

RIGA TECHNICAL UNIVERSITY

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**EVALUATION METHODOLOGY OF LAND USE
EFFICIENCY IN LAND MANAGEMENT**

Summary of the doctoral thesis

Riga 2013

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Faculty of Engineering Economics and Management
Institute of Building Entrepreneurship and Real Estate Economics
Department of Building Entrepreneurship and Real Estate Economics and
Management

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Summary of the doctoral thesis

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CONFIRMATION

With this I certify that I have developed this doctoral thesis, which has been submitted to Riga Technical University for the scientific degree of doctor in economics. The doctoral thesis has not been submitted to any other university for the scientific degree.

Armands Auziņš _____

____ . ____ , 2013.

Doctoral thesis is prepared in Latvian language. It has 204 pages in total, including an introduction, 3 chapters, conclusions and proposals, 216 bibliographical sources, 11 Annexes, 7 tables, 29 pictures, 10 formulas.

Doctoral thesis and its summary are available in the Scientific Library of Riga Technical University at 10 Kipsala Street, Riga, Latvia.

Reviews of the thesis can be sent to: RTU P – 09 Promotion Council, Ms. Inga Kokorēviča, Faculty of Engineering Economics and Management, Dean department, Riga Technical University, 6 Kalnciema Street, Riga, LV-1048, Latvia. E-mail: inga.kokorevica@rtu.lv. Fax: +371 67089345.

GENERAL DESCRIPTION OF THE THESIS

Topicality of the Study

The issues of rational use of land resources and land use monitoring have at present become topical both nationally and globally on the intergovernmental level. The vital need of each country is to define land use and property rights, to determine the value of the protected matter and monitor its use, observing land policies and the basic principles of sustainable development, thereby contributing to the value of land and related resources.

The objective of territorial cohesion is to promote harmonious and sustainable development of all EU (European Union) national territories on the basis of spatial characteristics and available resources. In order to attain the goal the need for better methods of causal relationship analysis of the positive and negative effects in spatial development is determined. Thus, in the land management system it is necessary to use indicators the public can understand better, by means of which it would be possible to convincingly reveal the nature and trends of the development of the specific territory, the expected results.

The coordination of spatial development and sectoral policy trends of the economy should be promoted at all levels of administration by developing and implementing guidelines for the promotion of spatial cohesion in the sense of compulsory analysis of the effects of spatial development and regular assessment on national level. Thus for the assessment of the territorial impact monitoring indicators can be identified, as well as qualitative studies can be carried out.

In the document approved in Latvia in 2008 'Land Policy Guidelines for 2008 – 2014' a specific goal: 'to define national policy for land use and to create optimal conditions for land use and its sustainability' has been set out.

For the assessment of the results of the implemented land-use policy measures specific indicators that reveal underlying changes in the qualitative and quantitative content should be used. Inefficient use of the natural resources of the land and lack of coherent policies in land use has been mentioned in the guidelines as one of the main problems. Thus, the land policy development and implementation is to be attributed to the development of the sectors of the economy and efficiency assessment of land-use – applicable methods and the indicator system developed for this purpose in relation to the basic principles of sustainable development.

Topicality of the thesis is related to the knowledge of land use and land management within the framework of the following socio-economic and political aspects:

- the absolute limitedness of land resources and renewable biological resources;

- spatial development planning experience and challenges encountered during the implementation of the land reform;
- difference in the quality of the content of spatial planning and implementation problems;
- the results of the administrative-territorial reform and problems in determining of the development indicators of the spatial development areas;
- practices of the organisation of land use and the need for engineering infrastructure improvements in land management;
- absence of systems approach on various land-use management levels;
- Deficiencies of the real estate market and their impact on land use efficiency results.

Given the topicality of the thesis, the following **research hypothesis is proposed**: *the application of evaluation methodology of land use efficiency is closely linked to the functional goals and objectives of the specific land management level, it provides the opportunity to increase the efficiency of land use and contributes to better and more efficient way of land use from the perspective of the landowners and the public.*

In order to examine the proposed hypothesis the following **goal** has been established: *to develop evaluation methodology of land use efficiency and a system of indicators to be used in decision-making at different levels of land management.*

In order to attain the goal of the study and to examine the hypothesis the following main **objectives** have been addressed:

- 1) to analyse the present activities of land management institutions and evaluate their impact on the efficiency of land use;
- 2) to evaluate the operating usefulness of various land management institutions in terms of improving land use efficiency;
- 3) to identify the main factors influencing land use efficiency, to develop quantitative and qualitative indicators to be applied in the evaluation;
- 4) to systematize terms and concepts used in land management and in the evaluation of land land use efficiency;
- 5) to explore the theoretical aspects characterising land management and land use efficiency and to identify relevant associated concepts and processes;
- 6) to analyse the approaches, methods and indicator systems applied in the evaluation of land use efficiency for different levels of land management;

- 7) to develop the methodological solutions and substantiate its application in determining the indicators characterising the efficiency of land use at each level of land management.

The object and the subject matter of the study

The **object** of the study is land and valuable resources, related to its use including forests, water, agricultural land and other land, including building infrastructure, the main purpose of which is determined according to natural spatial characteristics, the traditional human activities, as well as the planned socio-economic and environmental development needs. The **subject matter of the study** is evaluation methodology of land use efficiency that should be applied in land management, the methodological content of which can contribute to sustainable use of land resources at regional, national, transnational and global level.

The theoretical and methodological basis of the study

The theoretical and applied research, studies and publications of Latvian and foreign scientists, published international scientific papers and studies on land management and land use efficiency, its assessment opportunities and experience in different countries on the theoretical and methodological framework: (G. Larsson, J. Zevenbergen, A. Vitikainen, D. Steudler, D. North, O. E. Williamson, A. J. Smyth, J. Dumanski, H. Demsetz, R. Costanza, I. Williamson, S. Enemark, H. Dunkerley, J. H. Spangenberg, T. L. Saaty, E. Beinat, P. Nijkamp, S. Chen, C. Pollitt, G. Bouckaert, etc.), the scientific research papers of management, economics and urban planning researchers and specialists in the field of land use management (A. Boruks, K. Špoģis, A. Dobele, J. Briņķis, O. Buka, E. Vanags, I. Vilka, J. Vanags, L. Krilovs, T. Tambovceva, V. Praude, J. Beļčikovs, O. Krastiņš Z. Markovičs, etc.), the directives, concepts, guidelines and programs worked out by the United Nations Economic Commission for Europe (ECE) and the Food and Agriculture Organization (FAO), the World Bank (WB), as well as the EU that have been implemented and are being developed; the regulations and guidelines; adopted by the Parliament and the Cabinet of Ministers of the Republic of Latvia (LR), the studies and informational materials of the Ministry of Environmental Protection and Regional Development and the subordinate organizations and institutions under supervision, the informational materials and information system data of the State Land Service, the European Commission and the databases of the Central Statistical Bureau (CSB), the scientific publications abroad and in Latvia, monographs, the latest scientific and methodological solutions to the evaluation of land use and the decision-making in the land management sector, materials from international scientific conferences and seminars, study and scientific literature available on *Ebrary*, *Scopus*, *Web of Science* and other electronic databases, publications in mass media and specialized publications and international experience in the

assessment of land use effects and investments serve as the theoretical and methodological basis of the study.

The study materials prepared by the author of the thesis and information collected and analyzed in scientific publications, experience gained by participating in international conferences and seminars, by lecturing at the university, as well as cooperating with Latvian and foreign scientists and specialists in the land management sector.

In order to attain the goal of the study, during the process of work on the study general scientific research methods: the logical-constructive, the graphic, the monographic, the analysis and synthesis, the induction and deduction, the historical approach methods the sociological research methods – the analysis of documents and collecting of information, the collation and grouping, the survey, the mathematical methods of research – statistical data analysis, the correlation, regression and dynamic time series analysis and other research methods have been used. The information base of the work consists of scientific literature, regulatory laws and other legal acts on land management, the published and unpublished data of branch ministries, data published by CSB, electronic resources, databases, publications in mass media, as well as the research results of the author.

Scientific novelty

- 1) the most significant land use problems in the land management system have been identified and a resultative evaluation of the efficiency of land use in Latvia has been prepared, as well as the factors affecting efficiency of land use have been identified and assessed;
- 2) different levels of land management and sustainable land management system have been substantiated, as well as the framework model for implementing this system and the functional model for sustainable land management process have been developed;
- 3) methodology to be applied for evaluation of land use efficiency that involves the conditions, methods, models, classifications, an indicator system, the stages of evaluation process and sequential procedures, integrating mathematical and expert assessment methods has been developed and substantiated;
- 4) based on the created framework model for land use assessment, a system of indicators, applied for evaluating the performance of land use has been designed and the land-use performance indicators have been developed corresponding to each level of land management;

- 5) an input-output-outcome framework model of land-use management has been developed in order to create and apply a system of indicators for the evaluation of the efficiency of land use in accordance with the goals of different levels of land management;
- 6) the scientific relevance and application of land management concepts and terms has been specified, as well as the terminology applied for the evaluation of the land use efficiency has been systematized and the definitions of several terms related to land management have been developed;
- 7) a set of fiscal land-use planning algorithms has been designed on the basis of the methodological framework for land use efficiency assessment to support land administration and decision-making processes and to promote better and more efficient land use.

The approbation and practical application of the research results

The author has reported the main results of the research reflected in the thesis and they have been discussed in scientific conferences, seminars, workshops and target groups with the participation of the leading experts in the industry, including those related to land-use planning and implementation, as well as the representatives of the professional non-governmental organizations of Latvia.

The results of the research carried out within the scope of the doctoral thesis have been discussed in the working group for the concept development of the Law on Land Management, as a result of which the solutions proposed by the author were included into the draft Law on Land Management. The author has prepared scientific publications and reported the results of the present and other research related to land-use management at conferences.

The methodological solutions developed during the study as well as the system of indicators used in evaluating the efficiency of land use have been practically verified on the level of local governments, by discussing them at seminars, workshops and working groups with the leading experts of the industry, land-use management professionals, by carrying out efficiency assessment and developing the set of fiscal algorithms for land-use planning, in cooperation with local government software provider and geospatial software developer experts. Publications are being prepared on the system applied in the evaluation of land use efficiency and application possibilities and results of the set of fiscal algorithms for land-use planning.

The author has participated in several research projects, within the scope of which the issues of land use efficiency, evaluation methodology in the process of land management have been studied:

Publications

The research results have been published in 19 scientific publications, including ***articles in internationally recognized peer-reviewed editions:***

1. Auzins A. Grinbergs M. Geipele I. Influence of Development of Land Use Goals to the Economics of Latvia. Proceedings of 2nd International Conference on Applied Social Science (ICASS 2012). – Kuala Lumpur, Malaysia. ISBN 978-1-61275-006-4, Information Engineering Research Institute, USA: – IERI, 2012. – pp.238-243.
2. Auziņš A., Kāpostiņš E. New Land Management Law for Providing a Sustainable Land Management in the Republic of Latvia. Proceedings of “FIG Working Week 2012 – Knowing to manage the territory, protect the environment, evaluate the cultural heritage”. – Rome: ISBN 97887-90907-98-3, online FIG database.
3. Auziņš A., Vanags J. Analytical Assessment of Sustainable Development Concept //Scientific Journal of Riga Technical University. ISSN: 1691-4341, Geomatics (11), vol.8, 2012. –pp.49-53.
4. Auziņš A., Grizāns J., Vanags J. Green Infrastructure Development – Challenge of the Modern Urban Dynamic Growth //Scientific Journal of Riga Technical University. ISSN: 1407-7337, Economics and business (3), vol.22, 2012. –pp.51-58.
5. Auziņš A., Vanags J. Conceptual Framework of the Sustainable Land Management. Economic Development and Foreign Trade. Proceedings of 1st International Scientific Conference “Whither Our Economies”. – Vilnius: ISSN (online) 2029-8501, Mikolas Romeris University, 2011. –pp.228-239.
6. Auziņš A., Vanags J. Key Social Economic Aspects of Sustainable Land Management in the Baltic Countries. Resources and Education, No.25. Proceedings of International Scientific Conference “Economic Science for Rural Development 2011”. – Jelgava: Latvia University of Agriculture, 2011. –pp.15-23.
7. Auziņš A. Zemes pārvaldības institūcijas // RTU Zinātniskie raksti. Ģeomātika. ISSN: 1691-4341 – series 11, vol. 6, 2009. –pp. 53. – 68.
8. Auziņš A. Zemes pārvaldības līmeņi un to funkcionālie mērķi. 50. RTU konferences SCEE’2009 “Scientific Conference on Economics and Entrepreneurship” krājums CD formātā, 2009.gada 15.-16.oktobris, Latvija, Rīga. – IEVF. – pp 10.
9. Auzins A. Towards more efficient transaction procedures in Latvia. Real property transactions. Procedures, transaction costs and models. Zevenbergen J., Frank A., Stubkjær E. (Eds.). – Amsterdam: ISBN 978-1-58603-581-5, COST Office, IOS Press,2007. –pp.81-97.
10. Auziņš A. Nekustamā īpašuma veidošanas institucionālie aspekti Latvijā. RTU Zinātniskie raksti. Ģeomātika. ISSN: 1691-4341 – No.1 (2005), pp. 90 – 99.
11. Auziņš A. Institutional Arrangements: A Gate Towards Sustainable Land Use // Nordic Journal of Surveying and Real Estate Research. ISSN 1459-5877, No1, Finnish Society of Surveying Sciences, Helsinki, 2004. –pp.57-71.
12. Auziņš A. Institutional Aspects of Real Property Formation: The Case of Latvia. Regional Development, No.6. Proceedings of International Scientific Conference “Economic Science for Rural Development 2004”. – Jelgava: Latvia University of Agriculture, 2004. – pp.41-46.
13. Auzins A. Land Tenure and Real Property Transaction Types in Latvia. The Ontology and Modelling of Real Estate Transactions. International Land Management Series. Stuckensmidt H.,

Stubkjær E., Schlieder C. (Eds.). – United Kingdom: ISBN 0 7546 3287 3, Ashgate Publishing Ltd., 2003. –pp.83-96.

14. Auziņš, A. Terminology Resources in Land Management: Development Need and Possibilities. Transactions of the Estonian Agricultural University 216. Baltic Surveying' 03. April 16, 2003. Estonia, Tartu. – Tartu: Estonian Agricultural University, 2003. – pp 5 –11.

15. Auziņš, A. The Role of Land Survey in Land Management System. Regional Development, No.1. Proceedings of International Scientific Conference “Economic Science for Rural Development”. – Jelgava: Latvia University of Agriculture, 2003. – pp.51-58.

16. Auziņš A. Ģeomātika. Nozares attīstības nepieciešamība un iespējas // RTU Zinātniskie raksti. Arhitektūra un būvzinātne. ISSN: 1407-7329 – series 2, vol. 3, 2002. – pp. 77 – 82.

Other important publications:

1. Auziņš A. Īpašuma topogrāfiskie uzmērījumi. ISBN 978-9984-32-916-1 – Riga: RTU Publishing House, pp. 2009 – 134.

2. Auziņš A. Zemes pārvaldības pamati. ISBN 978-9984-32-279-7 – Riga: RTU Publishing House, - pp. 2008. – 107

3. Auziņš A. Zemes pārvaldība. Ģeomātikas pamati. Štrauhmanis J., Bikše J., Klētnieks J., Balodis J., Kaļinka M., Vanags V., Zvirgzds J., Knoks M., Stūrmanis E., Auziņš A., Rausis A., Metuma O. Mācību līdzeklis. ISBN 9984-32-084-7 – Riga: RTU Publishing House, 2006. – - pp. 46–50.

Publication of research results at conferences and seminars

The author has reported the results of the research at 25 scientific and scientific-practical conferences and seminars.

The structure and the volume of the study

The doctoral thesis is an independent study, developed and written in Latvian. The study consists of an introduction, three chapters, main conclusions and proposals, bibliographic lists and attachments. The thesis includes images, tables and appendices that explain and illustrate the research content. Within the course of carrying out of the doctoral thesis more than 300 different sources, of which 216 are included on the bibliography have been used.

In the introduction the topicality of the study has been established, the object and the subject matter of the study have been set out, the goal and the objectives of the study have been determined, the structure of the thesis, the research methods have been reflected, the theoretical and methodological substantiation of the study has been provided, the limitations and the scientific novelties of the study have been determined, information has been included on the approbation of the major findings and the publicity of the study and the theses of the promotional work have been set out.

In the first chapter land use problems are described, the significance of the efficiency in land management has been demonstrated, the development of land use objectives and the impact of the results on the economy of Latvia have been researched, the problems of land use classification and the activities of land management institutions have been evaluated, the analytical assessment of land management systems of different countries and a result-based land-use efficiency rating at different levels of land management has been provided, the character and trends of the changes in the factors affecting land use results have been determined, as well as the directions for the solving of problems identified in land-use have been indicated.

In the second chapter the theoretical aspects of the efficiency evaluation of land use within sustainable land management framework have been analysed and the historical development of land use regulation and the socio-economic and environmental content of land-use has been explored, the definitions of the most important concepts and terms have been set out, the factors, influencing land use efficiency and measurable characteristics have been provided, different land use efficiency evaluating methods have been summarised and researched and indicators have been established, as well as the framework model for evaluation of land use efficiency has been created and a system of indicators has been proposed.

In the third chapter the methodological approaches for the evaluation of land use efficiency have been included and the results of the research carried out have been summarized, the land use assessment experience and the analytical evaluation and application of indicators characterizing the efficiency of land use have been provided, as well as the practical use of the methodological solutions, selected methods and the system of indicators applied in the evaluation of land use efficiency has been substantiated.

The summary of the study encompasses the resulting key findings and recommendations.

The main conclusion of the study — developed and scientifically justified methodology for evaluating the efficiency of land use is required for continuous monitoring of the use of land resources and decision-making in order to promote efficient and sustainable use of resources in the public interest.

MAIN SCIENTIFIC DEVELOPMENTS OF THE STUDY

1. Problems in land use and the role of efficiency in land management

1.1. Practical aspects and problems of land management

Land management issues are constantly focused on both in the world's most developed countries and in the so-called developing countries. In Latvia, which is still in a transition period to developed market economy, the role of the state in the land-use issues is even more topical than in the more developed European countries. One of the characteristics of Latvia and other transition countries is the lack of systemic and targeted action in ensuring oversight of land use, which in many places is dominated by the personal ambitions of individual entities rather than action under the law.

When exploring the use of the terminology related to land management area in the long term, the author concludes that the terminology is not sufficiently systematised and therefore sometimes may be misleading. The need and the opportunities for the development of land management terminology are explained by the establishing of a shared understanding of sectoral processes, relevant context, the existing traditions and experience. Constant research of terminology resources allows identifying both the formal and informal processes of creating terminology. In the result of researching of the ontology of the notions the author has come to the conclusion that the application of *concepts* in different countries varies insignificantly and between them a steady consistency may be observed, while the *terms* used are different, to be more precise — their meaning is different. The author agrees with the view of many scholars that the terms are used according *to the context* and the related objectives and content.

In the concept of Land Management Law in Latvia 'land management' is defined as 'a set of actions and measures of land policy implementation, which focuses on the promotion of sustainable land utilisation, ensuring a balance between land use and protection'. In the understanding of this concept 'land' characterises the environment for human socio-economic activities and is the basis for the existence and functioning of ecosystems, including the resource itself, and the dimensions of value and rights. Land property includes both the upper plot and the underground layers, as well as the human improvements and naturally occurring objects, such as forests and water. Thus, the term 'land use' refers to the utilisation of the useful properties of the land, whereas the term 'land protection' refers to the conservation of biodiversity, protected areas and the quality of land as well as prevention of land degradation.

When researching and analysing the practical aspects of land management and assessing the nature of land management, the author concludes that it is within the framework of land

management where the land-use problem issues should be researched and the efficiency of land use should be evaluated for the purpose of its improvement.

1.2. Land use objectives, their development and the impact of results on the economy of Latvia

Land users are landowners, tenants and possessors. *Administration and control of land management process* in order to implement certain goals and objectives is the task of the public administration entities (public authorities, municipalities and non-governmental organizations). The needs of the people have a tendency to grow. Meeting of the increasingly growing needs of the population and monitoring the activities of private sector (private land users, developers and private businesses) by limiting the negative impact of land policy and ensuring the *balancing of different interests* is one of the main tasks.

Experience and the specific character of the use of land indicates the development of long-term plans in line with the principles of sustainable development. This means that in the long-term land management needs are given priority in comparison to short-term business interests. It is also determined by limited land resources and their ability to regenerate.

Land management can be seen as an area for the implementation of the concept of sustainable development. Thus, determining of a system of criteria and indicators necessary for uniform evaluation of land use efficiency would form the necessary conditions for sustainable use of land resources, balancing at the same time both spatial development and protection of natural resources and their ability to regenerate.

Researching and analysing land use problems and their trends in land management, the author concludes that at present aspects of interaction between urban and rural areas, which are crucial for increasing the efficiency of land use come to the forefront. However, for better understanding of these interaction aspects and evaluation of the impact on national economy and regional development it is necessary to analytically assess land use objectives in urban and rural areas.

It is concluded that, in rural planning setting of land use priorities, however, is considered to be more important than in urban areas, particularly in relation to the creation of new infrastructure — strict limitation of construction works in unreclaimed natural areas. Clarifying objectives is largely dependent on the priority land uses and land acquisition in order to ensure the priority uses as well as the aspects of maintaining high level of productivity, land conservation and restoration.

Analysing *rural land* use trends, the author concludes that at least during the last decade human resource development, agricultural product market changes and migration of population to

more densely populated areas are key factors that have influenced changes in land use objectives in rural areas. Thus, these factors should be considered in order to anticipate the development of long-term land use objectives and to avoid stimulating investments in the development of infrastructure, which would have no rational use.

Urban development as well as rural area development is planned in the long-term perspective and based on the principles of sustainable development. Urban environment is characterized by limited use of resources and high environmental demands.

Analysing the trends of *urban land use* development, the author concludes, that at least during the last decade the development of human resources, socio-economic development, changes in the urban environment, interaction between cities and regions and land resource availability are the key factors affecting change in land use the objectives of the European cities and towns. Thus, these factors should be considered in order to provide long-term land use development objectives and not to promote as a result investments in the development of infrastructure, which would not correspond to the demographic and socio-economic development.

In land management land use objectives are being implemented by designing spatial development plans and determining land use conditions in the respective area. Researching and analysing land use planning and plan implementation process interactions, it is concluded that more emphasis should be placed on *high-quality planning process* that focuses on the implementation of the made decisions and approved plans which includes research and analysis of basic information, involvement of local community, researching of needs and capacity-building, development of assessed planning solutions, and as a result making justified decisions. The qualified specialists, involved in the process, have to be sufficiently competent in conflict resolution, balancing of the interests and promoting of cooperation and development in line with the needs of the local society.

Land use is planned by designing spatial development plans, thus justifying the practical implementation of better and more efficient land use, as a result of which the area would maximally benefit.

UN-ECE emphasizes land and property taxes as an important source of revenue for the budget of public sector. Property tax has an important role in the work of local governments, ensuring decentralization in the issues of land use. Exploring the experience of other countries, it is concluded that the tax revenue constitutes up to 70–90 % of local government budgets. In addition, taxes are not considered to be only a source of revenue for the budget, but more broadly as *the 'land-use planning fiscal instrument'*, facilitating production goals, providing land for construction, reducing land speculations, mobilizing land market and organizing land use.

As a result of the study it is concluded that the role of the property tax (PT) as land-use planning fiscal instrument is gradually increasing, and will continue to grow in the future, especially when the government of Latvia is planning to reduce the tax burden on labour in the country and transferring the establishing of the value of tax rate for real estate properties to the local authorities.

However, collecting and analyzing the research on the previous experience of land use and tax management, the author has not obtained confirmation that the increase of tax would promote land-use efficiency in the long term.

Nevertheless, there is a reason to believe that the contribution of each industry or the value added in the total GDP of the country has to be attributed to the implementation of the functional objectives of the industry in the specific territory.

The author has carried out a study, which aims to identify the main land use objectives and in accordance with their development in the foreseeable period of time, to characterize the impact of these developments on the sectors of the national economy of Latvia. During the research the key aspects of the interaction between the real estate market and the economy were identified, as well as the dynamics of the development of economic sectors was explored, which allowed to draw several important *conclusions*:

1. Determining of land use objectives has to be considered an important regulatory instrument for the economy, whereas economic development substantiates the actualisation of land use goals, thus mutual influence or interaction can be identified.
2. Real estate transaction prices in future will largely depend on the GDP, or more specifically on the structure of GDP. Contributing to sustainable economic development in the long term, it is necessary to focus on the real estate market as a function of the economy.
3. Municipalities should maintain updated information on the amount of property tax both in % of the GDP and in total tax revenue, as well as in tax revenue according to the land use objective (in Latvia at the moment — purpose of the real estate use) territories, allowing continuous analysis of developments in the area and contributing to the planned development of appropriate territories with the help of tax revenue as an important fiscal instrument.

1.3. Classification problems of land use

Developing of land-use classification is closely related to the collection and analysis of statistical and spatial data. When examining classification problems, the author of the study

identifies their dual nature. On the one hand, classification of certain data serves for data analysis and interpretation on relevant territories for the respective period, whereas on the other hand, data classification and aggregation is influenced by variable trends and requirements, resulting in the need to alter data parameters, structure and even methodology. In the first case, the data can be analyzed over a longer time period; however their application in many cases does not reflect the development trends in the respective area. In the second case, data analysis and comparison over time is difficult or even impossible, whereas in a shorter period of time it is possible to identify the processes taking place in the respective area with more precision.

When examining the composition of land resources in the respective territory, the prevailing resource properties can be identified, which allows determining the functionality of the territory and the purpose of land use. In the system of planned land use in the respective territory land is used in the implementation of the spatial development plans, whereas the plans are adjusted, taking into account the needs of the population and the level of the actual land use. The opportunities for the actual land use are the basis for the evaluation of a specific land unit and the administration of the tax.

When analysing the classification problems of land-use, the author concludes that the various land use classifications have to be systematised within the framework of a specific jurisdiction, determining not only their purpose and content, but also their data classification criteria, interoperability and conditions of use, as well as the procedure of updating.

1.4. Analytical assessment of land management systems

An important prerequisite for growth is the institutional framework in which the overall economic growth would benefit the majority of individuals, and this system will ensure that their earnings are not unfairly 'redistributed'. It has been researched that sustainable development is based on the rule of law and effective democracy, which is to be achieved by arranging institutions in accordance with the objectives put forward.

Based on the analytical assessment of land management systems of different countries, the author concludes that the historical trends of the land management system in Latvia indicate its more expressed compliance with the Scandinavian model and the system should be designed in the future by integrating into cooperational model of the Baltic Sea Region. At the end of the relatively long land reform period of more than 20 years, a single Land Management Law is needed in Latvia, which would provide opportunity to modernize the outdated provisions of the Civil Law related to

rights *in rem* and to include provisions of land reform that were previously included into a number of laws and which will be topical in the future into a single act of legislation. This law should determine at least the land use assessment methodology for the land in the ownership or possession of public sector, which so far has not been developed systemically in Latvia.

As a result of research and analysis of the land management systems, the author believes that the land management systems as a whole are characterized by processes of spatial development planning and implementation, whereas the operation of the systems in detail has to be assessed by analyzing the real estate transaction procedures of the respective country, thus identifying the resources necessary to provide the procedure, the regulatory normative acts and the parties involved as well as different constraints.

1.5. Land management institutions and assessment of their activities

Exploring the theoretical approaches and analyzing processes taking place in land management, the author finds that *the institutions* indicate man-made restrictions that govern the interaction of individuals. Institutions are formed to reduce uncertainty, providing a framework for casual relationships in order to facilitate protection of individual and public interests under the conditions of market economy. An institution is characterized by specific regulatory functions that include both developing of regulatory norms and their continuous improvement, as well as enforcement of the existing rules of the organization and monitoring of compliance. Thus it can be concluded that in practice the 'institution' concept is often narrowed down, attributing it only to organizations. From the theoretical point of view, institutions are studied in the institutional economics and management science.

The analysis of the actions of land management institutions and related problem issues provides an idea of the functions, objectives and responsibilities in land management of the structural units of the state and local governments as well as the characteristics of laws and regulations in the field of land law. The author believes that this kind of institutional environment analyses provides a justification for the need of constant *institutional arrangements*, as a result of which the established land management objectives are to be reached and efficient land use is to be provided.

One of the basic issues of land management institutions is decision-making and the impact of decisions, especially political decisions, on land use and development in the medium and long term.

The *functional goals* of entrepreneurs is performing of economic activities in the production or provision of services, providing cost efficiency and profitably as a result of it. However, the

operational objectives of the state authorities and local governments are related to providing stable income level to the population and continued increase of prosperity level. Non-governmental organizations are co-participants in the process of land management and represent the interests of the respective professional sector.

The public sector provides the formal institutional environment in the country and creates conditions for good practice in land management through *administrative-supervising functions*: policy development, monitoring of implementation, promotion and coordination of processes and activities.

In practice, land use management takes place specifically on the municipal level. Local governments administer taxes and fees, which constitute their budgets. According to the zoning local authorities determine the actual land use and promote sustainable upkeep of land resource value capture.

When analysing participation of non-governmental organizations in the field of land management, the author concludes that NGOs or the so-called ‘social partners’ do not directly perform any of the land-use-related functions, however their representatives and scientists are involved in the work of different cross-sectoral coordinating bodies of state authorities and advisory boards.

Land rights are related to the branch of law which regulates land use and protection issues. Many regulations and laws govern the most important areas related to the use and protection of land, which is explained by the *legal framework* in respect to land use and protection, land-use planning, real estate and property rights, use of natural resources, environmental protection and nature conservation.

When examining laws and regulations of different countries in the area of land law, it may be concluded that they are mainly centralized and envisage delegation to the downstream regulatory framework and guidelines for their respective fields.

When assessing public and private sectors acting in land management and their functional goals and objectives, as well as the regulatory framework and legal framework for land use and protection, the author has obtained the main conclusions and the study results. Absence of setting of accurate and transparent functions, lack of control for performance indicators of their implementation and achieved objectives serves as the basis for frequent domination of the ambition of individuals or groups, which in general hampers transition of the state to advanced market economy thus extending the transitional period. For the implementation of the national land policy, operational objectives and tasks established for state and local authorities and assessment of the

mentioned implementation it is necessary to create in the future justification for the operation of any authority in the area of land use, reorganization, restructuring or elimination.

1.6. Performance assessment of land use efficiency on each level of land management

When assessing the land management process, a variety of activities related to land use and land protection, the functional goals of the state and local authorities, business and household relations in land use, as well as the regulatory framework for land use and protection, different *levels of land management* are substantiated. Depending on the objectives of each level and functions performed the state, municipal and land users' level may be singled out in land management.

The author of the study concludes that performance assessment of land use efficiency in relation to the land management level interaction allows to identify the actual land use and compare it to the potential one, to implement corrections to a variety of processes to increase efficiency, which in turn would promote economically viable, socially responsible and environmentally sound decision-making. Therefore overall in the country as a result of efficient use of land resources added value would be augmented and welfare of its citizens would be increased.

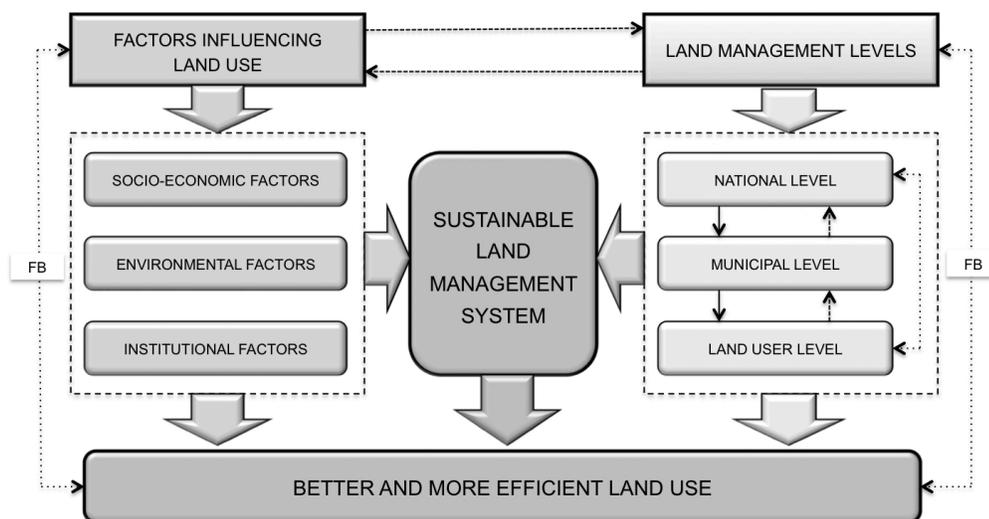
1.7. Factors influencing the results of land use, nature and trends of their alterations

A number of international reports have underlined an integrated approach and interaction of economic, social and environmental aspects. Therefore, in order to examine certain criteria or characteristics and to determine certain indicators using the appropriate available data administration systems, it would be necessary to adequately identify the influencing factors as well. Figure 1.1 contains the model of factors influencing land use results and mutually related land management levels proposed by the author in a sustainable land management system.

The factors influencing land use results are diverse and have to be researched from different perspectives.

Evaluating the various data systems and indicator-forming areas, it can be concluded that there is no clearly identifiable boundary between economic and social aspects, whereas the *analytical context* is determinant. Thus, the condition to continuously improve the *socio-economic efficiency* can be determined as an important complement to the previously assessed elements.

The elements, characterising the impact of the analyzed factors can be used in order to develop criteria and determine certain socio-economic, environmental and institutional performance indicators with the aim of theory comparison.



Abbreviations used in the figure: FB – feedback

Fig. 1.1. Framework model for a sustainable land management system

When evaluating the hierarchy of land management levels in Figure 1.1 it can be recognized that they are mutually interrelated — the coherence of national, local and land user levels is direct. The relation of the national level to land user level is indirect, which is determined by the influence of regulatory enactments determining institutional environment, including land use on the performance of the functional goals of the respective level.

Feedback refers to the objectives of each level, allowing conclusions to be drawn: if households are able to provide home consumption and savings by selling labour resources, whereas companies are able to provide economic activity and as a result to make a profit, they are able to pay taxes, fees and other payments, thus the local government can provide persistent income level and have sufficient financial resources in the budget to promote community development. Comprehensive development of local governments contributes to development of the country as a whole by increasing the GDP of the country and allowing for a steady increase in the well-being of the population. Feedback effects on the attaining of functional objectives in order to raise efficiency of land use have to be determined by evaluating the achieved resulting indicators.

1.8. Land use efficiency problem issues in Latvia and in other countries of the European Union

By researching and analysing of European experience and identifying problem issues of land use efficiency, in general it can be concluded that the range of problem issues has to be related to implementation results of land management process: to what extent *a balance* between the use of land for development and protection of land resources has been attained, ensuring their ability to

regenerate, taking into account the conditions and principles for sustainable development. This general aspect determines the need to ensure efficiency assessment for the socio-economic, environmental and institutional aspects of land use.

Land use efficiency largely depends on the implementation of the principles of land use in practice. By assessing and summarizing the experience of EU in ensuring land use efficiency, the author has identified and included into the study *land use principles*. These principles are contained in the draft Land Management Law and considered to be important for taking land use management decisions.

These principles emerge from the policies implemented in the state and enforced in the framework of land-use planning in accordance with the specific characteristics of the relevant territory, local situation and circumstances, by designing and implementation of spatial plans, detail planning, land survey projects, nature conservation plans, construction plans or by implementing real estate management activities.

The collected and analysed experience of foreign countries has shown the efficiency of resolving land use issues locally, by addressing topical problem issues at the municipal level and by implementing specific projects. Thus in the context of the respective solutions project implementation instruments and methodologies are to be studied.

2. Theoretical aspects of evaluation of land use efficiency within the framework of land management

2.1. Land use and historical development of its regulation

Land use development has a long and controversial history, related to the realization of essential individual interests and use of valuable resources. By tracing the historical stages and important aspects of this development it can be concluded that *the land use concept* also developed at the same time.

By evaluating contribution of D. Ricardo from the point of view of land use development, it is concluded that he has created justification for determining the best and most efficient land use and significantly contributed to the property tax application, which generally focuses on more rational management of territory and correspondence of tax administration to public interests, creating opportunities for wider application of the principles of equity in the development of tax system. This leads to a better understanding of land supply and demand conditions as well as better understanding of the nature of an important land management concept of 'ground rent'. Thus, ground rent is not a

natural, but an economic category, expression of certain socio-economic relations, which is closely related to property and market relations.

Historical evolution analysis of land use and its regulation suggests that in ancient times the prevailing land use objectives indicated the ensuring of individual and group livelihoods and other basic needs, whereas at present it is more related to certain distinct purposes for which spatial development plans are developed and territory use and building regulations are made. Thus, land-use regulation is determined by guidelines and the regulatory framework, the developing of which is related to public participation and agreement, according to the interests and competencies of the involved management entities.

As a result, positive changes in the well-being of citizens and activities of economic sectors are expected, constantly planning land use and implementing the land use plans in practice. The author concludes that *land use rights* resulting from planned and socially acceptable development in a given area are *an important addition to real property rights*, vitally necessary for the increase of the overall value of land resources.

2.2. Land use efficiency, its socio-economic and environmental content

Evaluating the historical development of economic theory, it is concluded that representatives of the English classical school A. Smith and D. Ricardo, who in their research discovered the efficiency opportunities of land resource use by expanding the exchange of goods across borders, may be considered the founders of the theory of economic efficiency.

By exploring the theoretical aspects of the efficiency concept in relation to land use, the author concludes that it is applied not only in the economic analysis for comparisons of resource allocation alternatives, when carrying out economic activities, but also in the analysis of the environment and the ecological systems, ensuring the protection and ability to regenerate of land resources. Thus, *land use efficiency* is defined and analyzed in relation to the theoretical aspects of the efficiency concept, but implemented in practice in relation to specific land-use planning and implementation tools.

In the evaluation of land use efficiency *value of the use of the environment*, the monetary value of those ecosystems, which are directly or indirectly used in economic activities and serve as a source of income, have to be evaluated.

As a result of the analysis of efficiency concept, the author concludes that land use efficiency has to be associated with the goal achievement and resource utility indicators. On the one hand, the efficiency indicator characterizes the success of the land management entity (public or private

sector) in achieving the initially set objectives (the result-based approach), but on the other hand, the efficiency indicator characterises the efficiency of the resources consumed in order to achieve the objectives and opportunities for optimization (the process-based approach).

However, land use efficiency has to be assessed by identifying its *qualitative changes in dynamics* in the process of land-use, by comparing the changes of the result or effect of land use to the changes in resources utilised for achieving of the effect. Thus, if the resultant effect is growing faster than the consumption of resources, the efficiency increases, whereas if the consumption of resources is growing faster than the resultant effect, the efficiency decreases. If the resultant effect increases proportionally to the consumption of resources, the efficiency is constant.

By exploring of the theoretical aspects of efficiency in relation to land use and evaluating its socio-economic and ecological content, the author proposes to define ***the efficiency of land use*** as ‘comparative assessment of deliberate action or use of land resources by land management entity derived by attributing the achieved result to the resources used in order to achieve result’.

Thus, land-use efficiency as a *condition for sustainable development* determines the need to use the values of human and land resources in such a way, that it would contribute to the *socio-economic* development, which would *constantly improve* the efficiency of consumption of available resources in the public interest without compromising the ability to regenerate of the natural resources.

The author of the study puts forward as the objective for evaluation of the efficiency of land use the following: to substantiate the best and the most efficient land use by ensuring land use planning and plan implementation in the respective area. Under this objective, the methodology is chosen and the system of indicators is developed.

2.3. The legal and economic content of the land management concept

By exploring the nature and significance of the land management concept, land management may be regarded as an important legal, economic and organizational measure significant for the economic functioning of the state designed to encourage the use of land in accordance with the interests of separate individuals and the public. Modern approach or the so-called *new land management paradigm* is described as a conceptual framework for the understanding of land administration systems and creating innovations in land management.

The positive experience of European countries indicates that land administration includes *information about the property*, its value and use and the processes of acquisition (registration) and

distribution. Thus, the real estate has to be related to the land governance rights, the value is usually associated with the real estate market value, whereas the use — to the right to use the land and benefit from it.

Subject to the modern view on the future development of land management sector and goals, the author suggests the term ‘land administration’ to be specified in the Latvian terminology and used as an integral part of land management. Thus, this term should be used in building the institutional environment in the land use management of Latvia.

When assessing the different available statements and identifying best practices, it can be concluded that the ‘land administration’ is implemented in the framework of the national land policy as a whole, which should be sufficiently clear and systematic. Land policy requires a multi-disciplinary approach, effective legal structure and updated informational resources, which in turn are required for implementation of land use monitoring and management.

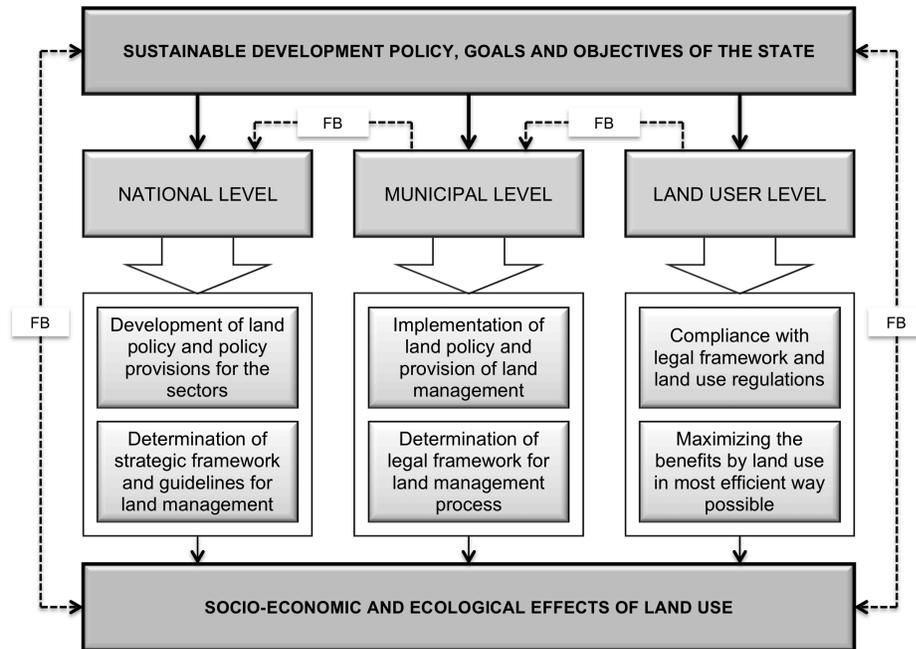
By exploring integrated land-use management development trends, the author concludes that specifically in this area the legal and economic content of land management has to be identified and appraised, because the preconditions for monitoring of the use of land resources and efficiency increase on the level of local governments have to be determined. Thus, at this level decisions are adopted and implemented relating to land use and building regulations and investments into the development of real estate and civil infrastructure, as well as means are allotted for the protection of land resources and ensuring of the opportunity to regenerate. However, in good governance the key role is attributed to cooperation and coordination of activities of all institutions involved in land policy implementation.

2.4. Land management levels and their interrelation

By evaluating land management processes, measures and the public status of the participants involved in them, the functional goals of the state and local authorities, the objectives determined for their fulfilment, the regulatory framework for land use and protection, as well as entrepreneurial, social and environmental aspects of land use, formally different land management levels can be identified.

Land management levels in relation to the objective of a sustainable system, functions of land management institutions and interests of participants of land management are reflected in Figure 2.1. Three main elements representing levels of land management are included into the sustainable land management system. Each level is represented by land management entities —

state, local government and legal possessors of land. Each of these entities has certain competence in relation to issues of land use.



Abbreviations used in the figure: FB – feedback

Fig. 2.1. Functional relationship of land management levels in the context of sustainable development

By exploring the land management system and determining its aspects of sustainable development, as well as assessing mutual interaction of land management levels it is possible to identify the entities of land management system: the legal possessors of the land, skilled professionals, politicians and community representatives who interact within the system using land resources and creating land use results or effects.

In the sustainable land management system the socio-economic, environmental and institutional aspects are dominant and the reasoning of the system has been found by analysing of mutual functional correlation of land management levels and the basic principles of the operation of the system.

2.5. Factors influencing land use efficiency and criteria

As a result of analysis of the factors influencing efficiency of land use it is possible to determine the criteria and specific indicators applied in the evaluation of efficiency.

The author concludes that specifically the *variability* of the factors influencing the land-use results indicates the importance of the concept of efficiency in the research of land management sector, by taking into account the potential objectives and results of land use, the resources needed to achieve them, in order to support and implement the best and most efficient land use. The impact studies of land use efficiency allow identifying the measure of the resident well-being in the context of sustainable development — increasing level of wealth, utilizing the least possible amount of resources for the purpose while aligning the needs with balanced sustainability.

Evaluation of the efficiency of land use is often associated with decision-making in the optimization of economic activities and the best possible management of land areas. For example, agricultural land management, by investments in improvement of engineering infrastructure and additional land acquisition in circumstances where there is uncertainty in the sales of agricultural products and initiating of other positive effects. This example displays variability of the land use intensity and its impact on land use results.

By collecting and analysing of a variety of science-based solutions for assessment of land resource usage, as well as factors and criteria influencing land use efficiency, the author proposes a framework model for evaluating land use efficiency.

The model included into the doctoral thesis shows opportunities for assessing efficiency of land use observing the *simultaneous influence* of socio-economic, environmental and institutional factors and identifying appropriate objectives and the linkages between them (see Fig. 2.2). Based on the analysis carried out in the study, it can be assumed that specifically these factors and linkages substantiate the identification of the criteria for evaluation of land use efficiency and developing of a system of the applicable indicators used in the evaluation with the aim of supporting decisions for better and more efficient use of land resources in the respective area.

The linkages characterize the interaction between the determined objectives and they are to be identified in order to promote a balance in the development of these objectives, and increase the level of welfare of the land management entities and the society in a whole. ‘Equity’, ‘acceptability’ and ‘justice’ form the internal linkages of the objectives.

However, besides these internal linkages included into the model, according to the context of the study, also external linkages can be identified. For example, ‘productivity’ as the linkage between socio-economic and environmental objectives, ‘monitoring’ as the linkage between institutional and environmental objectives, and ‘participation’ as the linkage between socio-economic and institutional objectives.

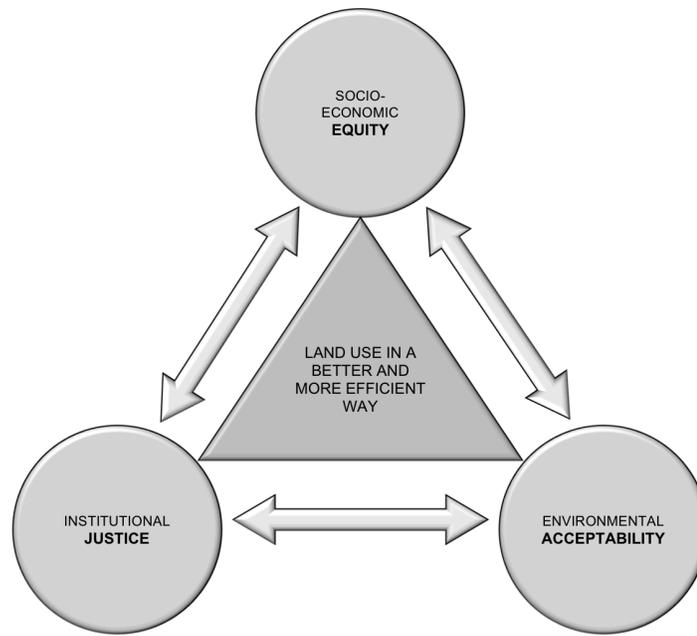


Fig. 2.2. Objectives for evaluation of land use efficiency

The external linkages are largely dependent on the development of the objectives and changes taking place in society and, therefore, their criteria have to be regarded as variable, detailable and linkable to the respective research context, namely methodological approaches of land-use efficiency evaluation and the availability of the respective data sets.

2.6. Methods applied in the evaluation of land use efficiency

At the basis of determining the efficiency of land use are the comparisons of inputs and outputs of land use as a diverse and valuable resource, its evaluation, analysis and synthesis. In line with the core of methodological solutions, according to the context of research, in order to complete a process or reach a goal, a technique or a set of techniques is chosen.

The choice of methods can be explained by the obtaining of the values of both the effects, namely the land use results and resources consumed in order to achieve the effects, as well as by the interpretation of results. For example, the application of the chosen methods allows to identify: the value of land resources, including ecological value; priorities for certain land use type, observing the diversity of land use in the respective territory; the quality of the environment; the satisfaction of inhabitants; the value of land resource consumption or non-consumption; and public benefits of either the land use or restrictions of land use.

After evaluating *the general scientific research methods*, the author believes that for evaluation of land use efficiency in the overall development context of the land management field, the logical framework method, SWOT and PESTE analysis should be used.

The developments in land management as a whole are affected by various internal and external factors. It is possible to identify the impact of these factors. Impact of these factors can be identified by evaluating the different land management levels and their goals, as well as by assessing the various objectives of land use development in order to determine the best possible and most effective land use.

The strategic development of complex economic systems is normally associated with the strengthening of the natural, comparative and acquired advantages, their further development and reducing of the impact of weaknesses. To get an idea of the competitive advantages and weaknesses of the respective system certain methods are commonly used. The most widely known is the PESTE and the SWOT analysis.

The author suggests that the two methods should be used together, including the assessment of institutional factors into PESTE analysis — *PESTEI-SWOT* in order to better assess the changes in land use efficiency and developments in land management field on the whole and to create a development strategy, which would allow to meet the needs of the inhabitants of the territory in respect to the use of land resources better.

In the scientific literature, the methods, applied in the evaluation of the land use efficiency are seldom analysed. However, in many scientific publications the methods are listed regarding to: evaluation of territory development; assesment of land-use typology, determination of the economic value of land resources; selection of indicators used in the evaluations; and the determination of the relative importance of the indicators etc.

Efficiency depends on the evaluation — the determining of the efficiency of any process is linked to the value of the result and costs of the assessor. Essentially a mathematical method, expert assessment and social survey method that would allow using *specific and weighted* efficiency indicators should be integrated into the evaluating of the efficiency of land use.

It is believed that one of the essential requirements for the application of evaluation techniques is creating of indicator time series, because important conclusions on the course of development processes can only be based on a sufficiently long observation history.

Summarizing the results of the study it can be concluded that the evaluation of territory development in Latvia through development indicators is carried out in order to obtain general information on the development of the statistical / planning regions and local government areas in

general, which does not support decision-making in order to promote more efficient use of land resources in the area. Therefore, the author argues that the territory development indexes now created in Latvia do not describe the use of land in terms of efficiency i.e. optimisation of the use of land resources and support to decision-making for better and more efficient land use.

If the goal is to determine the best and most efficient land use in a certain area, but there are a number of possible alternatives, such as to develop public building sites or expand private housing building sites, each alternative can be evaluated according to several criteria. Site development costs, environmental impact, impact on the composition of the land resources on the territory, access to public services, etc. may be evaluated. Thus, at least four criteria may be established on different measurement scales. In order to implement this purpose *Multi-Criteria Analysis (MCA)* can be used. MCA should be treated as a decision-making tool developed for the solution of complex multi-criteria problems. Such problems are related to the qualitative and quantitative aspects of the decision-making process. At present in land-use planning and land use diversification putting diverse, often — ‘conflicting’ land use objectives into balance is topical. One of the main reasons for the use of MCA in the world today is the need for implementation of an integrated approach in land use management. This analysis provides determining criteria and indicators in accordance with the objective of the research.

In order to evaluate the selected features and indicators both simple methods like ranging and rating are used and more complex, such as *the Analytic Hierarchy Process (AHP)*, which in the essence is one of the multi-criteria analysis methods. *AHP* methods facilitate decision-making in research, organizing the research problem components into a hierarchical structure. Thus, this method reduces decision complexity, providing for relatively simple pair comparisons between elements of the hierarchy. Synthesizing the results of the comparison of pairs, the method enables its user to make better decisions and to provide logical justification for the choices made. The application of the method envisages normalisation of different indicator values with different measurement units in the transition to a single non-measurement scale. In the case of alteration of qualitative indicators, such as changes of land-use pattern or in case of land resource availability, the alternatives can be evaluated using expert evaluation or the results of a survey and by determining the relative priority of each alternative, namely, weight. *AHP* belongs to the so-called subjective weighting methods, however the method envisages determining of the closeness of the subjective assessment of the experts and sensitivity analysis.

AHP is widely applied in the world for creating different indicators, offering land-use assessment model as an integrated environmental management tool and for application of result-

based multi-criteria analysis to land use decision-making, as well as in determining the relative weights of indicators for assessing the efficiency of land use and developing of tourist information systems.

Admittedly, the *AHP* method is based on subjective expert assessments, however, the study results included in several scientific publications indicate application of this method in conjunction with *Principal Component Analysis (PCA)* and *Entropy method (EM)*, the application of which according to current indicator data can provide relatively unbiased results, but their use is subject to specific prerequisites.

In association with investments in land infrastructure development and improvement, for more efficient use of land and measure the efficiency, *Cost-Benefit Analysis (CBA)* is widely used. This method is used in economics for investment or investment performance evaluation in determining the adequacy of benefits over cost-benefit assessment in monetary terms. As the investments are related to the time factor, with the help of discounting of the value of all future costs and benefits the net present value is established.

However, from the point of view of the use of land resources and environmental conservation, the application of this method for justification of investment efficiency has been subject to much criticism. Firstly, all gains and losses have to be expressed in monetary terms, whereas in many cases this leads to further complications, since not all benefits or losses can be easily transformed into cash. Secondly, when applying discounting, future damage is not averted to the appropriate extent, as many environmental benefits or damages may manifest themselves many years later. Hence discounting ‘shifts’ the public costs closer to the beginning of the period, future costs and benefits are not properly evaluated in comparison with the cost-benefit evaluation of the starting time. This is contrary to the key principle of sustainable development — inter-generational equality of opportunity. In addition, as a result of discounting, a higher discount rate contributes to faster utilization of both renewable and non-renewable resources, which generally indicates the restrictions of application of this method for evaluating of land use efficiency.

In cases where a particular goal is determined and to achieve it there is a number of alternatives, *Cost-Efficiency Analysis (CEA)* can be used. The difference of the method from the above can be found in the fact that the effect is not measurable in monetary terms and is attributable to qualitative benefits. In other words, it refers to qualitative assessment of human activities and benefits as a result of these actions. This method is used in planning and management of many processes.

Economists have developed methods with the help of which one can determine *the Environmental Economic Value (EEV)*. The environmental benefits are expressed in monetary terms, to be compared with the costs. Environmental economic valuation is based on people's opinions and priorities on the assumption that all the pollution effects can be measured in monetary terms. However, the environmental assessments in monetary terms should be used with caution, as in such valuations the risk of irreversible change as well as interconnection and interdependence of ecosystems does not appear.

One of the most complex economic evaluation methods for ecosystems envisages the determination of *the Total Economic Value (TEV)*. Scientists from different countries have developed and continue to develop this valuation concept.

Practical application of *correlation and regression analysis* methods in land-use studies envisages creating of a dynamic data series on various indicators of land use and the impact of results or consequences on efficiency. One of the main issues, which can be dealt with using this method, is the effect of different results of land-use on the efficiency of land use and the best possible use of land, as a consequence of which there would be the largest benefit. Correlation analysis allows for determining of the direction, strength, weight and reliability of the factors influencing the efficiency of land use.

Optimal decision-making method is related to the optimization of problem solving, by creating and defining models to support land-use planning, by widely applying the geographic information system (GIS) technology. For example, using of GIS with multiple analysis, the best land-use spatial assessment is justified, whereas by analysing the land use system the possible scenarios for a sustainable agricultural production system are created.

The evaluation of the multiple applications of the above *mathematical methods* allows the author to conclude that in it is possible to apply its different variations depending on the purpose and the volume of the study for assessing of the efficiency of land use in support of better and more efficient land use.

The goal of *sociological studies* is to obtain reliable and relevant information about a certain researched process or phenomenon. The course of this type of research may be divided into the stages of preparation, implementation, data analysis and obtaining of results. Both quantitative and qualitative approach can be applied in the assessment of the efficiency of land use.

Surveying of the respondents on topical issues of the use of land resources within the scope of the study, scientific methods of analysis have to be applied, careful observation has to be carried

out and accurate hypothesis has to be formulated, the results to be obtained have to be prospected, as far as possible combining surveying with other data collection methods.

Expert evaluation methods are applied in the handling and use of data obtained with the help of experts. Expert assessments are to some extent biased. Expert evaluation methods are used in situations where there is no access to objective data in order to apply the calculation methods, listed in the decision-making theory, such as index selection, prioritization, ranking, determining of validity or relative importance, choosing the best decision or synthesis etc. The mentioned aspects determine the place and role of the expert methods in decision-making.

The explored *sociological research and expert assessment methods* enable the author to conclude that in the land use efficiency assessment peer evaluation methods should be primarily used, whereas the opinion of the local community i.e. the opinion of the residents should be researched periodically by introducing of a sociological opinion polling system in relation to issues of more efficient land use. In the scope of the evaluation system the inquiry forms, a common set of indicators and the application of methods that achieve the best results in terms of efficiency should be specified.

2.7. Indicators applied in the assessment of land use efficiency

In determining indicators to be used in land-use efficiency measurements, priority should be assigned to indicators that best describe the public gain, therefore in determining them both the service providers and the recipients should be involved. To measure the result, indicators that are measurable in numbers, simple and easy to understand, logical and repeatable, timely, easily and economically retrievable and indicate causality are used. The number of the indicators to be used has to be limited in order for the acquired information to be commensurate with the resources contributed to the obtaining and processing of the information.

Indicators obtained by evaluating the efficiency of land use can be applied to describe *the inputs made* (consumed land, human, material and financial resources) and *the outputs achieved* (the indicators characterizing the achievement level of land use objectives). The relationship between inputs, outputs and achievement of the results can be described by *economic or quantitative efficiency*: the expenditure of the resources in order to reach the results (comparison of resource indicators, output indicators and resulting indicators), as well as *functional or qualitative efficiency* — output impact on the attainment levels (outcome and impact indicators).

As a result, *land use efficiency* has to be associated with the impact of gains on the meeting of residents' needs and expectations, service quality and availability, the best and most efficient way

of land use. This approach suggests assessment for sustainable use of land resources and therefore assessment of the direction of territory development or replacement of ‘compass’ with a setting up of a ‘road map’, which is useful for support and adoption of a variety of land-use management decisions.

An integrated approach substantiates decision-making processes. Thus, the indicators point out numerical information that helps to explain the changes in land use in a foreseeable period of time. According to the research context, a system of selected indicators makes it possible to gather complex information, such as information on the efficiency of varied land-use in a given area or information that describes different levels of land management.

The author concludes that in determining of the system of indicators to assess the efficiency of land use, selected indicators should be objective and measurable, mainly quantitative, easy to understand, easily accessible, current, flexible to change, comparative and dynamic, as well as suitable for substantiation of decisions.

In the assessment of sustainable development additionally to the sets of indicators the so-called aggregated indicators or *composite indicators* are used. The composite indicators are sometimes also referred to as integrated indicators or indexes that are indicative of a selected element interaction.

In the formation of the composite indicators the multi-criteria analysis method is used and they are applied to measure multidimensional concepts such as competitiveness, territory development level, sustainability and evaluating the efficiency of the regions, however in their application not only advantages, but also significant drawbacks exist.

Land use efficiency is an index that includes benefit from the same unit of land during a certain time period, using it for a particular purpose. Thus, evaluation is provided to land use efficiency as an economic category, whereas efficiency (E) is in general form expressed as a function, which includes land use result or effect and the resources used to achieve this effect:

$$E = f(Rz; Rs), \quad (2.1)$$

$$E = Rz / Rs, \quad (2.2)$$

where

Rz — effect from land-use activities;

Rs — resources consumed to achieve the effect.

In determining the efficiency of land use dynamics (ΔE) or *qualitative changes* in the process of land-use, the following relationship should be used for its evaluation:

$$\Delta E = \Delta R_z / \Delta R_s, \quad (2.3)$$

where

ΔR_z — changes of effect in relation to land-use activities;

ΔR_s — changes of the resources used to obtain the effect;

which indicates an increase in efficiency if the effect is growing faster than the resources are spent to achieve it, but the efficiency reduces if the consumption of resources is growing faster than the effect. If the effect increases proportionally to the expenditure of resources, the efficiency is regarded to be constant.

At the basis of determining the characteristics and influencing factors of the land use efficiency, as well as formation of the system of land use efficiency indicators is the potential development of human resources (population, number of employees), land resources (land area, resource quantity and diversity) and capital (capital investments, infrastructure investments).

Determining of indicators for evaluation of land use efficiency is ambiguous and largely depends on the chosen research purpose and context, as well as the appropriate choice of approach and methods. Thus, it would be necessary to assess and justify the gains from application of the selected indicators, for example, because some parameters are needed to determine the efficiency of use in the extraction of a certain product or when operating in the same economic sector, from each of the managed areas the greatest possible quantity of produce is gained, after selling of the product — in terms of money per area unit. Other indicators would be needed to describe the intensity of land use, according to a specific land use permit corresponding to the functional zoning and its relationship to the land value. Other indicators — for determining of overall land use efficiency of a given area, regardless of land use.

By evaluating the theoretical aspects of the approaches, methods and indicator formation used in the sustainability assessment, the author proposes to use the framework model for land use evaluation presented in the promotional work, determining land use indicator system applied in assessing of the efficiency of land use.

The author concludes that there are no reasonable grounds to believe that the land is being used in accordance with the public interest, if a system for evaluating the efficiency of land use is not implemented.

According to the land use efficiency evaluation model, the purpose of the system of efficiency indicators is to justify decision-making on land use in the best and the most efficient way. This purpose determines application of different land-use efficiency indicators. The system for

assessing the efficiency of land use indicators proposed by the author is illustrated in Figure 2.3 in a hierarchical form, whereas in an expanded form, with the relevant indexes and their measurement units it is included in the Annex of the thesis.

This system is designed according to previously analysed factors influencing the efficiency and identified links between goals. The three-tier system encompasses 3 factors and 3 linkages that are split respectively into 24 measurable characteristics. Indicators, collected over a certain period of time and analyzed on the respective level of land management form the third level of hierarchy and are divided into: indicators of resources or inputs, performance or output indicators, outcome indicators and impact indicators. Outcome indicators reflect comparison of performance indicators over different time periods, as well as comparisons of planned and actual results. Outcome and impact indicators in total reflect qualitative or functional efficiency and focus on qualitative changes in the society and the environment, creating justification to decisions about future land use. Indicators that can be used on different land management levels are included into the system of indicators.

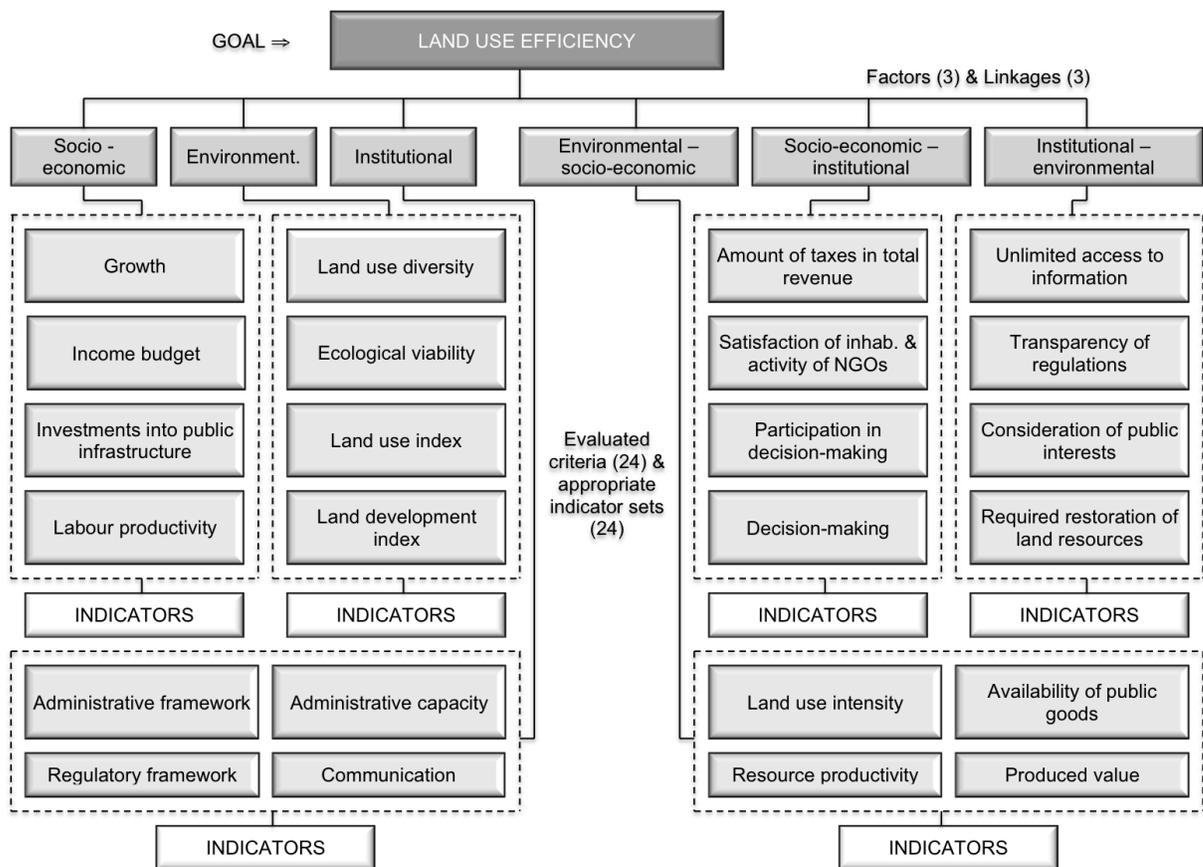


Fig. 2.3. The system of indicators applied in evaluation of land use efficiency in the form of a hierarchy

Depending on the level of the results achieved, it is possible to determine the critical point, reaching which a decision on how to proceed is definitely taken. Outcome indicators to which the critical limit — *thresholds* would be applicable are marked in the table in the Annex to the thesis with a ‘+’.

Outcome indicators applied in land use efficiency assessment are defined to assess whether the previously set objectives have been met, whether they are achieved effectively, as well as to improve land-use management related processes and to inform the public about the contributions and benefits of using land resources. However, in order to create and use a system of efficiency indicators it is necessary to choose an appropriate model, within the scope of which the cause–effect relationships would be analyzed.

By evaluating the theoretical aspects and results of several studies, the author offers a input-output-outcome framework model. The model included into Figure 2.4 forms a framework for land use efficiency assessment on the basis of the researched socio-economic, environmental and institutional situation in the area, identified problems and stated needs for the solution of these problems. By determining land use goals, it is necessary to align them with needs. Socially responsible behaviour is within the competence of land management entity both when setting objectives of land use, resources required for land use, land use procedures and in obtaining and aggregating performance indicators.

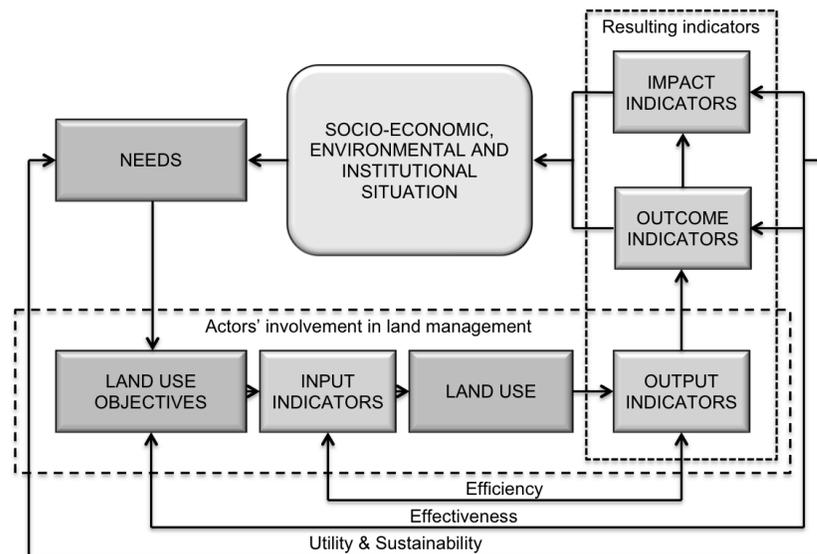


Fig. 2.4. Input-output-outcome framework model of land-use management

Outcome indicators and impact indicators specify the processes in the community and solutions required in order to improve the socio-economic, environmental and institutional situation.

Quantitative or economic efficiency is determined by comparing the investments to benefits, whereas the functional efficiency or effectiveness is determined by comparing the specified land use objectives and the results obtained. To what extent the obtained results allow to meet the needs of the community, indicates the suitability and sustainability of the land-use management systems established on the territory.

The indicator system for evaluating land use efficiency developed by the author is to be applied in land evaluation not only of state and local government, but also private land management entities. In addition, efficiency indicators, together with the opportunities offered by GIS and expert / social assessments of better and more effective options for the use of land resources would provide a more balanced justification for decision-making than the tracking of the created effects and invested resources on the respective territory.

From a practical point of view, the indicators included into the system can be used according to the research context and level, as well as subject to availability of current data. To assess the efficiency of land use for selected indicator groups it is possible to create aggregate indicators (composite indicators), however the system has been envisaged for determining the efficiency of land use in the respective area, taking into account the diversity of land use and different dimensions of efficiency. *Land-use efficiency index* in the respective area may be determined using a linear weighted sum method after calculating the value of efficiency and establishing individual weights for selected indicators.

Consequently, a single index of a relatively simple composition would clearly demonstrate the differences in land use efficacy in different jurisdictions, whereas for resolving of specific tasks related to the evaluation of land use and land monitoring decision taking a broader range of indicators would be used.

2.8. Definition and process model of sustainable land management

By evaluating sustainable development and sustainable land management definitions and guidelines, taking into account not only the land resources such as soil, trees, water, but also the related infrastructure, necessary for effective management, including drainage, driveways, landscaping elements, dams and other structures, the author proposes to define *sustainable land management* as follows:

‘Management system in which land use and the necessary infrastructure form a single generative resource, which is used according to the sustainable development criteria adopted in the

country in order to ensure the constantly changing needs of the people, balancing the use of land resources and preserving their ability to regenerate in the given the area’.

Thus, the concept of sustainable land management includes a systemic approach and it explains that the availability of land resources in a foreseeable period of time is not possible without adequate infrastructure and is envisaged in the state policy planning documents. The balance of the use of land resources can be found in a limited use of the respective resources, by continuously maintaining the natural resource recovery potential.

In the present paper the author proposes a functional model of sustainable land management process. The content and the principles of this process to be implemented are determined by the state policy for sustainable land use and its execution by local governments. A continuous *updating mechanism for the system*, which provides the necessary sensitivity and flexibility in respect to internal and external change in the economic, social and environmental aspects of land use is embedded into the sustainable land management process.

3. Methodological solutions for evaluation of land use efficiency

3.1. Experience of land use evaluation abroad and in Latvia

Land use evaluation experience indicates sectoral approach, which focuses on research within specific projects mainly in rural areas. The evaluation experience in rural areas is to be associated with land consolidation project solutions, providing real estate development processes and engineering infrastructure improvements. By contrast, in the urbanised environment the urban and spatial structure analysis is carried out mainly by promoting compact and multifunctional urban structure formation as well as the spatial and architectonic perception of the construction. In many locations the evaluation is carried out by using GIS technologies, multi-criteria analysis and solving optimization tasks.

It is concluded that in the scientific literature more attention is paid to land-use evaluation and optimization, as well as conflict resolution, using a variety of techniques, including GIS, land consolidation, land use potential evaluation, scenario analysis, the decision support etc.

Land use evaluation experience summary and research suggests that specifically in terms of efficiency the land use process is not comprehensively evaluated and evaluation experience is relatively small. In most cases, the evaluation is focused on development projects and related to application of socio-economic indicators in cost-benefit analysis. Current foreign land-use assessment experience reflects systemic approach, primarily through the input-output and cost-

benefit analysis methods. Thus, the obtained effects and the socio-economic nature of resources used to obtain them are indicated. The system is built and the evaluation takes place where it is topical.

3.2. The analytical assessment of indicators characterizing land use efficiency and application in decision-making at different levels of land management

The indicator system has been created by aggregating and evaluating varied land-use assessment experience, as well as expert survey data and discussing the opportunities of use of the respective indicators in target groups. The indicators included into the system allow explaining the processes of land use from the point of view of efficiency in the widest possible form. However, it has been researched that the indicators in the estimates are used in accordance with the purpose and context of the relevant study, observing the different functional goals of land management entities and the need to support the decisions on the respective land management level. The application of the indicator system makes it possible to evaluate the regularities that determine and affect land-use, to support the decisions for the best possible and more efficient land use, as well as provide prospective development directions and the required resources in the respective area.

The indicator system has been established in a 3-stage hierarchy centered on the *assessed criteria*. The assessed criteria characterise the impact of factors affecting the efficiency of land use on the interaction of land use objectives. Thus, the factors included into the system and linkages of the objectives explain the determining of the criteria to be assessed and their possible grouping, when forming aggregate indicators, including a comprehensive land-use efficiency index for the respective level of land management. This points to the flexibility of the system, because it is possible to choose and use in calculations the most appropriate groups of indicators to be researched, which according to the experts would be significant on the implementation stage of the indicator system, selecting the indicators according to their importance and availability of topical values.

Since the data included into the system of indicators are envisaged for application in land use efficiency assessment on different levels of land management (LML), in the work with specific designations, the explanations for which are provided before the indicator system table, it is stated to which level the indicators correspond.

The application of the indicators characterizing the land use efficiency in decision-making on different LMLs is explained by different goals of LMLs, the resource parameters set for their implementation, the functions and actions to be performed, as well as the obtained results. Thus,

impact indicators have to be identified and measured, which, together with the outcome indicators are focused on the evaluation of the quality land use efficiency evaluation — impact and resource level alterations (Δ) or setting of the marginal values.

The indicator system table encompasses the critical limit or *threshold* of the indicators used in the respective LML, the achievement of which, as reflected by the indicator value obtained, causes the need to take a decision on further actions and the obtaining of the indicator value on the necessary array. The determining of the critical limit must be based on land-use planning and development programs that have to be addressed the interaction of LML.

The offered indicator system indexes include both effects and resources as well as their alterations, by comparing output indicators at different points in time. The actual values of the indicators obtained at specified reporting dates — p_1, p_2, \dots, p_n can be assessed within the relevant measurable characteristics (P_n). Efficiency alterations (ΔE) depend on the dynamics of the actual values of the indicators by comparing their values at different time reference dates (t).

With the aim of comparing land use efficiency an aggregate pointer or index characterising efficiency is created, which depends on the linearly weighted total of the indicators after determining of indicator values and individual weights.

To display the development of various dimension of land use efficiency in a more obvious way, it is necessary to group measurable criteria. The alterations of each evaluated criteria (P_n) over a given time period are to be identified by comparing the alterations of different respective indicator values obtained at different reference dates. When preparing the efficiency index (EI), it is necessary to formulate the respective function, for which the index tends to peak.

When determining a single land-use efficiency index of the respective LML, it is possible to characterize the spatial differences and to justify the strategic land use decisions in a relatively simple and clear way. In order to identify the reasons for territorial differences from the point of view of efficiency of land use, to assess the development of the different dimensions of efficiency and to substantiate land monitoring and land use management decisions, group indexes of the measurable criteria are prepared.

3.3. Practical application of the methods used for evaluation of land use efficiency in land management

The national or state land management level is considered to be the setter of land policy framework, the provider of economic sectoral policy and the setter of strategic framework and guidelines for land management. In contrast, on the land user level land is used in accordance with a

specific legislative procedure, by maximizing the various benefits as effectively as possible. Thus, municipal land management level has to be considered central for sustainable land use and protection in the public interest.

The aim of organising *expert surveys* is to obtain an expert, Latvian municipal land-use planning (spatial planning) specialist assessment on the efficiency of the land use on the territory of the local governments in the Republic of Latvia. The general aggregate — the number of respondents is 119, the response factor is 71%.

The absolute majority (95%) of municipal staff responses indicate that information concerning changes to the functional zoning in the area is obtained occasionally from the applications of residents and entrepreneurs. In a relatively small number of local governments (12%) a common format has been developed and is used to gather public opinion about the desired development and changes in the functional area zoning. A clear majority of municipal staff (94%) have pointed out that methods are needed in order to determine land use efficiency.

The response of the experts confirms that in the majority of municipalities (67%) up to the present time a system of indicators envisaged for the monitoring of territory development has not been developed, even though such a system would be required. In the half (50%) of the municipalities (31%), where such a system has been developed and is being used, the developed system of indicators does not help to clarify how efficiently the land resources are being used on the territory of the local government.

By evaluating the system of indicators used for assessing the efficiency of land use, the percentage of expert *preferences in relation to indicator groups* according to their importance are: the economic indicators (32%), environmental quality indicators (19%), social indicators (16%), environmental performance (ecological) indicators (13%), statutory regulation indicators (1%) and administrative management indicators (9%). When creating the system of indicators applied for land use efficiency evaluation, expert *preferences in relation to integrated indicator groups* in percentage according to their importance are: socio-economic indicators (47%), environmental and ecological indicators (33%) and institutional indicators (20%). Expert assessment of the socio-economic and environmental and ecological indicators is not affected by the dominance of land resources in the respective municipal area, observing the distribution of the functional zoning of the territory. The analysis of expert opinions in respect to the need and possibilities to assess land use efficiency, substantiating the decision making for better and more efficient land use, indicates the need for systemic assessment, by effectively justifying it, however at the same time evaluating the

opportunities critically and pragmatically, having general knowledge of the spatial development situation in the area.

The results of the expert opinion analysis indicate the use of original method of analysis using two features — the necessity and the feasibility. The results of expert survey demonstrate the need for local governments to develop and implement a common approach to obtaining, collection and evaluation of information on the situation in respect to the alterations, necessary in the functional zoning of the area, as well as to develop and implement a common methodology for evaluating the efficiency of land use at the municipal level.

The competence of the experts, i.e. experience and education, allows to evaluate the versatility and complexity of activities in spatial planning and land use management. The results of the study indicate the need for training seminars or special courses for local government specialists on evaluation of land use efficiency, data maintenance and collection, information processing, and the analysis and administration of dynamic data series.

By evaluating the procedure and results of expert survey, significant issues to be clarified in the future by organizing studies of qualitative character, thus specific expert interviews in working groups should be carried out. For example, by evaluating the efficiency of land use on the territory of a specific local government, the working group shall determine the available and applicable indicators and their relative importance (weights), as well as assess and clarify land use efficiency evaluation model.

The practical benefits of the study can be considered land-use efficiency evaluation on the level of local governments, creation of indicators used in the assessment system, the breakdown rate of the indicators, which has to be taken into account in determining the relative importance weights of the indicators, as well as establishing of a system for information gathering and monitoring of spatial development planning and plan implementation in order to support decision-making process for land use in the best possible and most efficient way.

As a result of the research carried out, including empirical research in Salaspils local government, it is proposed to subdivide the *land-use efficiency evaluation process* into four steps: the preparatory work, the evaluation, the assessment of the results, and the decision-making. Each step in the process involves a sequence of actions (procedures) and has to be related to the involvement of experts and operational decision-making.

The preparatory work encompasses a feasibility study of the evaluation process. At the evaluation step the major evaluation procedures of land-use efficiency are performed by carrying out quantitative efficiency calculations, whereas during the result assessment step the qualitative

assessment of land use efficiency has been envisaged by comparing and validating of the obtained results and alterations of the indicators characterizing them. The decision-making step characterises *the response* to the necessary adjustments and improvements in order to facilitate better and more efficient use of land, as well as to provide a summary report.

The system of indicators (see Fig. 2.3) applied in evaluating the efficiency of land use encompasses 24 evaluative criteria, however this number is too large to determine a single aggregate indicator. Several studies point to the fact that experts are able to compare rates and determine their relative priorities without losing the importance, if the number of indicators does not exceed 10. Thus, for evaluation with the *AHP* method it is proposed to create a 3-tier hierarchy with 6 first-level elements (3 factors and 3 linkages), with 4 second-level elements in each of the first-level elements (a total of 24 evaluative criteria) and a corresponding group of indicators for each second-level element on the third level. According to the established hierarchy and the LML pairs comparison matrices are created, and the relative importance is determined for the indicators, used in the evaluation.

Using the results of the expert assessment carried out within the scope of the study and evaluating the first level hierarchy aggregates in the matrix A (X_1) their relative importance is calculated: the socio-economic (X_1) $\alpha_1 = 0.235$; environmental (X_2) $\alpha_2 = 0.165$; institutional (X_3) $\alpha_3 = 0.10$; environmental-socio-economic (X_4) $\alpha_4 = 0.20$; socio-economic-institutional (X_5) $\alpha_5 = 0.1675$; institutional-environmental (X_6) $\alpha_6 = 0.1325$. However, by using the mentioned methods and by calculating the relative importance of indicators for the whole hierarchical system at the same time, these values have to be updated.

The standardized indicators are calculated from the initial indicators with different units of measurement, which disappear as a result of standardization, and the different indicators become comparable with each other. Thus, the simple and frequently used linear standardization correlations are to be used. When evaluating the land use efficiency it would be desirable to apply the minimum-maximum values for the standardization intervals (-1; 1) or (0; 1). When choosing the interval (0; 1), negative parameter values are theoretically possible as well.

By using the linear weighted sum method after calculating of the efficiency values and determining the individual weights of the selected indicators, the aggregated efficiency indicators (indexes) in the respective LML are defined. Thus, the *land-use efficiency index* is expressed by the equation:

$$E = F_1 \times \alpha_1 + F_2 \times \alpha_2 + \dots + F_n \times \alpha_n = \sum_{i=1}^n F_i \times \alpha_i, \quad (3.1)$$

where

E — land-use efficiency index;

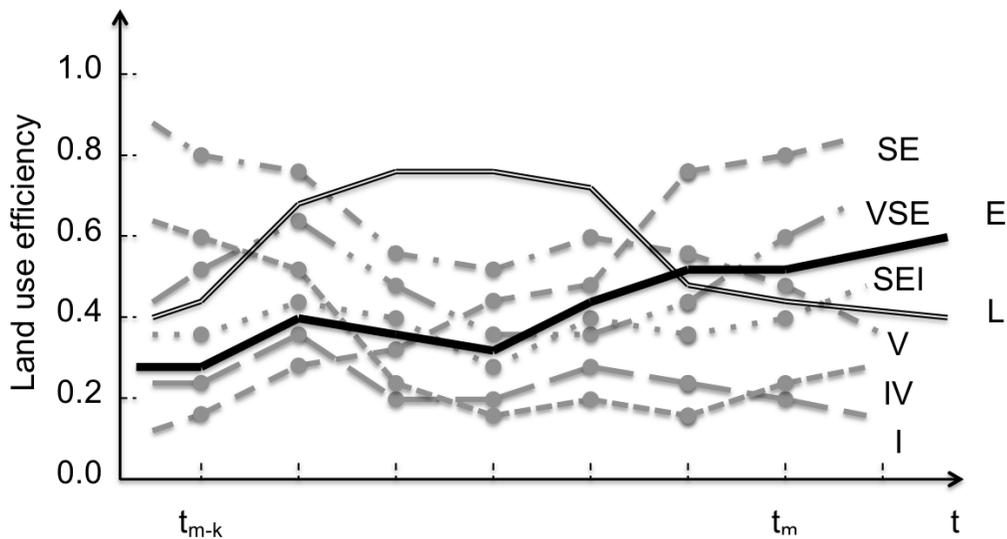
F_i — value of the indicator characterising efficiency;

α_i — relative importance of the indicator characterising efficiency.

In evaluating the efficiency of land use and determining the value of its index, also the determination of mutual consistency of components (agregated indicators) constituting the index is essential. *Consistency Index* describes how harmonious is the development of the sub-systems characterising the efficiency in the land-use process at the relevant period of time.

The closer are the values of the consistency level for the obtained aggregated indicators (indexes) in each subsystem (6 first level elements of the hierarchy, see. Fig. 2.3), the more the land-use process is to be considered harmonious. The consistency level (L) is in the range of (0; 1).

The resulting aggregate indicator (index) standardized values are summarized in a table and represented graphically (see Fig. 3.1). According to these values and certain characteristics – for the obtained value intervals on the scale (0; 1) *development level* of each *indicator* can be assessed, such as low, medium, high. It is possible to establish a more detailed level depending on fluctuations in the development of the respective indicators over time.



Abbreviations used in the figure: SE — socio-economic, V — environmental, I — institutional, VSE — environmental-socio-economic, SEI — socio-economic-institutional, IV — institutional-environmental, L — consistency level, E — land-use efficiency index

Fig. 3.1. Schematic model of the development of land use efficiency

Identification and analysis of the level of development for the aggregate indicators allows to identify, which of these indicators influencing the respective level, promotes alterations in efficiency

and to what extent it impacts either increase or decrease of land use efficiency, which in total affects land-use efficiency index alterations in the respective period of time (*t*).

Such an approach to evaluating the efficiency of land use makes it possible not only to identify the necessary changes in the land use planning process and support decisions for better and more efficient land use, but also to analyse both indicators used and obtained in the evaluation, as well as to analyse the sensitivity of their relative weights. Such a sensitivity analysis would allow experimentally find out how sensitive are the aggregates created on each level of the hierarchy to the changes in value of relative importance of each indicator.

Describing the evaluation process of land use efficiency in general, it can be argued that it is largely based on subjective evaluations, which in turn depend on the experts' competence and responsibility in land use management. However, in the contemporary democratic society and decentralized spatial planning system such as in Latvia, it is deemed appropriate for such a system and promoting development, contributing to the growth of the experts themselves and responsibility for the identification of qualitative changes in society and the environment as a result of land use.

In assessing the current situation in the implementation of land use efficiency evaluation process in Latvia, the reasons are identified, why the evaluation and specific calculations do not provide an objective assessment of the situation and at the same time specified the *conditions* to be implemented.

Doing research on land use influence on the national economy, the author has analysed the 'tax' functions, and identified the primary property tax revenue function in relation to land use — *land-use planning fiscal measure*.

The author has developed and proposes to use ***a set of fiscal land-use planning algorithms***. The algorithms are to be used for software module development. The module solutions envisage GIS implementation, using the State Real Estate Cadastre IS textual and graphical data set and tax administration system interaction, thus creating the necessary data rows and graphical data visualization.

The algorithms have been developed and included into the thesis, administering the methodological framework of land-use efficiency assessment in order to support land administration and decision-making processes and to promote better and more efficient land use.

The *purpose* for use the set of algorithms is related to the development of land administration and decision-making tool, a software module in order to support *the impact of alterations* in the objectives of the real estate use (OREU) and their basic values on the cadastral value of real estate objects, the amount of the property tax (PT) and the amount of local government budget revenues.

In order for the developed set of algorithms to be implemented in practice and the developed software module to be piloted, several problems have to be solved. The main problems are: lack of sufficient historical data time series for the context of the analysis, disarray of the cadastral survey map data, municipal GIS structure differences and different approaches to data administration. Thus, the mentioned problems in local governments should be resolved, as well as the software developed and tested within a specific project.

Maintaining current information on land use results in local governments and implementation of fiscal algorithm sets would allow continuously analysing the development trends in the area and contributing *to the development of planned areas* through tax revenues as an important fiscal tool. For example, analysis of *the impact* of the amount of tax rebates and tax rate value application on the tax revenue by OREU groups and for different territories. Textual and spatial information structured according to context of the analysis *would constitute the substantiation* for municipal spatial development (comprehensive) planning, local (neighbourhoods) planning, thematic planning and detailed planning.

3.4. Systematisation of the terminology used in land management

As a result of discussions and a number of scientific publications, the author has organised terms used in land-use management, which have been collected, analyzed and included in the dictionary and textbook issued by the RTU Publishing House, as well as for a wide range of users in digital form available on a website. In the mentioned sources of information the interpretation of the major land use terms and concepts, used in land management is available. The terms, used in land management have been arranged, examining the operation and experience of land management systems of different countries, as well as discussing the definitions of the respective concepts and applications at international seminars and conferences. Content analysis of terms and their meanings and inclusion into dictionaries in Latvian has been discussed in working groups, inviting competent researchers and industry specialists. In the relevant sections of the doctoral thesis, according to the context of the analysis, explanations and equivalents in English have been provided for the major terms and concepts, which comply with recognized and generally accepted use in the land management sector.

However, in the course of the study it has been concluded that land management processes evolve, open discussions are held and over time a need emerges to carry out appropriate terminology additions or corrections, which would contribute to the practical implementation of the methodology

established in the doctoral thesis when assessing land use efficiency on different land management levels.

CONCLUSIONS AND SUGGESTIONS

Within the course of the completion of the doctoral thesis the theoretical and practical aspects of land-use have been examined, as well as methodology for evaluation of land use efficiency and a system of indicators to be used in decision-making at different levels of land management have been proposed and contribute to land use in the best and the most efficient way. The theoretical insights and empirical results included into the thesis assert that the goal of the study has been achieved, and the hypothesis has been proven. According to the hypothesis proposed in the study, the stated goal and the problems solved, the author has summarized the results of the research carried out and defines the following key conclusions and resulting recommendations:

1. By researching and analysing the practical aspects of land management and evaluating the concept of land management, it is concluded that within the framework of land management the land-use problem issues have to be researched and the efficiency of land use has to be evaluated with the purpose of its improvement.
2. The need and opportunities for development of land management terminology are explained by forming of shared understanding of sectoral processes, relevant context, the established traditions and experience. Constant research of terminology resources makes it possible to identify both formal and informal processes of terminology development. Research of the ontology of concepts leads to the conclusion, that the use of concepts in different countries varies insignificantly and a steady consistency may be observed between them, while the terms used are different, more precisely they have a different meaning.
3. Based on the analytical assessment of land management systems of different countries, the author concludes that the historical trends of the land management system in Latvia indicate its more expressed compliance with the Scandinavian model and the system should be designed in the future by integrating into the cooperation model of Baltic Sea Region. At the end of the relatively long period of land reform — more than 20 years, a single Land Management Law is needed in Latvia, which would provide opportunity to modernize the outdated provisions of the Civil Law related to rights *in rem* and to include provisions of land reform that were previously included into a number of laws and which will be topical in the future into a single act of legislation. This law should stipulate at least the land use

assessment methodology for the land in the ownership or possession of public sector, which so far has not been developed systemically in Latvia.

4. When evaluating the land management process, a variety of activities related to land use and land protection, the functional goals of the state and local authorities, business and household relations in land use, as well as the regulatory framework for land use and protection, different levels of land management are substantiated. Depending on the objectives of each level and functions performed three levels have been singled out in land management, namely, the national, municipal and land users level.
5. The author of the study concludes that performance assessment of land use efficiency in relation to the interaction of land management levels allows to identify the actual land use and compare it to the potential one, to implement corrections to a variety of processes with the aim to increase efficiency, which in turn would promote economically viable, socially responsible and environmentally sound decision-making. Therefore overall in the country as a result of efficient use of land resources added value is enhanced and welfare of its inhabitants is increased.
6. The analysis of the activities of land management institutions and related problem issues provides an idea of the functions, objectives and responsibilities in land management of the public authorities as well as the characteristics of laws and regulations in the field of land law. There is a reason to believe that this kind of analysis of institutional environment provides a justification for the need of constant institutional arrangements, as a result of which the established land management objectives are to be reached and efficient land use is to be provided.
7. Simultaneous influence and variability of the socio-economic, environmental and institutional factors affecting land-use results indicates the importance of the concept of efficiency in the research of land management sector, by taking into account the potential objectives and results of land use, the resources needed to achieve them, in order to support and implement the best and most efficient land use.
8. Land management can be seen as an area for the implementation of the concept of sustainable development. Thus, determining of a system of criteria and indicators necessary for uniform evaluation of land use efficiency would create the necessary conditions for sustainable use of land resources, balancing at the same time both spatial development and protection of natural resources and their ability to regenerate.

9. The evaluation methodology of land use efficiency is concerned with systemically created set of applicable evaluation techniques, and includes the conditions, integrated methods, models, classifications, system of indicators and sequential evaluation procedures. In the essence mathematical, expert assessment and social survey methods have to be integrated into the evaluation of the land use efficiency, which allows for the application of specific and weighted efficiency indicators in calculations.
10. The evaluation methodology of land use efficiency is developed, and the efficiency indicator system is established to justify the best and most efficient land use through ensuring land-use planning and implementation of the plans in the respective territory. There is no reason to believe that the land is being used in accordance with the public interest, if a system is not implemented within an established methodological framework for evaluating the efficiency of land use.
11. At the basis of determining the efficiency of land use are the comparisons of inputs and outputs of land use as a versatile resource, its evaluation, analysis and synthesis.
12. In evaluating land use efficiency primarily mathematical methods and expert assessments are to be used. The researched mathematical methods allow concluding that in different variations depending on the purpose and scope of the study it is possible to use them for assessing of land use efficiency in order to support better and more efficient land use. The opinion of the local community (residents) should be researched periodically by introducing of a sociological opinion polling system in relation to issues of more efficient land use.
13. By researching the methods, applied for evaluation of land use efficiency, it is concluded that on different levels of land management different evaluation methods should not be distinguished. Thus, the choice of method is more attributable to the aim and resolving of the respective problems than to land management level.
14. Determining of indicators for evaluation of land use efficiency is ambiguous and largely depends on the chosen research purpose and context, as well as the appropriate choice of approach and methods. Thus, it would be necessary to assess and justify the gains from application of the selected indicators.
15. By exploring of the theoretical aspects of efficiency in relation to land use and evaluating its socio-economic and ecological content, the definition of the efficiency of land use is offered.
16. Based on the research carried out, the definition of sustainable land management system is offered. Thus, the concept of sustainable land management includes a systemic approach and it is explained that the availability of land resources in a foreseeable period of time is not

possible without adequate infrastructure and is envisaged in the national policy planning documents. The balance of the use of land resources is to be found in a limited use of the respective resources, by continuously maintaining the natural resource recovery potential.

17. By evaluating the theoretical aspects of the approaches, methods and indicator formation used in the sustainability assessments, it is proposed to use the framework model for land use evaluation, designing the indicator system applied in assessing of the efficiency of land use. Input-output-outcome framework model of land-use management has been created in order to develop and apply the indicator system in accordance with the goals of different land management levels.
18. As a result of the study a system of indicators, applied in evaluating of land use efficiency, which is designed according to previously analysed factors influencing efficiency and linkages between objectives is offered. The system includes three factors and three linkages, which are respectively divided into 24 measurable criteria. Indicators, gathered over a certain period of time and analyzed on the respective level of land management are divided into: input (resources) indicators, output (effects) indicators, outcome indicators and impact indicators.
19. The study outcomes suggest that evaluation issues of land use efficiency are particularly relevant at the municipal land management level. The analysis of the local expert assessments on the needs and possibilities to assess the efficiency of land use in support of decision-making for better and more efficient land use indicates the necessity for systemic evaluation by constructive argumentation.
20. The results of performed expert survey demonstrate the need for local governments to develop and implement a common approach to obtaining, collecting and assessing of information on the situation in respect to the alterations, necessary in the functional zoning of the area, as well as to develop and implement a unified methodology for evaluating the efficiency of land use at the municipal level. The results of the performed analysis of expert opinions indicate the application of an original method of analysis, using two criteria – necessity and probability.
21. The results of the research included into the thesis substantiate the need for organisation of the evaluation process of land use efficiency and analysis of the obtained results to support a decision-making within developed methodological framework. The results of the evaluation are focused on opportunities to improve land use and increase its efficiency as well as on possible adjustments to the evaluation process.

22. The set of fiscal algorithms for land-use planning is being offered through the methodological framework for evaluation of land use efficiency, in order to support land administration and decision-making at the municipal land management level and to promote better and more efficient land use.
23. The author assesses the present situation in the evaluation of land use efficiency in Latvia applying common methodological approach as the beginning of the development stage for the mentioned process. For the organization of systematic evaluation process at all levels of land management establishing of competent expert groups and constructive its action have a decisive role.

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Summary of the doctoral thesis

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