

Modelling Of Development Of Ecological Tourism

Hanna Mashika, Iryna Davydenko, Oleksandra Olshanska, Yaroslav Sydorov, Igor Komarnitskyi, Yevheniia Lypnytska

Abstract: Currently, special attention in the economy of developed countries is paid to the development of ecological tourism services. This is one of the forms of outdoor activities, where a person not only restores his health but also receives aesthetic pleasure, observing flora and fauna of the environment. The purpose of ecotourism is the rational use of nature in the tourist direction to ensure the environmental safety of the future generation and its stable development. To recognize ecotourism, the following requirements must be met: the service provided must be environmentally friendly, the transport service of tourists environmentally friendly, drinking and food products must be environmentally friendly and healthy, which must contain local products, qualified guides must accompany tourists to places of interest. The paper analyzes the three-factor model "Economics – Ecology – Social", in which the socio-cultural factor is added to economic and environmental indicators. To illustrate multidimensional qualitative variables an oriented graph is conveniently used in work, in which the vertices are a set of scenarios, and the directional arrows are possible transitions between scenarios. The described qualitative model is a flexible modelling tool and allows you to analyze the development of systems that have exceptional properties or are strongly influenced by qualitative factors. The tourism industry is a complex object consisting of various subsystems, the functioning of which depends on many external factors. These factors are sometimes almost impossible to quantify but can be qualitatively assessed, i.e. evaluate the impact of qualitative factors on quantitative indicators and how they are interrelated. Qualitative modelling is a formalized logical thinking algorithm that allows you to create a simulation model of an integrated system.

Index Terms: Development, Ecological Tourism, Modelling, Three-factor model, Ecotourism, Ecological Tourism, Environmental Safety, Tourism Industry.

1. INTRODUCTION

Tourism at the present stage is becoming an essential part of the lives of many people from different countries. Every year, the global tourist flow becomes a record compared to the previous year. Various tourist destinations are popular among tourists: from a beach holiday by the Mediterranean Sea to climbing Mount Everest. The demand for travel is becoming more diverse every year, in connection with this, there are new types of tourism that are gaining momentum and cover an increasing number of consumers [1-4]. These types of tourism include cinema tourism, photo tourism, hobby tourism, shopping tourism, extreme and ecological tourism.

So, ecological tourism has become popular all over the world for several decades due to the functions it provides, which are very significant (rest and familiarization with nature, direct and indirect participation in the maintenance and arrangement of protected natural areas, environmental education and education). Ecotourism was born as the opposite of many other types of tourism, which put a significant load on the host tourist area. Ecotourism continues to gain popularity among tourists and occupy an essential place in the tourism industry. Humankind considers the development of ecological tourism as one of the options to preserve the natural and cultural diversity of planet Earth.

Today, the term "ecotourism" is often used by travel agencies, specialists to refer to activities related to the use of natural landscapes and objects. We can name several significant projects in this area: the development of rural tourism, ecotourism in nature reserves, tours in the process of scientific conferences, etc. The phrase "ecological tourism" began to be widely used in the world in the early 80s.

The International Ecotourism Society [5] and WWF World Wide Fund for Nature [6] define ecotourism as a responsible journey to the natural areas that help to protect nature and improves the well-being of the local population.

The main criteria for ecotourism are as follows (Fig. 1):

1. Travel destination - places with relatively untouched nature or preserved authentic life.
2. The purpose of ecological travel is the study of natural and cultural features. Acquaintance with the traditional life of the locals, or acquaintance with the wildlife.
3. The tourism process does not harm natural ecosystems.
4. It is economically beneficial for residents to preserve nature and traditions [7-10].

In fact, this is not an easy task - to make public rest in nature not harmful to ecosystems, and the local population would benefit from caring for environment, preserving the traditions of the region and elevating them to the rank of cultural heritage. But there are already good examples of projects implemented in this area.

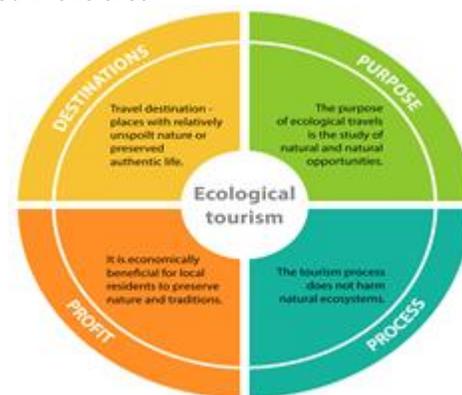


Fig. 1. Ecotourism components.

In Canada, studies have shown that wildlife-related tourism accounts for only about 1/4 of domestic tourism, which could amount to an annual income of between 660 and 1.2 trillion dollars. Thus, ecotourism can become a severe financial article in the economy of the region, and a means for environmental protection and support of nature reserves. But for this, it is necessary to prioritize and formulate requirements

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correctly. Firstly, two models of ecological tourism with different specifications for their provision are distinguished: Western European and Australian. Representatives of the first model include developed countries - Italy, Spain, France, Germany, etc. The requirements, in this case, to ensure ecotourism is very high - this is the creation of maximum comfort for a person's life in nature. Such a model requires the construction of comfortable hotels, campsites, bridges, architectural structures, deforestation for supermarkets, parking and rest houses, the development of a transport network, etc. Such tourism is expensive, but it brings high incomes. On the other hand, it leads to disturbances in natural lands, a high degree of urbanization, air, soil and water pollution, deforestation, and an increase in the disturbance factor for wild animals as a result of the accessibility of the territories where tourism is carried out [11-12]. The Australian model is implemented in Australia and the USA. The basis of this model is the concept of conservation and maintenance of natural conditions. This is consistent with both government policy and the geographic and environmental terms of Australia: extensive forests, multi-species flora and fauna are preserved here, more than 1000 Specially protected natural areas (PAs) have been created. Ecotourism, in this perspective, is aimed at the knowledge of nature and its protection. Camping, in this case, is combined with cognitive, sporting and aesthetic goals. Such tourism is often carried out on the territory of PAs. The experts of the World Economic Forum presented a ranking of the countries with the wealthiest nature in the Travel and Tourism Competitiveness Report. Criteria such as the number of UNESCO World Heritage Sites, the number of species of animals, plants and protected areas were taken into account. Also, experts investigated the ecology of the regions (Fig. 2).

Rank	Country	Value (1-7)	Trend
1	Brazil	6.1	↔
2	Mexico	5.6	↔
3	Costa Rica	5.4	↔
4	Peru	5.3	↔
5	China	5.3	↔
6	Australia	5.2	↔
7	Thailand	4.9	↔
8	Tanzania	4.9	↔
9	Spain	4.9	↔
10	United States	4.9	↔

Fig. 2. Top 10 countries with the wealthiest nature.

2 QUALITATIVE MODEL FOR THE DEVELOPMENT OF ECOLOGICAL TOURISM

Increasing demand for tourism services, characterized by an environmental focus, which is based on the principles of sustainable use of natural resources, preservation of natural, social and cultural relationships, stimulated the development of various activities. The experience of many countries and regions shows that the development of tourism, the principal and only purpose of which is to make a profit quickly, destroys the basis necessary for the successful functioning of the tourism industry. The following adverse effects of the growth of an uncontrolled tourism product on the economic, environmental and socio-cultural spheres of life in the host territory can be distinguished: ecological pollution; damage to

historical and natural monuments; cultural degradation of the area; aggravation of complex socio-economic problems. Meanwhile, the popularity of most tourist centres is often based on a clean environment and the identity of the local culture.

Nature-oriented tourism can be characterized as a complex, diverse system in which several forms of tourism that function in the natural environment are clearly identified:

- natural tourism;
- fishing and hunting tourism;
- health tourism;
- trekking (hiking);
- travel with a naturalist;
- travel by bike;
- inland water tours;
- sea voyages;
- speleotourism;
- horseback riding [13-14].

Ukraine has a rich and diverse natural complex and is no exception. The success of ecotourism in Ukraine is possible only if the basic principles of sustainable development are observed. Economic sustainability: provides economic development efficiency and a situation in which the chosen method of resource management makes it possible for future generations to use them. Environmental sustainability: ensures development compatibility with the maintenance of basic environmental processes, biological diversity and biological resources. Social and cultural sustainability: ensures that development is compatible with the preservation of cultural values and traditions, as well as local identities. Based on this, we can reflect the model of nature-oriented tourism in Ukraine in the form of a diagram (Fig. 3).

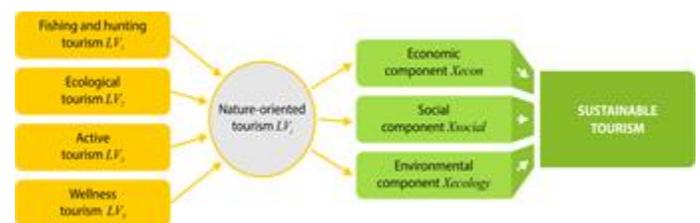


Fig. 3. Ecotourism components.

The problem of organizing investment in the tourism sector, taking into account environmental and socio-cultural impacts, is becoming more and more urgent and necessitates a tremendous practical need to conduct research on the investment process in the tourism industry and the theoretical justification of the choice of investment activities in compliance with the criteria of economic efficiency, environmental safety and socio-cultural sustainability. The tourism industry is a complex object consisting of various subsystems, the functioning of which depends on many external factors. These factors are sometimes almost impossible to quantify but can be qualitatively assessed, i.e. evaluate the impact of qualitative factors on quantitative indicators and how they are interrelated. Qualitative modelling is a formalized logical thinking algorithm that allows you to create a simulation model of an integrated system. Qualitative modelling methods will be used in this study to model ecological tourism in Ukraine. The first step in qualitative modelling is the identification (identification) of all variables of a qualitative model: X1, X2,

..., Xn. The generated set of variables contains both exogenous and endogenous variables. At the next step, using logical thinking, expert estimates or results obtained by quantitative methods, it is necessary to determine pairwise interdependencies of variables. Figure 4 shows examples of six possible dependencies between two variables.

Using graphs, you can formalize information that cannot be taken into account using ordinary equations. The relationship between every two variables is described using a triplet:

$$(X_i, DX_i/DX_j, DDX_i/DDX_j) \quad (1)$$

Obviously, the variables are not always connected by an unambiguous relationship, which means that it is not still possible to describe pairwise relations between all variables. However, qualitative modelling does not require the determination of all pairwise dependencies: it is sufficient to determine a reasonable number of logical connections.

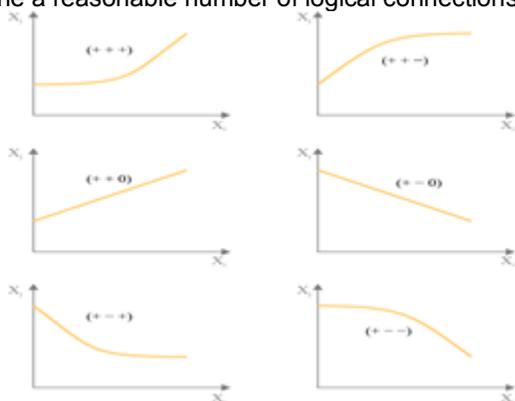


Fig. 4. Qualitative addictions.

A qualitative decision is considered defined if the corresponding qualitative triplets describe all the qualitative variables:

$$(X_1, DX_1, DDX_1), (X_2, DX_2, DDX_2), \dots, (X_n, DX_n, DDX_n) \quad (2)$$

where X_i is the i th variable, and DX_i and DDX_i are the first and second qualitative derivatives, respectively, of the independent variable t (usually t is a time parameter).

Qualitative model has m qualitative scenarios. A set of m qualitative n -dimensional scenarios can be described using the following set of triplets:

$$\left[\begin{matrix} (X_1, DX_1, DDX_1), \\ (X_2, DX_2, DDX_2), \dots, \\ (X_n, DX_n, DDX_n) \end{matrix} \right]_j, j = 1, 2, \dots, m \quad (3)$$

Using a simple algorithm that obeys mathematical principles, one can determine all possible transitions for one-dimensional triplets. For example, a triplet $(-- +)$ can go into a triplet $(--0)$, or $(-0+)$, or (-00) . Accordingly, for n -dimensional transitions, it is necessary to comply with the transition rules for n one-dimensional transitions.

To illustrate multidimensional qualitative variables, it is convenient to use a directed graph in which the vertices represent a set of scenarios, and the directed arrows

represent possible transitions between scenarios. The described qualitative model is a flexible modelling tool and allows you to analyze the development of systems that have exceptional properties or are strongly influenced by qualitative factors.

3 ECOLOGICAL TOURISM DEVELOPMENT MODELLING.

We introduce the following variables into the qualitative model of the development of the ecological tourism complex "Economics-Ecology-Social".

Private investment in a tourist complex (InvP). Investments are a determining factor in the development of any industry and any region. The main problem of the ski tourist complexes of Ukraine is the high seasonality: a massive flow of tourists falls in the winter. Green summer tourism needs to be developed. The prospects and return on investment in the summer ski resort are well recognized internationally; therefore, when creating a favourable investment climate for international investment, this type of tourism can be expected to develop. Public investment in the tourist complex (InvST). State investments are necessary for the development of the region's infrastructure, the low level of which is currently one of the main constraints to the development of tourism. Government Environmental Investment (InvSE). These investments are necessary to maintain the ecological balance of the region, which should be controlled at the highest level. The level of development of summer ecotourism (SummerT). The development of summer and off-season tourism will solve the problem of seasonality that exists today. The presence of a well-developed infrastructure of summer tourism will significantly increase the image of the region, as many types of summer tourism are prevalent all over the world. Infrastructure (Inf). A necessary factor in the development of the tourism industry. Without a developed infrastructure, it is impossible to attract enough private investment. Obviously, the development of infrastructure will inevitably lead to environmental degradation. Therefore, measures must be taken to compensate for this effect. Image of the region (Image). The image of the area is vital for both investors and tourists. Therefore, this factor also affects the attraction of private investment and the profitability of the entire tourism complex as a whole. Ecology (Eco). A factor that must be taken into account to preserve the uniqueness of the natural complex of the Ukrainian Carpathians and ensure sustainable development of the region. Profitability of a tourist complex (Profit). It characterizes the effectiveness of the functioning of the tourist complex, affects the success of attracting private investment. Sociocultural satisfaction (Social). It is manifested in improving the quality of life of local communities, in supporting and expanding cultural wealth by contributing to their knowledge and preservation. Social comfort is largely determined by the level of public investment, and also increases if tourism brings income to the local population. To determine all possible qualitative scenarios of the presented models, it is necessary to identify the signs of the derivatives of the dependent variables based on the independent variables and relationships given in Table. 2. With known values

Table 1 shows all the links of variables in the model "Economy - Ecology - Social", based on the judgments made above, and recorded in the form of triplets.

Using the programming language R, a program was written to search for all possible qualitative scenarios of the models

under consideration. As a result, it was found that the “Economics – Ecology – Social” system can be in 35 states (table 2). To determine all possible qualitative scenarios of the presented models, it is necessary to identify the signs of the derivatives of the dependent variables based on the independent variables and relationships given in Table 1 above. With known values

$$\text{sign}(DY / DX), \text{sign}(DDY / DDX), \text{sign}(DX / Dt), \text{sign}(DDX / DDt) \quad (4)$$

need to determine the value of

$$\text{sign}(DY / Dt), \text{sign}(DDY / DDt) \quad (5)$$

TABLE 1.

Qualitative Dependencies in the Model “Economics – Ecology – Social”

		x1	x2	x3	x4	x5	x6	x7	x8	x9
		InvP	InvST	InvSE	SummerT	Inf	Image	Eco	Profit	Social
x1	InvP				++-					
x2	InvST					++-				++-
x3	InvSE							++0		
x4	SummerT						++-			
x5	Inf	++-						++-		
x6	Image	++0							++0	
x7	Eco									
x8	Profit	++0								++-
x9	Social									

TABLE 2.

Qualitative scenarios in the model “Economics – Ecology – Social”

	Eco	Image	Inf	InvP	InvSE	InvST	Profit	Summe rT	Social
[1.]	+++	+—	+—	+—	+++	+—	+—	+—	+—
[2.]	+++	+—	+—	+—	+++	+0	+—	+—	+—
[3.]	++-	+—	++	+—	++-	++	+—	+—	+—
[4.]	++0	+—	++	+—	++0	++	+—	+—	+—
[5.]	+++	+—	+—	+—	+++	++	+—	+—	+—
[6.]	+++	+—	+0	+—	+++	++	+—	+—	+—
[7.]	+++	+—	++	+—	+++	++	+—	+—	+—
[8.]	+0+	+0-	+0-	+0-	+0+	+0-	+0-	+0-	+0-
[9.]	++	++	++	++	++	++	++	++	++
[10.]	++	++	++	++	++	++0	++	++	++
[11.]	+—	++	+++	++	+—	+++	++	++	++
[12.]	+0	++	+++	++	+0	+++	++	++	++
[13.]	++	++	++	++	++	+++	++	++	++
[14.]	++	++	++0	++	++	+++	++	++	++

[15.]	++	++	+++	++	++	+++	++	++	++
[16.]	+00	+00	+00	+00	+00	+00	+00	+00	+00
[17.]	++-	++	++	++	++-	++	++	++	+—
[18.]	++0	++	++	++	++0	++	++	++	+—
[19.]	+++	++	++	++	+++	++	++	++	+—
[20.]	++-	++	++	++	++-	++	++	++	+0
[21.]	++0	++	++	++	++0	++	++	++	+0
[22.]	+++	++	++	++	+++	++	++	++	+0
[23.]	++-	++	++	++	++-	++	++	++	++
[24.]	++0	++	++	++	++0	++	++	++	++
[25.]	+++	++	++	++	+++	++	++	++	++
[26.]	+0-	+0+	+0+	+0+	+0-	+0+	+0+	+0+	+0+
[27.]	+—	+++	+++	+++	+—	+++	+++	+++	++-
[28.]	+0	+++	+++	+++	+0	+++	+++	+++	++-
[29.]	++	+++	+++	+++	++	+++	+++	+++	++-
[30.]	+—	+++	+++	+++	+—	+++	+++	+++	++0
[31.]	+0	+++	+++	+++	+0	+++	+++	+++	++0
[32.]	++	+++	+++	+++	++	+++	+++	+++	++0
[33.]	+—	+++	+++	+++	+—	+++	+++	+++	+++
[34.]	+0	+++	+++	+++	+0	+++	+++	+++	+++
[35.]	++	+++	+++	+++	++	+++	+++	+++	+++

Based on possible one-dimensional transitions using a programming language for statistical data processing R, a syntax was written to construct a graph of possible transitions between system states. Models can be represented in the form of figures whose vertices are the dynamic states of the systems from Table 2. The arrows indicate the possibility of transition between countries (Fig. 5). Visual analysis of the obtained graphs, analysis of the dynamics of the target variables of the "Profitability", "Ecology", and "Sociocultural satisfaction" models make it possible to identify the main state clusters of the modelled systems. For a better understanding of the essence, each cluster was given a conditional name based on knowledge of the dynamics of the target variables. In our model, there are two “good” clusters (“Rich, happy, relatively clean”). In these clusters, the variable responsible for the ecology of the region decreases, however, with a positive second derivative. Variables characterizing profitability and sociocultural satisfaction are growing. From the cluster "9–10–13–14–15" it is easy to get into the cluster "11–12", where enormous damage will be done to the environment. This can happen in the case of high growth rates of infrastructure, as well as a sharp reduction in public investment in the background.

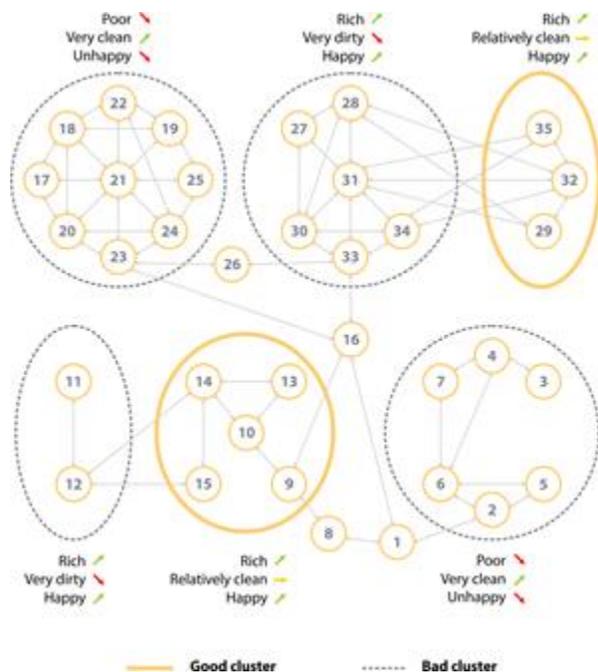


Fig. 5. Ecotourism components.

From the “29–32–35” cluster it is also easy to get into the “Very dirty” cluster, but the possible reasons for the transition will differ. In this cluster, the growth of infrastructure will not have any consequences, since it is characterized by exceptionally high growth rates of infrastructure, and at the same time, an acceptable level of ecology is maintained. The only reason for the transition to an undesirable cluster will be a sharp decrease in the level of public investment in the environment. Thus, the 29–32–35 cluster surpasses the 9–10–13–14–15 cluster for two reasons: firstly, it is more stable, and secondly, it is not irrevocable. Within the framework of this cluster, it is possible to move from a moderate growth of the sociocultural satisfaction factor (scenario No. 29) to accelerated growth of this factor (scenario No. 35), while the remaining elements will remain unchanged. The optimal cluster “29–32–35” is characterized by the dynamics of the variables included in the model, shown in Figure 6. In the “Economics – Ecology – Social” model, in the optimal cluster, the growth of most variables (“Profitability”, “Image”, “Infrastructure”, “Private Investments”, “Summer Ecotourism”, “State Investments”) is provided at a faster pace (second derivative triplet is positive) due to the inclusion in the model of a variable that takes into account the social aspect. As the analysis of the interdependence of variables shows, the critical factor is infrastructure development.

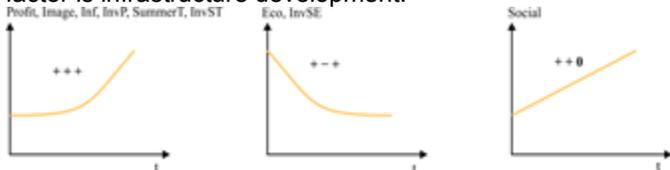


Fig. 6. Dynamics of variables in the cluster “Rich and relatively clean”.

When implementing design decisions in order to comply with the principles of ecological balance, protective engineering and geological measures should be provided for in the

construction of all facilities, compliance with environmental and sanitary-epidemiological standards when locating engineering transport and recreational infrastructure facilities, comprehensive landscaping and rational greening of the territory, the introduction of a separate collection system for solid household waste on the territory of the tourist and recreational zone and much more. Taking into account the modern achievements of scientific and technological progress, it seems possible to bring ecological tourism of the Ukrainian Carpathians to the international level, minimizing the negative impact of the developed infrastructure with strict compliance with all environmental standards, the introduction of energy-saving technologies and the use of ecofriendly equipment. The created algorithm for the qualitative modelling of sustainable tourism development paths can be further used for specific tourism projects, optimizing investments in the tourism industry, as well as for high-quality modelling of complex systems in various areas of the regional economy.

4 CONCLUSION

Many tourist centres are gradually switching to ecological tourism. Even those places that, in their essence, cannot claim to be ecotourism centres with unspoilt nature, apply some initiatives that make the world cleaner and travel conscious and environmentally friendly. This applies to hotels, transport, food, energy. Hotels want to become more environmentally friendly: many large chains have stopped using small plastic bottles with cosmetics (instead of them, a dispenser is installed in the bathroom, which is filled with shampoo or shower gel) and wash towels at the request of guests (rather than without fail every day, as it was earlier) - this saves resources. One more step: large hotel chains in Asia and Central America stopped using plastic straws for cocktails and disposable plastic dishes: they were replaced by bamboo straws and decomposable plates from potato starch. So hotels support local producers and reduce the amount of plastic garbage that enters the oceans, eventually falls into small pieces, forms entire garbage islands there and causes the death of animals and birds that eat it for food.

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