustainability practice. As a result of realization of the model, GDP per capita should be reduced with preservation of society's satisfaction level, criteria of favorable environment should be adapted and changed, and volume of hazardous waste of production should be reduced with preservation of the GDP volume.

4 Discussion

Realization of the determined directions and the offered tools of sustainability management of socio-ecological systems will allow regulating the contradiction between socio-economic and ecological interests in the modern global economic system. At the national level – depending on the unique peculiarities of a specific country – it is possible to select and realize the best fitting direction of sustainability management depending on the set criteria of optimization.

5 Conclusion

It should be concluded that sustainable development of socio-ecological systems could be ensured by joint efforts of all economic agents. In the conditions of globalization, the problem of provision of sustainable development of socio-ecological systems should be solved by all members of international economic relations.

To a certain extent, a limitation of the results of this research is the full character of the offered tools and the model of sustainability management of socio-ecological systems in the conditions of globalization, as well as non-domination of solutions on Pareto limit for the developed model of multi-criterial optimization.

In the process of further research in the sphere of sustainable development, the attention should be paid to development of the mechanism of prioritization of optimality criteria for various socio-economic and ecological systems.

References

Hák, T., Janoušková, S., Moldan, B.: Sustainable development goals: a need for relevant indicators. Ecol. Ind. **60**, 565–573 (2016)

Aznar-Márquez, J., Ruiz-Tamarit, J.R.: Environmental pollution, sustained growth, and sufficient conditions for sustainable development. Econ. Model. **54**, 439–449 (2016)

Cheng, Y., Johansen, J., Hu, H.: Exploring the interaction between R&D and production in their globalization. Int. J. Oper. Prod. Manag. **35**(5), 782–816 (2015)

Ferrão, P., Ribeiro, P., Rodrigues, J., Lopes, A., Costa, E.L.: Environmental, economic and social costs and benefits of a packaging waste management system: a Portuguese case study. Resour. Conserv. Recycl. **85**, 67–78 (2014)

Frolov, D.P., Popkova, E.G., Stratulat, I.V., Shulimova, A.A.: Complex management of promising technologies: a case study of Russian nano-industry. Nanotechnol. Law Bus. **12**(2), 148–160 (2015)

Grincheva, N.: Sustainable development in cultural projects: mistakes and challenges. Dev. Pract. **26**(2), 236–250 (2016)

Kopnina, H.: The victims of unsustainability: a challenge to sustainable development goals. Int. J. Sustain. Dev. World Ecol. **23**(2), 113–121 (2016)

Marsh, P.: The New Industrial Revolution: Consumers, Globalization and the End of Mass Production, pp. 1–311 (2012)

Moussiopoulos, N., Achillas, C., Vlachokostas, C., Spyridi, D., Nikolaou, K.: Environmental, social and economic information management for the evaluation of sustainability in urban areas: a system of indicators for Thessaloniki, Greece. Cities **27**(5), 377–384 (2010)

Popkova, E.G., Abramov, S.A., Ermolina, L.V., Gandin, E.V.: Strategic effectiveness evaluation as integral part of the modern enterprise management. Asian Soc. Sci. **11**(20), 16–21 (2015)

Ren, X.: Building globalization: transnational architecture production in urban China. Urban Morphol. **16**(2), 165–166 (2012)

Sturn, R.: Economic citizenship rights as barriers to trade? Production-related local justice and business-driven globalisation. In: Merle, J.C. (ed.) Spheres of Global Justice, pp. 663–679. Springer, Dordrecht (2013). https://doi.org/10.1007/978-94-007-5998-5_53

Nadtochey, Y.I.: The phenomenon of one-sidedness in the policy of the USA and Russia. Int. Process. **8**(24), 85–95 (2010)