Rational use of derelict buildings from the viewpoint of sustainable development

Jurgita Antuchevičienė and
Edmundas Kazimieras Zavadskas

Department of Building Technology and Management,
Vilnius Gediminas Technical University,
Sauletekio al. 11, LT - 2040, Vilnius, Lithuania
E-mail: Jurgita.Antucheviciene@st.vtu.lt

Abstract: In the paper the problem of derelict rural buildings and their environment in Lithuania is analyzed. Factors determining distribution and revitalisation perspectives of unused buildings are established by using methods of mathematical statistics. It has been estimated that the peculiarities of territorial distribution are different in various zones and of different development activities that are presented in the conception of the country's spatial development. Also, they differ according to the uses of the buildings. Sustainability indicator systems have been analysed and a system of criteria was worked out according to the common principles of sustainable development and to explored local peculiarities. The designed model of the indicator system is suitable for multiple criteria decision-making. It is also possible to adjust the proposed model for similar demands of other transition countries.

Keywords: sustainable development; derelict buildings; derelict environment; sustainability indicators; multiple criteria analysis.

Reference to this paper should be made as follows: Antuchevičienė, J. and Zavadskas, E.K. (2004) 'Rational use of derelict buildings from the viewpoint of sustainable development', *Int. J. Environment and Sustainable Development*, Vol. 3, No. 2, pp.96–110.

Biographical notes: Jurgita Antucheviciene is a Doctoral student and an assistant at the Department of Building Technology and Management at Vilnius Gediminas Technical University, Vilnius, Lithuania. Her previous qualifications include a Bachelor's degree in Engineering Sciences and a Master's degree in Social Sciences. Current research interests focus on: revitalisation of rural buildings, sustainable development and sustainability indicators, multiple criteria analysis and decision making.

Professor Edmundas Kazimieras Zavadskas is Principal Vice-Rector of Vilnius Gediminas Technical University, Head of the Dept. of Building Technology and Management at Vilnius Gediminas Technical University, Vilnius, Lithuania. He is Doctor of building structures (1973) and Dr. Sc. (1987, Building Technology and Management). He is a member of the Lithuanian and a member of several foreign Academies of Sciences. He is Doctore Honoris Causa (Poznan, Sankt-Petersburg). Research visits to Moscow Civil Engineering Institute, Leipzig and Aachen Higher Technical Schools. Close academic links with the universities of Aalborg (Denmark), Salford and Glamorgan (Great Britain), Poznan University of Technology (Poland), Leipzig Higher School of Technology, Economics and Culture (Germany) and Aachen

Higher Technical School (Germany). He is member of international organisations and a member of steering and programme committees at many international conferences. E.K. Zavadskas is a member of editorial boards of several research journals. He is author and coauthor of more than 300 papers and a number of monographs in Lithuanian, English, German and Russian. Research interests: building technology and management, decision-making theory, automation in design and decision support systems.

1 Introduction

Since 1987, when the World Commission on Environment and Development defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [1], sustainable development has received significant attention from the global community at international, national and local levels. To accomplish these tasks, a balance must be kept between growth, prosperity and the needs for economic as well as social development. The introduction of environmentally friendly products with a reduced consumption of natural resources, energy, and decreased emissions of pollutants needs to be promoted. Accordingly, human and natural environmental considerations need to be considered in economic decision making.

Sustainable development continues to receive increasing international recognition and it has become a key guiding principle for the global society at the start of the new millennium [2]. The European Union pays great attention to attitudes towards sustainable development. It has the most comprehensive and advanced environmental legislation in the world. That is the reason for requiring a clean and healthy environment for EU candidate countries from Central and Eastern Europe.

Enlargement of the European Union from 15 to 28 or more countries will bring with it at least a further 170 million inhabitants, a 58% increase in land area and a unique set of environmental problems and assets [3]. There are specific problem areas and objects in these countries, such as heavily polluted ex-military sites, industrial centres and large agriculture complexes that do not satisfy current technological, economic and ecological requirements and are located in the former Soviet Union countries. The question of rational management of such objects and their territories must be solved according to the viewpoint of sustainable development, because the Europe Union focuses on integration of the environment into economic and social areas. Environment and economic development are not mutually exclusive, neither is the welfare of people, according to the point of view of the EU.

The problem of derelict and mismanaged rural buildings in Lithuania that have a negative influence on the landscape, environment and economy has been analysed in this paper. Rational revitalisation of objects and their environment is modelled according to the aspect of sustainable development. The indicator system is designed and fitted for multiple criteria decision making. The system of criteria has been worked out according to common principles of sustainable development, to local conditions and to peculiarities of a problem. Existing sustainable development indicator systems have been analysed and the present situation in rural areas has been explored with the help of mathematical

statistics. Research results and their possible applications are presented in the reminder of this paper in more detail.

2 Specific features of countries in transition according to environmental, social and economic sustainability

When analysing sustainable development, two categories of countries are usually distinguished – developed countries and developing countries. Problems of poverty, equity, education and healthcare services are typical of developing countries. The developed countries face problems of an excessive consumption of natural resources and environmental pollution. Despite the mentioned differences, both groups of countries have a common feature, because their development takes place in the path of natural evolution. At the beginning of the last decade, after the former Soviet Union collapsed and the Soviet block was broken down, a third group of countries with specific features of their development were formed. The main feature of these post-communist countries is that they were deprived of the possibility of natural evolution [4].

The Soviet dictatorship showed respect neither for nature nor for humankind. Both were subordinated to the main goal of expanding material production, without regard for the wellbeing of the population, its quality of life, or for the natural environment. Environmental legislation meant little in a nation that was not based on constitutional principles. Soviet legislation consisted of grand pronouncements and largely unenforceable standards [5]. Soviet agriculture was environmentally destructive and wasteful of natural resources. Land was impoverished and eroded by unscientific attempts to extract higher yields. Chemical fertilizers and pesticides were overused on collective and state farms. Unique to the Soviet Union was the environmental impact of the militarised Soviet economy. Military bases contaminated the environment with fuel, lubricants, dumped garbage and equipment, and polluted groundwater supplies. Troop exercises destroyed forests and ruined agricultural land. Also, pollution was generated by the production and storage of chemical and nuclear weapons [6,7]. The mentioned problems were typical of the Baltic States because the Soviet government treated the non-Russian republics like colonies, exploiting their natural resources, degrading the land and locating polluting industries on their territory.

Lithuania started to implement its political, social and economic reforms a decade ago. Since the beginning of the restoration of independence in Lithuania attention has been focused on targets of a sustainability policy. During the last ten years Lithuania had the possibility to choose the way in which it was going to be developed. Lithuania has chosen the way based on the market economy and private property. In June 1992 the representatives of Lithuania took part in the United Nations conference on Environment and Development and they declared support for the way of sustainable development. Our country has joined a new era of economic, social and environmental sustainable growth. Now Lithuania is in the process of transition to a market economy with all the difficulties of the transition period [8].

On the basis of a new national economic development policy and taking into account new environmental protection problems and objectives, the Parliament of the country approved the Environmental Protection Strategy of Lithuania in 1996. The Government adopted an Action Program that aimed at a clean and healthy environment, biological diversity and landscape conservation and an effective consumption of natural resources.

Then, for the first time the term 'sustainable development' was officially mentioned in our country [4]. The environmental protection strategy was based on principles laid down in the Rio de Janeiro Declaration.

The Master Plan of the Republic of Lithuania is prepared till 2020 with correct realisation principles for sustainable development. The basic principle of the Master Plan is to ensure sustainable development of the country's territory, designating the best possible way to use the territory without harm to landscape and without violating the interests of the present and future generations. The Lithuanian Environmental Strategy and Action Programs are also based on these principles. In 1996–1998 the National Strategy for the Implementation of the Framework Convention on Climate Change, the National Strategy and an Action Plan for Biodiversity Conservation, Ecological Education Strategy and Action Plan were prepared and adopted. In 2000, Lithuania signed the Convention on European Landscape. This allows the country to develop protection and management of the landscape more intensively within the context of the system of European law and to formulate a more accurate state policy in this sphere.

Essential changes to the political and economic system determined great changes in different fields, which should be taken into account when analysing the experiences and prospects of development of the country.

3 The object of the research: derelict and mismanaged rural buildings

Rural property constitutes an important part of the economic potential in Lithuania. Buildings used for farming and as part the rural infrastructure constitute a great part of this type of property. Most of these objects were built during the Socialist years under social economic conditions. Political and economic changes were followed by an unsuccessful reorganisation of the agricultural sector in Lithuania.

The past decade has been a period of cardinal changes for the Lithuanian villages. Within the system of collective farms deteriorating and rapidly forming private farms, not only agricultural production but also the entire life of the rural population changed in essence. After the re-establishment of Lithuania's independence in 1991 the land reform legitimated private land ownership. In 1992, after the properties of collective and state farms had been privatised, people's farms, agricultural partnerships and other agricultural enterprises were established. However, most agricultural partnerships collapsed in a short time. In 2000, the areas of farm crops belonging to farmers and other inhabitants constituted over 87% of the total area of farm crops. This is characteristic in that private farms are small in Lithuania. In 2000, the average farm was 12.6 hectares and over 80% of the farms were smaller than 10 hectares [4]. Also, a majority of agricultural buildings are private property, but they are not used and have almost been destroyed. Many rural properties, due to their large parameters, energy susceptibility, technological and external (economic) depreciation do not meet the contemporary production requirements. Small farmers are not capable of using or holding large complexes in proper condition. These buildings do not satisfy the present technological, economic and ecological requirements. Much investment is required for the purpose of using these objects. Furthermore, quantities of agriculture production are declining and a part of the agricultural buildings will become derelict unless they are redeveloped and adapted for other uses. Animal production has decreased rapidly in the transitional period. As compared with 1990, only about 40% of meat and 60% of milk and eggs are produced. The main reasons for

such decreases are the restructuring of the agricultural sector and essential changes in the domestic and foreign markets. During the years of collective farming in seeking to provide the deficit market of the former Soviet Union with agricultural products, Lithuanian agriculture was thrown off balance and the production sector has been developed hyper-trophically.

As a result of the mentioned transformations, there are many derelict and mismanaged buildings in the rural areas now. According to data from the Lithuanian State Territorial Planning and Construction Inspectorate, there are nearly 6,300 derelict buildings and nearly 1,100 mismanaged buildings in the countryside. These objects occupy about 962 ha. This constitutes 0.52% of the total building area in Lithuania. These buildings are not used for any kind of activity. Many of them are semi-derelict and are falling into decay. A similar problem is relevant in other former socialist countries. Such a phenomenon is negatively influencing the economy of the country. It is hard to revitalize these buildings because of technological and economic changes during the last decade. They are also negatively influencing the environment and landscape, threatening people's safety and wasting the real estate whilst decaying irreversibly.

4 Goals and methodology of the research

The primary goal of this scientific research was to prepare suggestions and a model for the establishment of regeneration priorities of derelict property and its environment according to the general principles of sustainable development concerning local conditions and specific features of the object.

The solution by way of illustration is modelled on analysing buildings in the rural areas of Lithuania. These objects were built in the time of Soviet occupation and they are derelict and mismanaged at present. Many such properties are simply turned into warehouses or not exploited at all and are losing their trading and technological value. Many rural people are unemployed due to a rapid and not very successful reorganisation of the agricultural sector, during the transition period. A lot of social and cultural properties have also been damaged. This phenomenon exacerbates the social and moral crisis of the rural population in our country. Also, the territories of these buildings are not ecologically stable due to weak environmental legislation in the socialist years. Devastated objects are ruining the landscape and negatively influencing the environment. Consequently, rational possible use of derelict buildings from the viewpoint of sustainable development have been analysed in this paper. The economic benefits of revitalisation are combined with environmental potential as well as social interest.

There are several possible ways of arranging mismanaged buildings and their territories. It is necessary to set new ecologically motivated priorities in areas where huge anthropogenic intervention was made. Growing urbanised territory areas reflect the increase of the anthropogenic impact on the landscape. For example, in 1990–1995 a part of the annually urbanised territory in Lithuania consisted of about 0.01%, whilst in 1995–2000 the urbanisation rate increased by four times [4]. Buildings that are in a better state should be renovated and used for other purposes, especially since in the European Union and in Candidate Countries attention to urban renovation is given as opposed to development on new sites. Revitalisation variants should be selected according to technical conditions, social interests and environmental possibilities. A wish to use

land not for agricultural purposes, but for active recreation or for new construction, rapidly and essentially changes the traditional landscape structure, visual expression and threatens natural and cultural values. After the re-establishment of independence, a lot of attention was drawn to the development of the protected areas system in Lithuania. During the past decade the territory of protected areas more than doubled (from 4.7% to 11.9% of the territory of Lithuania) [4]. Therefore, revitalisation variants should match the common principles of sustainable development as well as the singularities of the analysed locality.

Buildings with great depreciation and those not fit for renovation must be dismantled instead of falling into decay or simply demolition. Dismantling instead of demolition helps to separate different building materials and to reuse and recycle materials giving superior utilisation options [9]. Recovering and reusing building materials can partially reduce the environmental impacts of the construction industry by decreasing the volume of construction and the demolition waste stream, conserve natural primary resource stocks and landfill space and generate a new source of building materials that is less energy and resource intensive.

The development policy and priorities must be based on reliable scientific information and knowledge. The revival of rural property as a process of investment and substantiation of the financing method has been analysed in several scientific papers [10–12]. Multiple criteria analysis is offered to determine efficient investment instruments and efficient lenders [13].

In this paper, a sustainable development approach and multiple criteria methods are used for finding rational trends because the analysed problem is complex and includes various fields and requirements from various interested parties. A model of an indicator system was worked out according to the common principles of sustainable development, for local conditions and to the peculiarities of a problem. For that purpose, sustainable development indicator systems, as developed by scientific and governmental institutions in Europe and other countries of the world and theoretical recommendations, are analysed here. There are very wide and varied systems of indicators that have been developed internationally and by local authorities. This review embraces a wide range of SD concepts from government and non-governmental organisations, industry and research including the OECD Pressure State Response Indicator model [14], Pentagon Model [15], Quantifiable City [16], etc. In the past 20 years many environmental assessment methods as well as sets of criteria of sustainable urban development have been formulated. These include, among others: the World Resources Institute [17], the World Conservation Union-IUCN [18], the Belgian government [19], UNEP [20], the UN Commission on Sustainable Development [21], the Environmental Challenge Group of the UK [22], the UK Local Government Management Board [23], the World Bank [24], etc. [25–29]. A fair amount of initiative has been aimed at developing sector indicators for agriculture, transport and energy. But there is no universal indicator system that can be used in every situation. A unique indicator set should be developed for the best achievement of the desired goals in any given situation.

In order to manage derelict buildings, firstly the existing situation needs to be explored according to the procedure of defining the indicator sets [30]. Therefore, scientific research of the present state has been completed in this paper. Observations of these buildings' territorial distribution and their peculiarities were made in the context of the conception of the country's economic, social and ecological sustainable development. Economic and social factors determining the distribution peculiarities

of unused buildings and their environment were established by using methods of mathematical statistics.

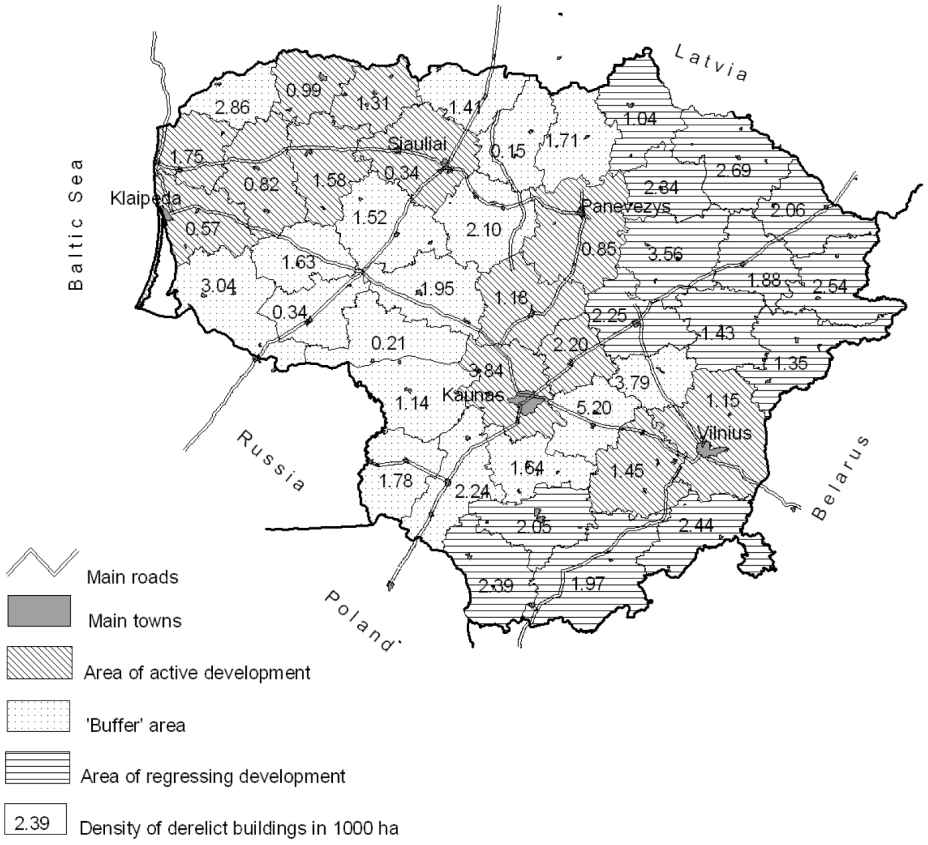
Depending on building distributions and established distinctions and the sustainable development indicator systems and theoretical recommendations that were analysed, the model of indicator system was proposed and based on these findings. Also, it is possible to realise such a model with the help of multiple criteria decision-making tools.

5 Results of the research: observed spatial distribution peculiarities of derelict rural buildings and a proposed model of an indicator system for their rational revitalisation

The relationship between derelict and mismanaged rural buildings and socio-economic conditions were analysed and spatial distribution tendencies of buildings in various regions of Lithuania were also established. In this paper, peculiarities of territorial distribution of derelict and mismanaged rural buildings in Lithuania and factors influencing them were analysed by using mathematical statistics methods. As a dependant variable in correlation, a number of derelict and mismanaged buildings in 1,000 ha of territory in an administrative region were used for this research. As independent (factorial) variables the authors used: farming land productivity grade, farming land percentage rented by farming communities, parameters of life quality, population activity indices, indices of farming and corn agriculture territorial concentration in the years 1990 and 1997.

The data is grouped into three regions according to the concept of the country's spatial development [31]. This concept is based on tendencies in the industrialisation of the country's economy, influences from the internal and external markets, the processes of the internal economy of the country, the economic, social and environmental quality, the system of settlements as well as on the inertia of the country's development. Lithuania's territory is divided into three main types of areas: areas of active development, areas of regressing development and 'buffer' areas, (see Figure 1). The largest amount of facilities held and the greatest variety of activity and maximum internal as well as foreign investment are characteristic of areas of active development. The main industries, science, cultural and facility centres and major highways are located in these territories, in contradistinction to areas of regressing development. The economic base of areas of regressing development is composed of agriculture, forestry and recreation. 'Buffer' areas take a middle place according to the character of activity, geographical and environmental situation and singularities of the local population. These differences must be taken into consideration when finding the most rational ways of derelict building management. The priorities of disposal should differ according to local requirements regarding finding a sustainable solution and meeting the environmental, social and economic needs and restrictions.

Figure 1 Lithuania and the concept of its spatial development



Also, the groups of mismanaged agricultural industrial buildings and rural buildings of other functions (housing and facilities) have also been analysed.

Several correlation matrices according to regional peculiarities and the use of buildings have been calculated and statistical connections have been estimated. Correlation matrices are compared and have the purpose of proving that their structure is statistically different. The statistic M is counted in order to compare matrices [32]:

$$M = \left[\left(\sum_{i=1}^{n} n_i\right) - k\right] \ln|R| - \sum_{i=1}^{k} \left[(n_i - 1)\ln|R_i|\right], \tag{1}$$

where n_i is the number of members of the set, k is the number of matrices compared, i=1, 2, … , k; $|R_i|$ are determinants of compared matrices, $|R|$ is the determinant of generalised and integrated matrix. The determinant of generalised and integrated matrix

$$|R| = \left| \sum_{i=1}^{k} \frac{n_i - 1}{\sum_{i=1}^{k} n_i - k} R_i \right| . \tag{2}$$

Determinants of compared matrices

$$R_i = [r] = \frac{1}{n_i - 1} \mathrm{Q}_i^T \mathrm{Q}_i, \tag{3}$$

where $[r]$ is the correlation coefficient, Q is the normalised matrix of primary data consisting of n series and $(m+1)$ columns, where m is number of factors.

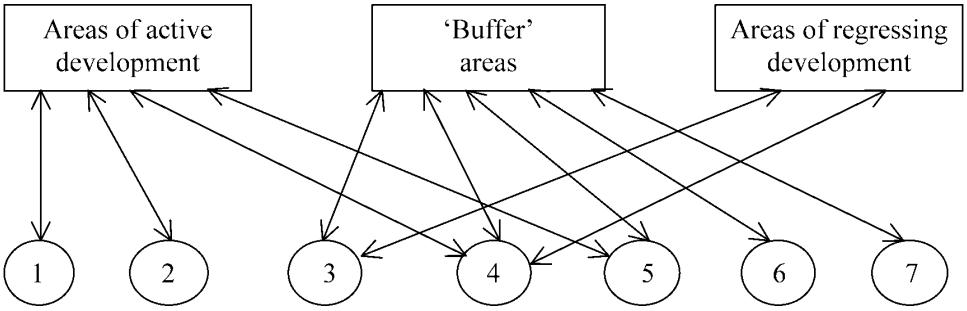
Compared matrices are not identical when $M > \chi^2_{l,\,q}$, where χ^2 – a radical of Pirson's distribution, when l is a degree of freedom and q is a level of credibility. A degree of freedom $l = {}^1/_2(k-1)\, m\, (m+1)$.

The statistics counted $M = 43.9$. With the credibility $p = 1 - q = 0.95$, $\chi^2_{l,\,q} = 43.7$. That indicates the fact that correlation structure of derelict and mismanaged buildings in areas of active development, regressing development and 'buffer' territories are different to the credibility $p = 0.95$.

The difference of the correlation structure of mismanaged agricultural industrial buildings and rural buildings for other uses (housing and facilities) was proved analogically.

Figure 2 Relation between mismanaged buildings and socio-economic factors in various zones of development activity:

1- Life quality parameters
2- Intensity index of agrarian land-ownership in 1990
3, 4- Indices of farming territorial concentration in 1990 and 1997
5- Population activity index
6,7- Indices of corn agriculture territorial concentration in 1990 and 1997



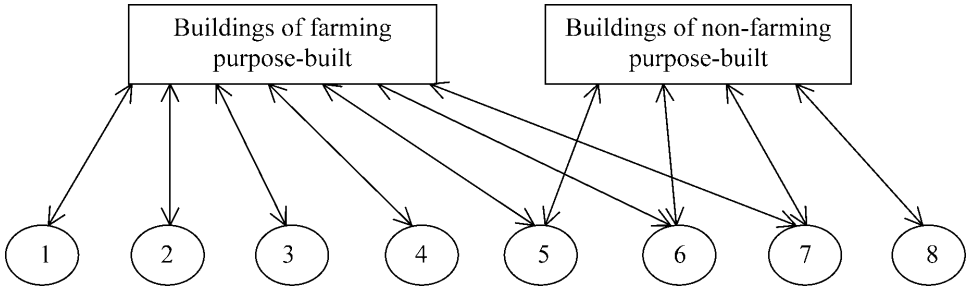
So, some conclusions can be drawn according to the results of this analysis. It is estimated that a correlation between derelict and mismanaged rural buildings and the regional concentration of economic, social and agricultural indices are different in zones of active and regressing development and in 'buffer' areas. Statistically significant relations between mismanaged buildings and socio-economic factors in various zones of development activity are shown in Figure 2**.** In areas of active development, the distribution peculiarities are influenced mostly by the population's activity indices and life quality parameters. In areas of regressing development, indices of farming territorial concentration are statistically most significant. 'Buffer' areas take an intermediate place according to their concept as well as to the results of the correlation analysis [33,34]. These connections are reversed. This point can be explained by the fact that stronger collective farms existed in districts with better agriculture conditions.

Stronger collective farms were less deteriorated and more farming communities were founded here. Farming communities use buildings for farming purposes and for their agricultural activities. So there are fewer derelict and mismanaged buildings in these regions. Many of the analysed buildings are private property, but they are not used and almost destroyed, because small farmers are not capable of using large complexes and maintaining them in a proper condition.

Analysis of mismanaged buildings used for farming showed that the distribution peculiarities of dependant variables are influenced mostly by indices of farming territorial concentration, farming land productivity and farming land percentages that are rented by farming communities. Distribution peculiarities of mismanaged buildings of other uses in rural areas are mostly influenced by the population's activity indices and life quality parameters [34,35]. There are many renovated buildings used for commercial purposes or manufacture in areas of higher activity or those with a higher quality of life, (see Figure 3).

Figure 3 Relations between mismanaged buildings for farming and non-farming purpose and socio-economic factors:

1 Farming land productivity grade
2 Farming land percentage rented by farming communities
3 Index of farming territorial concentration in 1997
4 Index of corn agriculture territorial concentration in 1990
5 Life quality parameters
6 Intensity index of agrarian land-ownership in 1990
7 Index of farming territorial concentration in 1990
8 Population activity index



The model of indicator system for the rational use of derelict buildings is designed according to the scientific research of a situation in transition and the analytical review of literature on sustainability development indicators.

Rational use of derelict buildings is analysed from the aspect of sustainable development for several reasons. Derelict and mismanaged buildings in former Soviet countries merged on the grounds of political, economic and social changes. These objects were built without proper environmental legislation. They are today, threatening the natural environment and people's safety as the buildings decay. The proper and sustainable management of these buildings and their territories could help decrease the rural, social and economic crisis as well as prevent environmental and landscape degradation. Moreover, sustainable development is greatly appreciated while planning the distribution and use of various national, local funds and financial funds of the European Union.

The solution from the aspect of sustainable development could be formalised with the help of sustainability indicators. In the research, sustainability indicators are used not for the purpose of understanding sustainability as in most analysed systems. They are used for decision making, because decisions supporting conflict solving and the involved stakeholders are also possible purposes for the use of sustainability indicators [36].

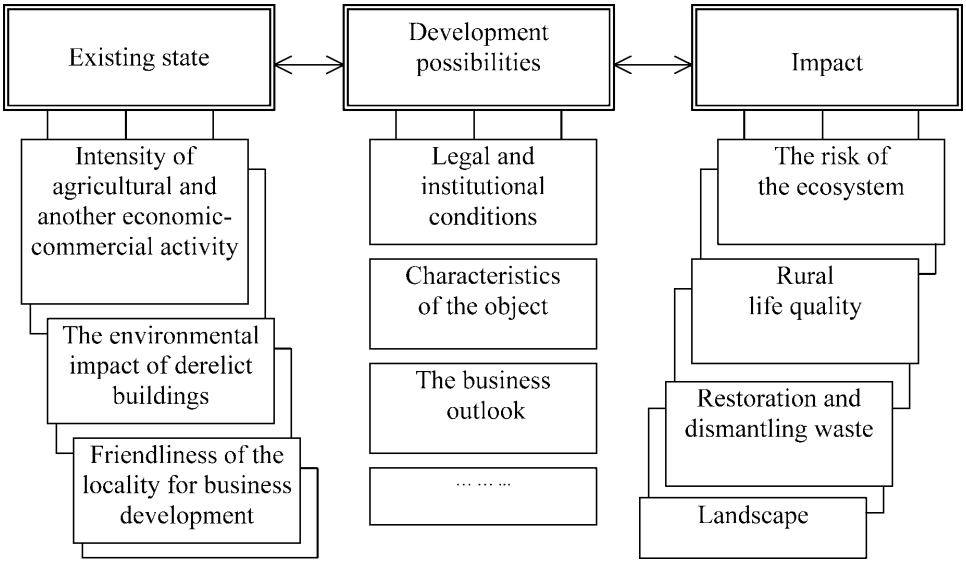
Classification of the indicators according to the typology was analysed. The model of indicator system for management of derelict rural buildings was designed on the grounds of Pressure – State – Response [14] and Driving forces – Pressure – State – Impact – Response indicator models. These models have tended to be used most often for identification and reporting on environmental indicators [37]. If other aspects are included, they become valuable tools for assessing all aspects of sustainable development [38]. When considering the specific features of an analysed problem, three typology groups are proposed, i.e. *Existing State*, *Development Possibilities* and the *Impact.*

Sustainable development requires system information. The total system is made up of a large number of component systems. Each of the systems proposed by the authors' typology group consists of several subsystems and constitute the whole system. Some of the main subsystems are shown in Figure 4. These subsystems describe various components of sustainability that are chosen according to the singularity of the problem. It is possible to change some of the component systems depending on the aim and circumstances of the research. Whilst solving the problem of derelict buildings arrangement and rational use, component systems involve the environmental impact of derelict, renovated or dismantled buildings, the economic benefits and changes in the local population's quality of life after the implementation of restoration variants and the business outlook.

In the next stage, it is necessary to define indicators that can provide essential and reliable information about component systems and the total system. All proposed subsystems consist of a number of indicators, selected from existing and approved sustainability indicator systems and adapted to local singularities and to peculiarities of the problem and are based on previous statistical research.

Indicators are quantitative in order to realise the model with the help of multiple criteria decision-making methods. The advantages of using multiple criteria decision-making methods for similar tasks are obvious and motivated by several scientific publications. In order to achieve the objective of development proposals that are more sustainable, it is necessary to explore the current situation, to identify a range of possible policies and to select the optimum for the situation under consideration. In all these cases there is a need for scientific methods and techniques [39]. Decision problems of the sustainable development type are conflicting by nature. A set of multiple goals and objectives needs to be considered simultaneously. Different stakeholders with different interests and values interacting with each other make the decision-making process much more complicated. Therefore, multi-criteria techniques seem to be an appropriate tool [40]. It can assure sustainability of the total system and objectivity of the solution and is based on mathematical methods.

Figure 4 Model of the indicator system of derelict rural building's rational use



Established spatial distribution peculiarities of derelict rural buildings in Lithuania demonstrated that the same solution is inexpedient for the whole territory of the country. The results of statistical analysis and the concept of the country's spatial development, presented in the Master Plan of the territory of Lithuania where areas of active development have been planned, outlined the possible differences between the restoration of different buildings. One ought to make renovations and use buildings not for farming in the areas of active development. In other localities these buildings can be effectively used for farming purposes and there are fewer possibilities to change their functions successfully. But the quantities of agricultural production are not increasing in Lithuania. So, damaged and unused farming objects ought to be dismantled or renovated and adapted for other activities according to local possibilities.

Appropriate statistical indexes were calculated (1), (2) and it was proved that the structure of correlation matrices was statistically different. This scientific argument confirms the assumption that the model should be adapted to local social, economic and environmental conditions.

For the reasons mentioned above, several decision-making matrices were composed. They consist of uniform subsystems that describe rural building revitalisation alternatives from the aspect of sustainable development, whilst values of criteria vary in different analysed areas and depend on restoration variants of derelict buildings and their environment. Also, the use of weighted decision making is preferable. The determination of weights of criteria allow us to distinguish the importance of the indicators. Different weights of indicators can be set in various evaluation matrices according to the existing singularities and the development possibilities that were established in previous research. The mentioned features enable us to adapt the proposed model for other goals, concerning location problems. It is possible to use the model in other transition countries and it helps to carry out objective and sustainable solutions.

6 Conclusions

The model of an indicator system for the rational use of derelict buildings from the viewpoint of sustainable development has been proposed. The model conforms to the situation of transition countries. It reflects European trends of sustainability, existing experiences in a field of indicator development and peculiarities of the problem.

It is estimated that the peculiarities of derelict and mismanaged rural building territorial distribution are statistically different in various zones of development activity as presented in the conception of Lithuania's spatial development and they differ according to the purpose of the buildings. The research indicates that the priority of rational use of buildings and arrangement of their territories depend on local features and peculiarities of the object. The same solution is inexpedient for application within the whole territory of a country and so the model should be adapted to local peculiarities.

The result of this scientific research is useful in solving problems concerning environment protection, landscape, life quality and economic sustainability, especially in Central and Eastern Europe Candidate Countries. The proposed model could be adjusted to the needs of an individual country and to a specific problem.

References

1 WCED (World Commission on Environment and Development) (1987) *Our Common Future*, Oxford University Press, Oxford.

2 National Research Council Board on sustainable Development, Policy Division (1999) *Our Common Journey: A Transition Towards Sustainability*, National Academy Press, Washington, DC.

3 Commission of the European Communities (2001) *Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions,* On the six environmental action programme of the European Community, Environment 2010: Our future, Our choice, Brussels.

4 Juknys, R. (Ed.) (2002) *National Report on Sustainable Development from Rio to Johannesburg. The Republic of Lithuania,* Vilnius, Lithuania.

5 Ziegler, C.E. (2001) 'Soviet studies: environment', in *International Encyclopedia of the Social & Behavioural Sciences,* Elsevier Science Ltd, pp.14723–14728.

6 Baltrenas, P., Ignatavicius, G. and Vaisis, V. (2001) 'Investigation of soil pollution with heavy metals in the Pabrade central military ground', *Environmental Engineering*, Vol. 9, No. 1, pp.3–8 (in Lithuanian).

7 Baltrenas, P., Oskinis, V., Ignatavicius, G. and Kumpiene, J. (2001) 'Soil transgression and possibilities of improving environmental protection in the tank field of the Lithuanian central military ground', *Environmental Engineering*, Vol. 9, No. 2, pp.103–109 (in Lithuanian).

8 Pakalnis, R. (2001) 'Sustainable development is the current modern way without alternatives', in Leal Filho, W., Pakalnis, R. and Sakalauskas, L. (Eds.): *Proceedings of the International Conference Sustainable Development in the Information Society*, Institute of Mathematics and Informatics, Vilnius, Lithuania, pp.10–13.

9 Schultmann, F. and Rentz, O. (2001) 'Environment-oriented project scheduling for the dismantling of buildings', *OR Spectrum*, Vol. 23, pp.51–78.

10 Lunkevicius, S., Ustinovicius, L. and Zavadskas, E.K. (2001) 'Possibilities of revitalization of unused rural property', *Statyba, Journal of Civil Engineering and management*, Vol. 7, No. 1, pp.44–55 (in Lithuanian).

11 Lunkevicius S., Ustinovicius, L. and Zavadskas, E.K. (2001) 'Substantation of financing approach for rural property', *Statyba, Journal of Civil Engineering and Management*, Vol. 7, No. 2, pp.148–157 (in Lithuanian).

12 Lunkevicius, S., Ustinovicius, L. and Zavadskas, E.K. (2001) 'Ranking efficiency of rural property investment projects using multicriteria decision methods', *Statyba, Journal of Civil Engineering and Management*, Vol. 7, No. 3, pp.238–246 (in Lithuanian).

13 Zavadskas, E.K., Kaklauskas, A., Banaitis, A. and Kvederyte, N. (2003) 'Housing credit access model: The case for Lithuania', *European Journal of Operational Research,* in Press, Corrected Proof, Available online 9 April 2003.

14 OECD (1994) 'Environmental indicators', *Organisation for Economic Co-operation and Development*, Paris.

15 Nijkamp, P. (1998) 'Macro-economic perspective (on SUD)', paper presented to the BEQUEST Workshop, Milton-Keynes (http://www.surveying.salford.ac.uk/bqextra).

16 May, A.D., Mitchell, G. and Krupiszewska, D. (1997) 'The development of the Leeds quantifiable city model', in P.S. Brandon, P. Lombardi and V. Bentivegna (Eds.): *Evaluation of Sustainability in the Built Environment,* E&FN Spon, Chapman & Hall, London, pp.39–52.

17 Hammond, A., Adriaanse, A., Rodenburg, E., Bryant, D. and Woodward, R. (1995) *Environmental Indicators: A Systematic Approach to Measuring and Reporting on Environmental Policy Performance in the Context of Sustainable Development*, World Resources Institute, Washington, DC.

18 Trzyna, T.C. (1995) *A Sustainable World: Defining and Measuring Sustainable Development.* IUCN, The World Conservation Union, Sacramento, Ca.: International Centre for Environment and Public Policy.

19 Gouzee, N., Mazijn, B. and Billharz, S. (1995) *Indicators of Sustainable Development for Decision-Making*, Federal Planning Office of Belgium, Brussels.

20 Bakkes, J.A., van den Born, G.J., Helder, J.C., Swart, R.J., Hope, C.W. and Parker, J.D.E. (1994) *An Overview of Environmental Indicators: State of the Art and Perspectives,* UNEP, Environmental Assessment Sub-Programme, Nairobi.

21 Moldan, B., Billharz, S. and Matravers, R. (1997) *Sustainability Indicators: A Report on the Project on Indicators of Sustainable Development (SCOPE 58)*, John Wiley and Sons, Chichester and New York.

22 MacGillivray, A. (1994) *Environmental Measures: Indicators for the UK Environment,* Royal Society for the Protection of Birds, Bedfordshire, UK.

23 Local Government Management Board (1994) *The Sustainability Indicators Research Project: Consultant's Report of the Pilot Phase,* The Local Government Management Board, UK.

24 World Bank (1995) *Monitoring Environmental Progress*, The World Bank, Washington, DC.

25 Crawley, D. and Aho, I. (1999) 'Building environmental assessment methods: applications and development trends', *Building Research & Information,* Vol. 27, Nos. 4–5, pp.300–308.

26 Deakin, M., Curwell, S. and Lombardi, P. (2001) 'BEQEST: The framework and directory of assessment methods' *International Journal of Life Cycle Assessment*, No. 6, pp.373–383.

27 Deakin, M., Huovila, P., Rao, S., Sunnika, M. and Vreeker, R. (2002) 'The procurement and assessment of sustainable urban development: mapping the application', *Building Research & Information*, Vol. 30, No. 2, pp.95–108.

28 Obst, C. (2000) 'Report of the September 1999 OECD expert workshop on the measurement of sustainable development', *Organisation for Economic Co-operation and Development, Frameworks to Measure Sustainable Development,* OECD, Paris, pp.7–17.

29 OECD (2000) 'Frameworks to measure sustainable development', *Organisation for Economic Co-operation and Development*, Paris.

30 Bossel, H. (Ed.) (1999) *Indicators for Sustainable Development: Theory, Method, and Applications*, A Report to the Balaton Group, International Institute for Sustainable Development, Canada.

31 Juskevicius, P. (1999) 'The concept of the country's spatial development', *Town Planning and Architecture*, Vol. 13, No. 2, pp.49–55 (in Lithuanian).

32 Aivazian S.A. and Mxistarian V.S. (1998) *Applied Statistics and Essentials of Econometrics,* Moscow, Junity (in Russian).

33 Antucheviciene, J. (2002) 'Territorial distribution peculiarities of derelict rural buildings in Lithuania according to the conception of the country's economic, social and ecological sustainable development', *Environmental Engineering*, Vol. 10, No. 2, pp.93–101 (in Lithuanian).

34 Antucheviciene, J. (2002) 'Relation between socio-economic development and mismanagement of buildings in rural areas', *Geography*, Vol. 38, No. 2, pp.74–80 (in Lithuanian).

35 Antucheviciene, J. (2001) 'Relationship between social economic conditions and distribution of unused rural buildings in Lithuania', *Social Sciences*, Vol. 32, No. 6, pp.49–55 (in Lithuanian).

36 Pastille Consortium (2002) *Indicators into Action. A Practitioners Guide for Improving Their Use at the Local Level*, A Product of Pastille for Local Authorities 2000–2002.

37 Ciegis, R. (2002) *Sustainable Development and Environment: the Economical Outlook*, International School of Management, Vilnius, Lithuania.

38 Wamsley, J.J. (2002) 'Framework for measuring sustainable development in catchment systems', *Environmental Management*, Vol. 29, No. 2, pp.195–206.

39 Bentivegna, V., Curwell, S., Deakin, M., Lombardi, P., Mitchell, G. and Nijkamp, P. (2002) 'A vision and methodology for integrated sustainable urban development: BEQUEST', *Building Research & Information*, Vol. 30, No. 2, pp.83–94.

40 Li, H. and Shen, Q. (2002) 'Supporting the decision-making process for sustainable housing', *Construction Management and Economics*, Vol. 20, No. 5, pp.387–390.